Research report

Road Drainage and Flood Risk

Prepared for

SCOTS & Transport Scotland

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Document history

Road Drainage and Flood Risk

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Executive Summary

This research project has investigated the potential conflicts between road drainage legislation and flood risk management legislation in Scotland. It has:

- reviewed the existing legislation and guidance relating to the interfaces between road drainage and flood risk;
- identified apparent gaps and conflicts, both actual and perceived, and split these into regulatory or behavioural and organisational issues;
- identified whether and to what extent these are causing problems in practice;
- recommended measures on next steps to bring the two elements into closer alignment.

Analysis of the existing legislation and guidance, and analysis of feedback from stakeholders has concluded that:

- There is a significant perceived, and potential actual, conflict between the asset owner's responsibility to keep roads free of water, and the opportunity to use roads for exceedance flow management;
- New roads should not present any conflict with flood risk management, assuming that practice is in line with current legislation and guidance;
- Differing levels of flood risk management protection are likely to occur in existing urban areas. Local Authorities have a responsibility for managing surface water risks, and improving in these areas through the surface water management plans required under FRM(S)A;
- The standards driven approach to maintenance and repair of roads may limit the realisation of opportunities to retrofit SUDS in the most cost beneficial way;
- There is currently no clear legislative route by which to proactively manage the cumulative impacts of climate change and urban creep;
- The risk of disconnect between the road drainage detail and masterplanning and considering drainage late within the planning process could significantly limit the contribution of road drainage to sustainable surface water management;
- Although good practice guidance promotes early and continued engagement between road designers and the planning process (including flood risk management), road drainage is not required to be considered until the latter stages of design. This may result in missed opportunities to achieve cost efficiencies (and more sustainable solutions and multiple benefits) by combining road drainage with SUDS for wider development;
- Adoption and maintenance of SUDS remains in many cases a barrier to their successful implementation. This is despite significant efforts to close off this issue in terms of policy and guidance;
- With limited space, complex issues, multiple stakeholders, concerns regarding SUDS adoption, and constrained resources, retrofitting SUDS to help manage exceedance flows has significant potential for conflict;

Based on the analysis of the existing legislation and guidance, engagement with stakeholders, and scenario analysis, the project has recommended a range of situation specific measures in the following categories:

- Dissemination and training;
- Research and pilot projects;

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- Improved communication and collaboration;
- Alignment of consent processes e.g. planning consent, building warrant, RCC and Scottish water consent for shared SUDS schemes;
- New / updated guidance and tools;
- Regulatory measures.

The key recommendations are that:

- The Roads (Scotland) Act be designated as a flood risk related function under FRM(S)A;
- Roads and flood risk management authorities request a review of section 99 of the Roads (Scotland) Act;
- Overarching drainage and flood risk policy guidance is produced to bring together the various existing policy and guidance requirements;
- Better data is captured from ongoing and new SUDS and road drainage projects to provide an evidence base for future projects;
- Strategic opportunity mapping of road schemes against flood risk areas is undertaken to develop flood risk maps for roads, and identify and prioritise action vs. flood risk hotspots.

These key measures need to be supported by a number of other measures including training, guidance, decision support frameworks, and continued improvements in partnership working between stakeholders.

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Contents

1 Introduction

1.1 Background

Water in and beneath a road has a major impact on a conventional road's performance and lifespan, causing deterioration which can have serious consequences for the safety and comfort of road users. Sections 30, 31 and 32 of the Roads (Scotland) Act 1984 provide roads authorities with certain powers to install drainage, erect and maintain barriers and drain surface water "for the purpose of draining the public road or proposed public road or of otherwise preventing surface water from flowing onto it." Roads are a significant contributor to surface runoff in urban areas, forming around 50% of the impermeable area and contributing a significant proportion of the flow in the drainage network during storm conditions. The way in which road runoff is dealt with can therefore have a significant impact on flood risk within urban areas. Roads themselves often provide conduits for water through the urban environment, so flood risk management practitioners may seek to take advantage of this by using the road network to store and route flows when designed drainage systems are exceeded.

The Flood Risk Management (Scotland) Act 2009 placed new responsibilities on local authorities in relation to flood risk management. It established a framework for coordination and cooperation between all stakeholders to achieve more sustainable, multi-functional flood risk management outcomes and the intention of this Act is clearly to encourage better aligned and more effective management of flood risk from all sources. There is concern amongst local authorities, however, that this is not happening in practice; and that a lack of alignment (and communication) between the road design and flood risk management functions within their organisations is leading to conflicting priorities which could hamper their ability to deliver best value solutions.

Local authorities therefore play a key role on both "sides" of the issue; as both roads authorities and responsible authorities for flood risk management, therefore any misalignment has the potential to lead to a conflict of interests.

1.2 Approach

This research project was commissioned by the Scottish Road Research Board to investigate perceived differences in standards and objectives between road drainage legislation and flood risk management legislation, as identified by the Society of Chief Officers of Transportation in Scotland (SCOTS) and help Scotland achieve better aligned and more effective management of the interfaces between flood risk management and road drainage, by either:

- Identifying and providing recommendations to resolve ***actual*** areas of conflict
- Understanding and providing steps to address ***perceived*** areas of conflict

A staged approach was taken as follows:

1. Undertake a targeted review of the relevant legislation, policy and guidance relating to both flood risk and road drainage, to consider interfaces between the two areas of practice, identify potential areas of conflict (and of opportunity), and assess the likely consequences of these with respect to Local Authorities' twin goals of a safe road network and effectively managed flood risk.
2. Engage with key stakeholders to discuss the findings of the first stage, confirm understanding of the existing theoretical situation, and find out what happens in practice
3. Assess whether and to what extent any potential conflicts identified are realised, what the consequences are and how these issues are currently addressed (if at all)
4. Recommend measures to improve alignment between road drainage and flood risk management

1.3 Structure of this report

Section 2 of this report provides an initial comparison of road drainage and flood risk management looking at the primary objectives of each to identify common priorities and potential areas of conflict. It then identifies the main points of interaction between the two fields of practice. This information is used to narrow down the field of research to focus on the key areas where there is interaction and potential for conflict.

Section 3 provides a high level summary of the current legislation and guidance which provide the current framework for road drainage and flood risk management, focusing specifically on what they mean for the key areas identified in Section 2. A more general overview of existing legislation and guidance is provided in Appendix A.

Section 4 uses hypothetical scenarios to bring to life the key areas of interaction and potential conflict identified in section 2, to analyse what the legislation and guidance means in practical terms.

Section 5 draws out the findings from the two strands of the research; the examination of existing legislation and guidance and the consideration of hypothetical scenarios; summarises the challenges identified, and provides recommendations for measures to help overcome these challenges and improve the alignment between road drainage and flood risk management in Scotland.

2 Initial comparison

2.1 Comparison of objectives

This section looks at the objectives of flood risk management and road drainage to identify similarities and differences. An initial mindmapping exercise was undertaken to identify the priorities of each. The outputs are presented in the figures below.

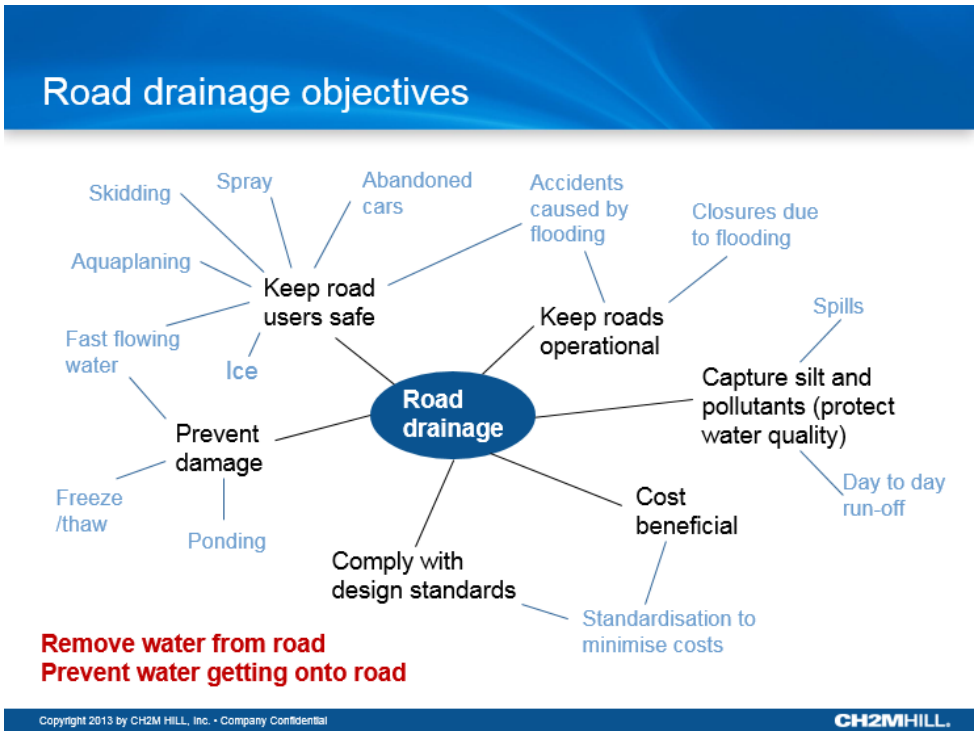


Figure 2-1: Road drainage objectives

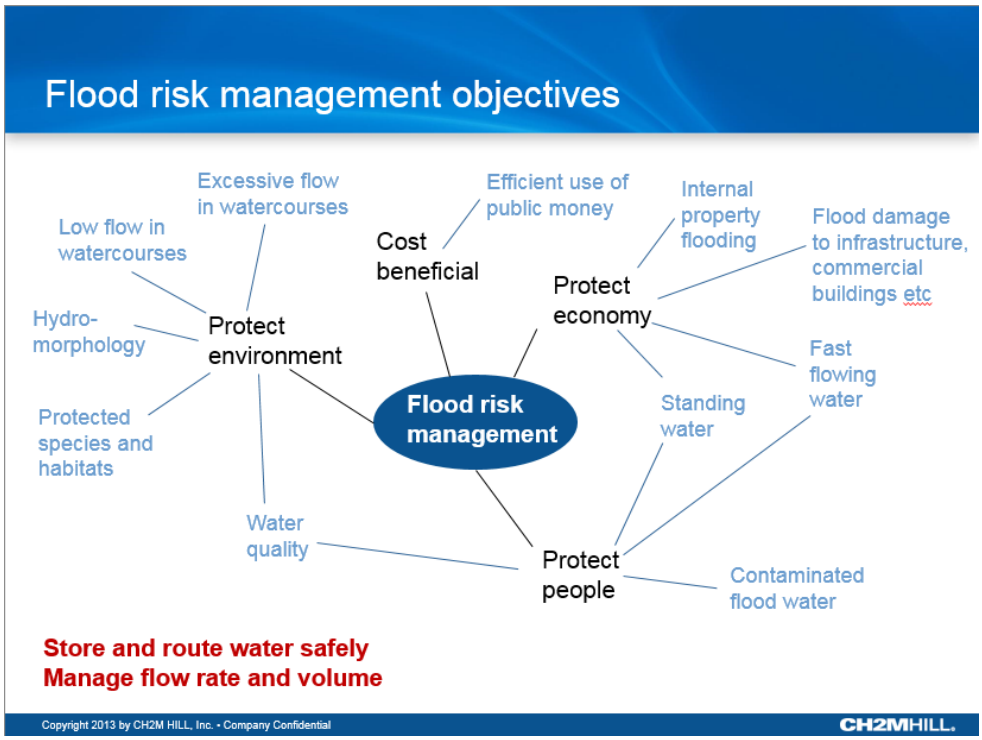


Figure 2-2: Flood risk management objectives

Several common themes emerged from this initial abstract analysis:

- Both flood risk management and road drainage seek to protect the economy, through avoiding damage to assets and maintaining business as usual. This could lead to conflict, but if approached from a "UK plc" perspective it could foster increased co-operation (see next point).
- Both disciplines are funded through public spending, so minimising spend and ensuring value for money are important across both. This common driver could be key to encouraging co-operation, since in many circumstances shared solutions can offer better overall cost benefit than individual ones.
- Protecting the public is key to both, although it relates to different groups (residents vs road users).
- Protecting water quality is a common requirement, although flood risk management has a broader remit in terms of protecting the water environment as a whole. Water quality is a significant driver for SUDS, which could help to normalise their use and pave the way to using them more commonly for flow management.

There are also some potentially conflicting objectives. Flood risk management focuses on protecting people, properties and the environment. This is done by reducing the likelihood and consequences of flooding for people and properties and preventing increases in flood risk, through attenuating flows as close to source as possible, routing them safely and controlling the rate and volume of discharges. The primary purpose of road drainage is to maintain the safety and serviceability of roads for their users, which typically means evacuating water from the carriageway and sub-base as quickly as possible and preventing water from getting onto the carriageway from elsewhere. Whilst it doesn't necessarily follow that this will lead to flood risk elsewhere, prompt evacuation of flows from carriageways is not ideally aligned with the important sustainable flood risk management principle of attenuating of flows at/close to source.

Another key difference between the two areas is the scale at which they consider water management. Flood risk management takes a strategic view whereas road drainage design is just one constituent of the equivalent strategic view in terms of managing the road network. With this in mind the wider field of road planning and design has been considered as part of this research to allow a more balanced exploration of the issues.

2.2 Areas of interaction

There are four main areas where road drainage and flood risk management impact on one another. These are:

- **The impact of road drainage on flood risk** – this relates to how road drainage affects flood risk in surrounding areas through the ways in which it handles 'normal' rainfall events: i.e. how it is designed to capture and route flows under normal operation, and whether it is required to consider and/or contribute to the wider aims of flood risk management.
- **What happens to road runoff which is not captured by the road drainage system (exceedance)** – the issues here are around how (or whether) exceedance flows are managed within road drainage design, and the way this impacts flood risk.
- **The impact of flood risk on roads** – how road design and operation is affected by flood risk.
- **Using roads to help manage flood risk** – this relates to the potential for using roads for the temporary storage and routing of flows during flood events.

We have used these areas of interaction to help focus the literature review and define the hypothetical scenarios used to analyse existing practice.

3 Regulatory framework

3.1 Introduction

There is an extensive body of literature on the subject of policy and process relating to both flood risk management and road drainage (the latter notably thanks to SCOTS and the SUDS Working Party in the form of SUDS for Roads). Chapter 4 of SUDS for Roads provides an excellent summary of the legislation and statutory obligations surrounding SUDS and roads (for all of the UK) as background for its guidance on adoption procedure for SUDS within roads. Section 1.2 of the same document provides a useful overview of the historical context of road drainage design. "Sustainable Flood Risk Management: A Glasgow Case Study - from paralysis to praxis?" (Adrian Cashman, University of Sheffield (RPA 7 – Stakeholder and Policy), June 2007) provides a valuable body of background information which has been key to the consideration of existing urban areas undertaken in Section 4 of this document.

Given the breadth of the existing information, the literature review undertaken for this research project is selective, focusing on legislation and guidance with specific relevance to the core question and utilising the existing body of research for additional reference. We have concentrated on identifying those parts of existing flood risk legislation and guidance which have implications for road drainage, and vice versa.

We have also considered the tier one literature for examples of international practice which could provide lessons for Scotland in this area. CIRIA C713, CIRIA 738 and UKWIR Report 14/SW/01/8 (Framework for Developing a Stormwater Management Business Case) contain the most readily accessible examples that provide relevant information, although these are not specific to the interrelation between road drainage and flood risk management.

This section highlights the key drivers for particular standards, approaches and behaviours which impact on the relationship between road drainage and flood risk. A more detailed overview of the relevant legislation, policy and guidance is provided in Appendix A. Figure 3-1 and 3.2 are based on the initial objectives analysis in section 2.1. They highlight the main legislation (highlighted in red bold text) and guidance relating to the objectives and key areas of interaction identified in section 2.

A summary table and more detailed overview of the legislation and guidance relevant to road drainage and flood risk management are provided in Appendix A.

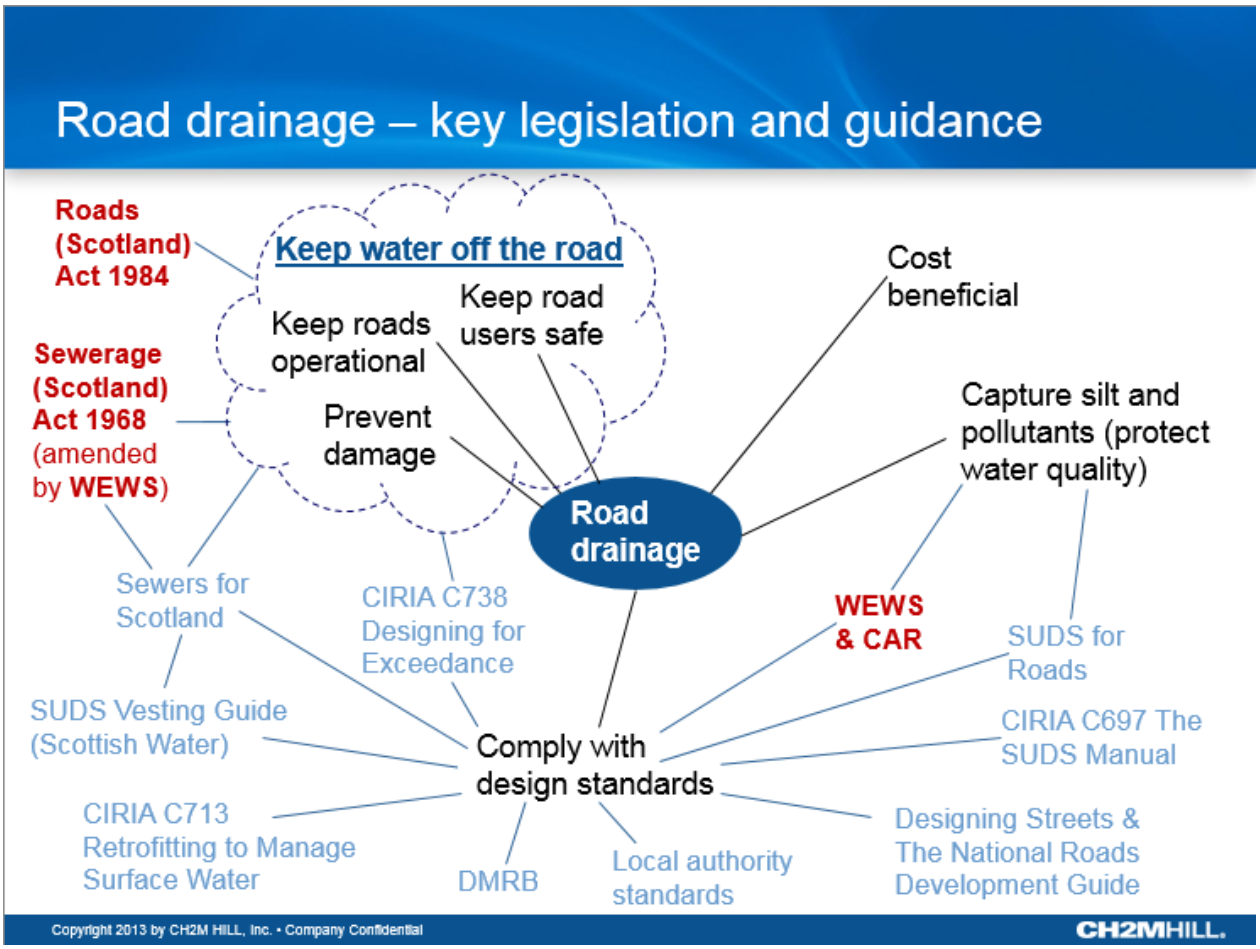


Figure 3-1: road drainage legislation and guidance

Figure 3-1 highlights the key legislation and guidance relating to road drainage in Scotland, developed from the objectives mindmap. The importance of guidance in road design is apparent from the plethora of guidance relating to the objective of complying with standards, and all the specific requirements for road drainage (e.g. design standards) come from guidance rather than from legislation.

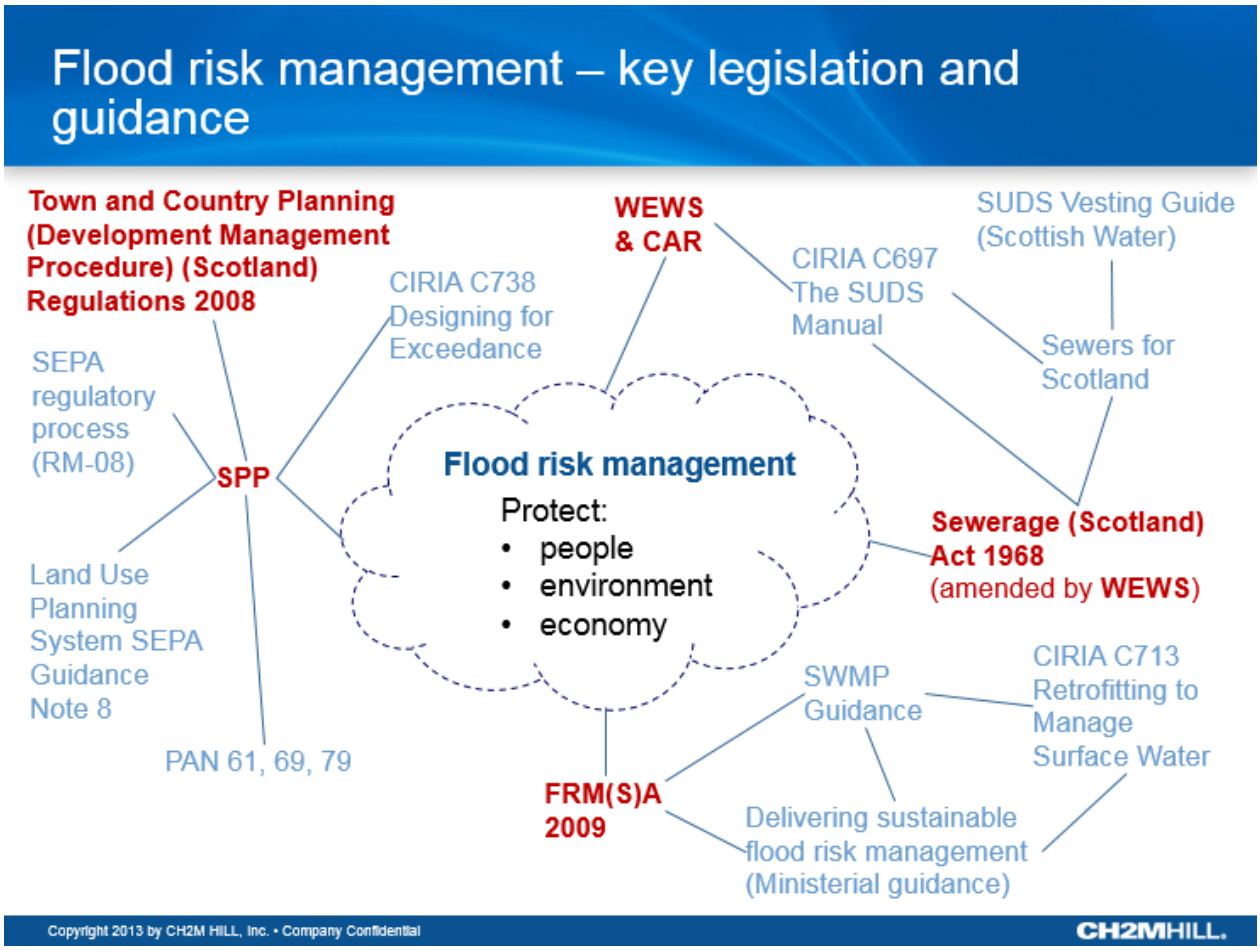


Figure 3-2: Flood risk management legislation and guidance mindmap

3.2 Synopsis of relevant legislation and guidance

As noted in SuDS for Roads, "legislation has advanced significantly in the area of water management and, arguably, roads legislation has not kept up." We have therefore considered the existing legislation and guidance from the perspective of how it relates to roads, to establish how (and whether) the key areas of interaction identified in section 2.2 are addressed within the existing regulatory framework.

As background information, below is a summary of the various drainage responsibilities within Scotland:

- Scottish Water: Drainage serving roofs and hardstanding areas from more than one curtilage
- Local Authority: Drainage serving roofs and hardstanding area within the curtilage (Building Standards), non-trunk public road drainage (Roads) & flood risk management
- Transport Scotland: Drainage of trunk road network
- Property Owner: Drainage serving roofs and hardstanding areas within their property boundary (curtilage)
- SEPA: Assist through regulation on quality (CAR Regs) and quantity (FRM Act – Competent authority)

3.2.1 Primary roads legislation

The main roads legislation for Scotland is the **Roads (Scotland) Act 1984**, which sets out the duties and powers of roads authorities (the **Transport (Scotland) Act 2005** is not discussed in this section as it does not have any direct reference to road drainage powers, duties or standards). The Roads (Scotland) Act 1984 gives roads authorities powers to protect the road and road users from the negative impacts of water as follows:

- Section 21 – establishes the requirement for Road Construction Consent, the purpose of which is to ensure new roads are constructed in accordance with appropriate development guidelines and to protect the future maintenance liabilities of the adopting roads authorities.
- Section 30 – provides roads authorities with powers to provide and maintain barriers or other works to protect roads from flooding (amongst other things).
- Section 31 – establishes powers for roads authorities to drain roads and to prevent water flowing onto them from surrounding land.
- Section 32 – enables roads authorities to contribute to any drainage works under the Land Drainage (Scotland) Act 1958 or flood protection work under section 56 of the Flood Risk Management (Scotland) Act 2009 that "are desirable for the protection or enjoyment of an existing or proposed public road".
- Section 99 – makes it an offence to allow "any flow of water or of filth, dirt or other offensive matter from, or any percolation of water through, the land onto the road"
- Section 99 – also gives roads authorities powers to prevent the flow of water (etc) onto the road from adjacent land, including the power to serve notice on landowners in breach of this, requiring them to undertake any necessary preventative works.

The Roads Act 1984 generally gives powers to roads authorities that enable them to manage and maintain roads. However, it does not impose on roads authorities any specific requirement to consider the wider impacts of the management and maintenance of roads (or construction of new roads) on the environment, society or the economy, including on flood risk. Having reviewed the wider range of relevant legislation and guidance it is apparent that whilst there are requirements to consider the impact of the construction, management and maintenance of roads on the water environment, these generally come from other, 'non-road' legislation. The sections below summarise the relevant powers and responsibilities set out in the wider range of legislation, in terms of the interrelationship between road drainage and flood risk management. A more detailed commentary on the legislation and guidance relevant to road drainage and flood risk management is provided in Appendix A.

3.2.2 Wider legislation with relevance for road drainage

Water Environment and Water Services (Scotland) Act 2003 (WEWS): this is the interpretation of the Water Framework Directive and (Section 20) gives Scottish ministers powers to introduce regulatory controls over water activities, in order to protect, improve and promote sustainable use of Scotland's water environment (see Water Environment Controlled Activities (Scotland) Regulations). This has been achieved by the introduction of the **Water Environment (Controlled Activities) (Scotland) Regulations (CAR) 2011** (originally introduced in 2005, with various amendments and additions since). WEWS (via CAR) makes SUDS obligatory for managing surface water drainage from all new developments excepting single dwellings and those draining to coastal waters. WEWS also amended the Sewerage (Scotland) Act 1968 to include SUDS, marking a step forwards in the debate over long term responsibility for SUDS.

The Conservation of Habitats and Species Regulations 2010: these Regulations transpose the EC Habitats Directive into UK law. Any new road or road drainage that has the potential to impact on a designated site requires a Habitat Regulations Assessment. If water forms part of the designation (e.g. wetlands) then these regulations require that the road drainage is managed in such a way as to protect the integrity of the site. This is very locally specific, however, and although an essential element of road design it is not a key driver of sustainable road drainage practices in general.

Land use planning policy and associated guidance: **Scottish Planning Policy (SPP) (June 2014)** directs that the planning system should promote a precautionary approach to flood risk from all sources, and, "avoidance of increased surface water flooding through requirements for Sustainable Drainage Systems (SuDS)". This applies to all new development including roads, thereby directing that all new roads and road schemes requiring planning permission should be designed with the aims of flood risk management and reduction in mind. SPP states that infrastructure and buildings should generally be designed to be

free from surface water flooding in rainfall events where the annual probability of occurrence is greater than 0.5% (1:200 years)[1]. The **Town and Country Planning (Development Management Procedure) (Scotland) Regulations 2008** establishes SEPA as a statutory consultee for development which "is likely to result in a material increase in the number of buildings at risk of being damaged by flooding", and Scottish Water where the development is "likely to require a material addition to or a material change in the services provided by that authority". This links flood risk management and surface water drainage as a material consideration of development planning, and thus of the design of any new roads included within such developments. **Designing Streets (2010) is** a material consideration under the planning system. It is a policy and guidance document for practitioners in Scotland involved in the planning, design, provision, approval and adoption of all new streets, and modifications to existing ones. It was produced by SCOTS (supported by Transport Scotland and the Scottish Government) to support the placemaking agenda, by raising the importance of street design issues from guidance and advice up to policy status. Importantly, it states that street design should run planning permission and Road Construction Consent (RCC) processes in parallel, and establishes street design guidance, as set out in Designing Streets, as a material consideration in determining planning applications and appeals.

The main flood risk legislation for Scotland is the **Flood Risk Management (Scotland) Act 2009**. This sets out the duties and powers of SEPA and the other public bodies in relation to flood risk management.

Figure 3-3 provides an overview of the flood risk management process for Scotland. In brief; SEPA is the flood warning authority and has an overarching role in flood risk assessment and the preparation of flood risk management strategy, whilst Local Authorities are responsible for flood risk management infrastructure. Part 1, Section 1 (1) imposes a general duty on Scottish Ministers, SEPA, local authorities, Scottish Water and other responsible authorities to exercise their flood risk related functions with a view to managing and reducing flood risk and to promote sustainable flood risk management. This is not specific to road drainage design and maintenance at the time of writing; however, it is included here because it has potential to become a significant piece of legislation in terms of road drainage design. Local authorities are also roads authorities, however the Roads (Scotland) Act 1984 is not currently designated as a flood risk related function. If the Roads Act is ordered by the Scottish Minister as a flood risk related function then roads authorities will be required under the FRM(S)A 2009 to exercise their roads related functions with a view to reduce flood risk and have regard to the social, environmental and economic impact of their functions. The FRM(S)A 2009 introduced the requirement for SEPA to develop flood risk management plans, and for local authorities to develop local flood risk management plans.

Figure 3-3 and Figure 3-4 illustrate the flood risk management process as established by FRM(S)A 2009. The Scottish Government has produced **Ministerial Guidance on Delivering Sustainable Flood Management (Scottish Government 2011)**, which sets out statutory guidance to SEPA, local authorities and Scottish Water on fulfilling their responsibilities under FRM(S)A2009 and, in particular, on the steps that should be taken to manage flooding in a sustainable manner. The Ministerial Guidance states that SEPA and the responsible authorities must work across traditional institutional boundaries to deliver an integrated approach to flood risk management. It also addresses existing development and retrofit, stating that, "Where possible opportunities to retrofit sustainable urban drainage and surface water management systems in existing developments should be identified and encouraged to keep water from entering the sewers in the first place." The Ministerial Guidance identifies Surface Water Management Plans as the best practice approach by which local authorities are expected to meet their responsibilities

[1] This would appear to rule out the use of developed areas as exceedance flow routes or temporary storage, although the use of the term "generally" provides an opportunity for negotiation. No further clarification has been issued on this point.

under FRM(S)A 2009, setting out the principles of integrated drainage[2] and establishing an expectation for local authorities to consider existing development (and therefore existing roads within urban areas) within their flood risk management plans.

> "Where possible opportunities to retrofit sustainable urban drainage and surface water management systems in existing developments should be identified and encouraged to keep water from entering the sewers in the first place."
>
> **Ministerial Guidance on Delivering Sustainable Flood Management (Scottish Government 2011)**

> "The long term answer to urban water management cannot be continual upgrading of sewerage infrastructure, for instance by creating ever larger pipes and subsurface storage, as this would be impractical and prohibitively expensive.
> Instead, an integrated approach to drainage that takes account of all aspects of the urban drainage systems and produces long term and sustainable actions must be deployed."
>
> **Ministerial Guidance on Delivering Sustainable Flood Management (Scottish Government 2011)**

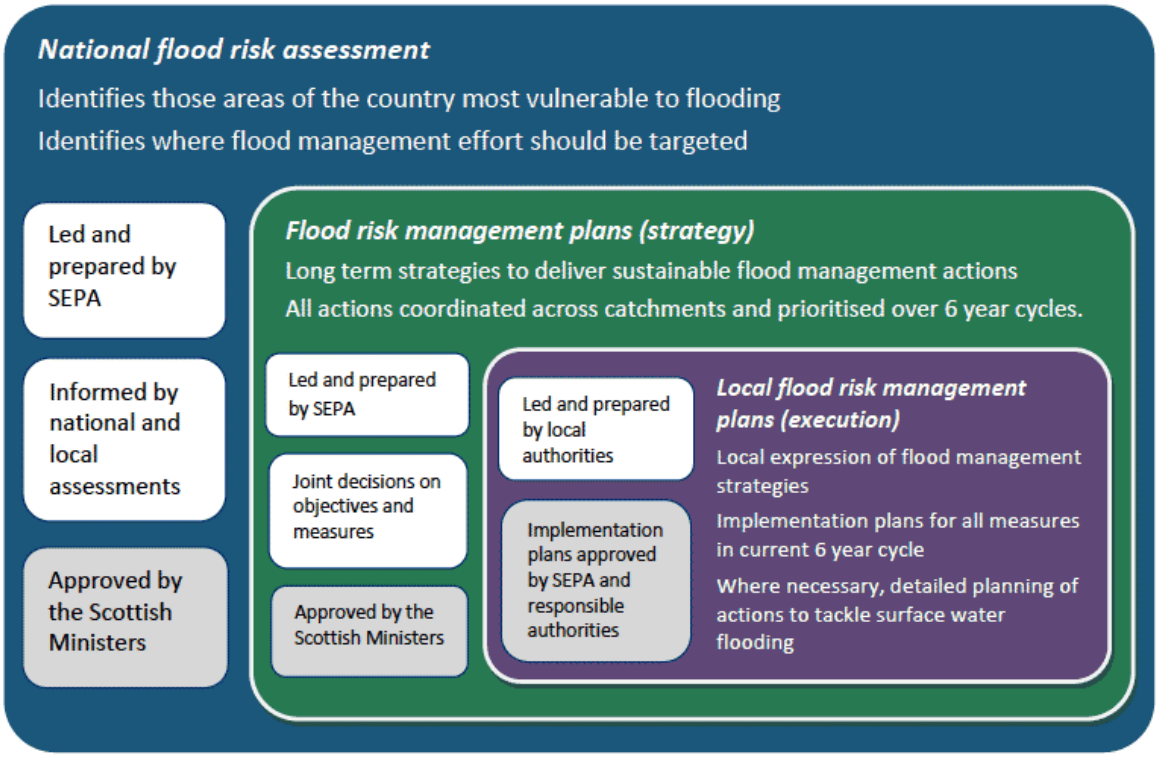


Figure 3-3: National flood risk assessment arrangements

[2] Increase the percentage of new surfaces which are permeable; aim to deal with storm water runoff from impermeable surfaces as close to source as possible; replace existing impermeable surfaces with permeable surfaces where possible; minimise the amount of drainage going underground…; maximise opportunities to manage surface water before it enters the sewer system; and, design for exceedance by ensuring that existing and new developments have flood plains and safe flow paths.

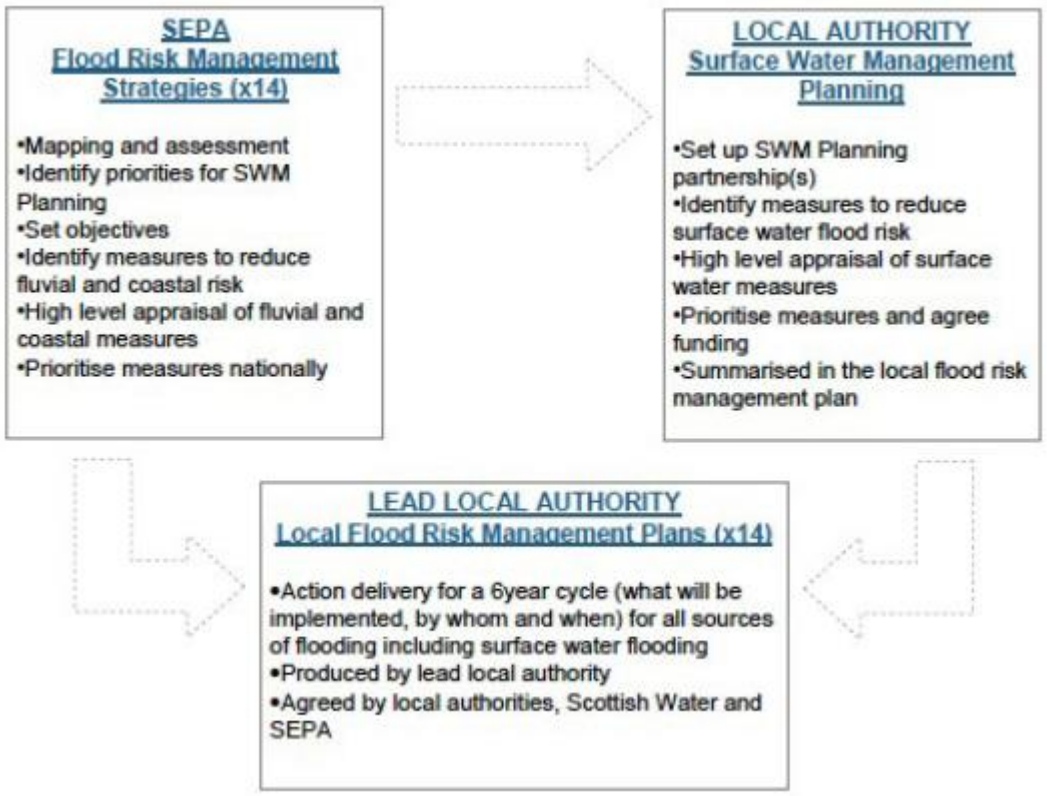


Figure 3-4: Overview of the flood risk management process (www.gov.scot)

The **Sewerage (Scotland) Act 1968:** Part 1, Section 7 states that "a roads authority and Scottish Water may agree, on such terms and conditions as may be specified in the agreement, to the provision, management, maintenance or use of their sewers or drains for the conveyance of water from the surface of a road or surface water from premises." Clause 3 of this same section notes that a roads authority or Scottish Water shall not "unreasonably refuse" such an arrangement, or insist on unacceptable terms. Part 1, Section 12(3) states that Scottish Water has the right to impose reasonable conditions on any flow which enters into Scottish Water system, including road runoff.

3.2.3 Relevant guidance

Developed by the Scottish Advisory and Implementation Forum for Flooding (SAIFF), which includes representatives from Scottish Government, local authorities, Scottish Water and SEPA, **Surface Water Management Planning Guidance, Feb 2013** provides guidance to assist responsible authorities in the preparation of Surface Water Management Plans (SWMP). SWMP are currently considered best practice by which to identify the most sustainable measures to manage urban drainage and the risk of surface water flooding as required by the FRM(S)A. It is expected that the FRM Strategies and LFRMP will identify the production of SWMP as a measure to manage the risk of surface water flooding. This guidance establishes the principles of integrated drainage (as listed below) and sets out best practice for identifying the most sustainable measures to manage surface water flood risk.

SUDS for Roads was commissioned and guided by SCOTS and the SUDS Working Party (in partnership with other public and private sector organisations) to provide best practice guidance for practitioners on the design, construction, adoption, maintenance, performance, applicability and whole life cost of SUDS associated with the treatment and attenuation of surface water runoff from roads and footways. It also highlights the need to design for exceedance. SCOTS has subsequently published an accompanying whole life costing tool, which provides roads authorities and their consultants with a consistent method for estimating the whole life cost (and carbon) for a range of SUDS features for road drainage.

The **Design Manual for Roads and Bridges (DMRB)** sets out standards for road design. It applies to all trunk roads since it is a requirement of Transport Scotland's contracts with its Operating Companies. Of

particular interest is HD33/06 section 1.4, which lists the three major objectives in the drainage of trunk roads as:

- the speedy removal of surface water to provide safety and minimum nuisance;
- provision of effective sub-surface drainage to maximise longevity of the pavement and its associated earthworks; and
- ***minimisation of the impact of the runoff on the receiving environment.***

These objectives juxtapose the speedy evacuation of water (as noted in section 2.1 above) with consideration of the impact on the receiving environment, at once placing consideration of flood risk management within the primary objectives of trunk road design and introducing potential conflict. DMRB sets out design standards for trunk road drainage (generally to accommodate a 1:1 year storm)[3], but there is no guidance regarding the management of flows from design exceedance events, i.e. when designed capacity is exceeded but not through any fault of the system. The standards simply leave it open to judgement that in certain circumstances the designer may choose to consider larger design events.

The **Network Maintenance Manual (NMM)** and **Routine and Winter Service Codes (RWSC)** guidance documents together set out the requirements and advice for the management of maintenance on the trunk road network. There is clearly an emphasis on keeping the carriageway free from standing water in these documents, although it is stated that the requirements for drainage also relate to the ***prevention and mitigation of the effects of flooding***. Maintenance and repair of existing roads is an activity which also presents opportunities to contribute to the wider aims of flood risk management by addressing legacy surface water issues, but this is not given consideration within the NMM or RWSC.

For non-trunk roads (excepting private roads) the roads authority is the relevant local authority. Local authorities have historically had their own **local authority road development guidelines**, and prior to the National Roads Development Guide there were no standardised development guidelines across the 32 roads authorities in Scotland. Some used the former Strathclyde Regional Council guidelines (last published in 1996) and others had their own roads development guidelines. However, conventional road drainage has historically been designed in accordance with Road Note 35, which states that suitable design frequency for design of road drainage is 1 in 1 year for separate surface water drainage in estate roads. These are now superseded by **Designing Streets (2010);** a policy and guidance document for practitioners in Scotland involved in the planning, design, provision, approval and adoption of all new streets, and modifications to existing ones (see Policy).

The National Roads Development Guide (2014) was developed by SCOTS (supported by Transport Scotland and the Scottish Government), to provide a consistent national standard for road design. It follows the same principles introduced in Designing Streets, with a change in policy to move away from a standards-based approach to one where designers, planners and roads engineers collaborate to develop a design-led solution. Its purpose is to be the technical enabler to the Designing Streets policy document, providing a consistent, accessible and relevant source of information that links related detailed and complex infrastructure requirements in one place. It includes updated guidance on how to obtain RCC, supports the principles of adopting a multi-disciplinary approach and early engagement to achieve a balanced outcome based on the wider function of the road as a street for all its users, and is designed to accommodate local authority variances. The National Roads Development Guide states that "road drainage must take full account of sustainable urban drainage systems and use 'Best Management Practice' structures and techniques in dealing with discharges to existing watercourses or public sewers", and refers designers to the relevant SUDS best practice guidance (as noted below).

Scottish Water updated its technical guide for developers involved in the design and construction of sewerage infrastructure in response to new obligations imposed by WEWS for the vesting of public SUDS. **Sewers For Scotland 3rd Edition**, published in April 2015, details the procedures and provides

[3] Longitudinal sealed carrier drains must be designed to accommodate a one-year storm in-bore without surcharge. The design must be checked against a five-year storm intensity to ensure that surcharge levels do not exceed the levels of chamber covers.

guidance for the design and construction of sewerage infrastructure, including SUDS in public land which are to be adopted by Scottish Water. It also sets a requirement for surface water drainage for new development, that flooding should not occur in any part of the site in a 1-in-30 year return period design storm, with a 1-in-200 year overall minimum flood resilience assessment check if required by SEPA and/or the local authority.

There is a series of Planning Advice Notes (PAN) and online guidance under SPP which provide more detailed guidance on specific areas of planning policy. The ones with relevance for flood risk and drainage are:

- **PAN61: Planning and Sustainable Urban Drainage Systems** – Good practice advice for planners and the development industry on SUDS. Can be used by local authorities to help ensure that flooding matters are considered at pre-application meetings with developers.
- **Online Planning Advice on Flood Risk (replaced PAN69)** – Background information and best practice advice in support of Scottish Planning Policy (SPP) 7: Planning and Flooding (previously a separate policy document but now incorporated within SPP)
- **PAN79: Water and Drainage** – Clarifies the role of the planning authority in setting direction of development to inform co-ordinated planning and delivery of new water infrastructure, explains the roles of Scottish Water and SEPA and encourages joint working

In addition, SEPA has published guidance on planning, comprising:

- **SEPA regulatory process (RM-08)** – Sets out SEPA's guidance on SUDS and the planning consultation procedure for new developments. SUDS are a legal requirement for all developments except single dwellings and those which discharge to coastal waters.
- **Land Use Planning System SEPA Guidance Note 8** – SEPA standing advice for planning authorities and developers on development management consultations

There is a range of relevant good practice guidance available from CIRIA including:

- **CIRIA C697 The SUDS Manual** – Best practice guidance on planning, design, construction, operation and maintenance of SUDS to facilitate effective implementation in developments.
- **CIRIA C738 Managing urban flooding from heavy rainfall - encouraging the uptake of designing for exceedance** – Provides best practice guidance on enabling better management of local flood risk and surface water by creating safe and resilient flood routes, temporary storage areas, and making use of other measures to reduce the impact of flooding. Report C738a summarises key findings from CIRIA project RP991 to support the delivery of drainage exceedance and refers to examples of good practice obtained from case studies, literature review and consultation with industry.
- **CIRIA C713 Retrofitting to Manage Surface Water** – Provides a framework to help more effective retrofitting of surface water management measures, to address surface water flooding and pollution within existing urban areas.
- **CIRIA Research Project RP993: Demonstrating the multiple benefits of SuDS – A business case (Phase 2), Draft Literature Review (October 2013)** – Literature review describing current practice in relation to using valuation tools and approaches to assess the value and distribution of the wider benefits of SuDS.

3.2.4 Conclusions from literature review

Review of the existing regulatory framework shows that the road drainage design standards and practices which impact on, or have the potential to contribute to, flood risk management are not generally derived from the roads legislation itself but driven mainly by guidance and by a suite of wider legislation.

Road drainage plays a crucial role in protecting the structural integrity of the road, as well as maintaining a safe surface for traffic and pedestrians. Road drainage design focuses on effective drainage of the

carriageway to prevent risk to vehicles and road users, and the Roads (Scotland) Act 1984 gives Roads Authorities specific powers to enable them to do this. Existing road design guidance encourages designers to focus on evacuating flows as fast as possible, which if not properly managed can overwhelm downstream sewer systems and watercourses, causing flooding, but this is not a legislative requirement. Although relevant guidance such as DMRB, The National Roads Development Guide and SUDS for Roads encourages road designers to incorporate sustainable drainage techniques, and planning policy requires them to demonstrate no net increase in flood risk, there is no explicit requirement within primary road legislation to consider the wider implications of road design on flood risk or contribute to its wider objectives. Guidance sets a general standard of 1:1 for gullies and no flow encroaching on the carriageway at the 1:5 year event (significantly lower than the standards used for either sewers or flood risk management), but there is no direction in the main road design guidance as to how to deal with flows over and above this once the system is inundated. Nor is there any specific requirement for road designers to seek to contribute to wider flood risk management goals, despite the fact that road runoff can be a significant contributing factor in the flooding of properties and inundation of sewer systems. In some cases this is picked up through other relevant legislation, for example where roads are subject to planning consent, or through guidance (e.g. flood risk assessment requirements in DMRB), but there is no consistent legislative requirement[4].

In terms of the key areas of interaction the following conclusions can be drawn:

- **The impact of road drainage on flood risk** – this is well covered for new roads, since these are required to meet SEPA's requirements for flood risk management under the planning system. There is a gap in terms of existing roads, despite the expectation set by the Ministerial Guidance for local authorities to consider existing development (and therefore existing roads) within their flood risk management plans, since there is no obligation for local authorities to deliver the measures set out in these plans (this will depend on availability of funding and local political priorities).
- **What happens to road runoff which is not captured by the road drainage system (exceedance)** – the design standards for road drainage are significantly lower than those for flood risk management. There is best practice guidance on designing for and managing exceedance, but there is no obligation on designers to comply with it.
- **The impact of flood risk on roads** – flood risk management legislation and land use planning policy address this issue for new roads, however, existing roads which are affected by flood risk rely on identification and resolution either through local authorities' flood risk management plans or through Transport Scotland's asset management processes. The implementation of schemes to reduce flood risk to existing roads is therefore dependent upon the availability of funding and either local political priorities or Transport Scotland's national scheme prioritisation system.
- **Using roads to help manage flood risk** – designing for exceedance is recommended in planning policy and in other guidance, however, use of roads to convey and store flows in times of flooding is contradictory to some of the primary objectives of road drainage, and roads authorities actually have specific powers to prevent flows getting onto the road from elsewhere.

[4] Unless the Roads (Scotland) Act 1984 is a ordered by Scottish Ministers as a designated function under the FRM(S)A 2009.

4 Scenario analysis

The sections below use hypothetical scenarios to bring to life the key areas of interaction and potential conflict identified in section 2, to analyse what the legislation and guidance means in practical terms.

4.1 Scenario analysis table

Table 4-1 sets out a range of scenarios selected to help relate the institutional and behavioural conflicts to practical situations, which are then linked to measures that could help overcome these issues.

Table 4-1: Summary of conflicts and recommendations for typical scenarios

Scenario	Key players	Theory		What happens in practice	Areas of potential conflict	
		Policy/legislation	Guidance		Regulatory	Behavioural/organizational
New build trunk roads (road only surface water) (and significant extensions)	Transport Scotland SEPA Planning authority	WEWS / CAR SPP Roads (Scotland) Act Designing Streets	DMRB SUDS for RoadsC738 Designing for Exceedance Online Planning Advice on Flood Risk SEPA Guidance Note 8 SEPA Regulatory method 8 (RM-08) Ministerial Guidance on Delivering Sustainable Flood Management (Scottish Government 2011)	SPP: • precautionary approach to flood risk • Flood risk assessment required if within 1:200yr flood risk area • Generally free from surface water flooding up to 1:200yr rainfall event WEWS/CAR: • SUDS required to manage runoff quality Roads (Scotland) Act: • (If draining to a public sewer) Section 7 agreement with Scottish Water • Powers to prevent flow of water etc onto carriageway DMRB: • Demonstrate no increase in flood risk • Carriageway free from surcharge up to 1:5yr event Ministerial Guidance: • Principles of sustainable drainage, including design for exceedance Other guidance: • Sustainable approach to flood risk • Use of SUDS for flow management (particularly SUDS for Roads) Design to manage exceedance flows New trunk roads designed and constructed in line with DMRB Planning permission required – SEPA and planning authority[5] consulted – this addresses the apparent ‘gap’ in design standards (1:5 / 1:30 / 1:200) Principles of SUDS for Roads applied consistently	None identified	Accountability issues, and risks to delivery timetables, may discourage Transport Scotland from implementing joint solutions, meaning opportunities to achieve cost efficiencies by partnering with other organisations in flood risk management schemes may be missed
New build non-trunk roads (and significant extensions)	Developer Roads authority Planning authority SEPA Scottish Water	Designing Streets WEWS / CAR SPP Roads (Scotland) Act Sewerage (Scotland) Act[6]	SUDS for Roads National Roads Development Guide SEPA RM-08 SEPA Guidance Note 8 Online Planning	SPP: • Precautionary approach to flood risk • Flood risk assessment required if within 1:200yr flood risk area • Generally free from surface water flooding up to 1:200yr rainfall event • Take into account depth of flood water, likely flow rate and path, and rate of rise and duration WEWS/CAR:	Potential legislative conflict to use of roads to manage exceedance: Roads (Scotland) Act 1985 (Section 99) section 99 of the roads states The owner and the occupier of any land, shall prevent any flow of water or of filth, dirt or other offensive matter from, or any percolation of water through, the land onto the road. A person failing to comply with this	Road designers and roads authorities often don’t understand what constitutes a material change to design from a flood risk perspective – risk of changes being made which are detrimental to flood risk aims Capacity constraints within roads authorities (and Scottish Water) make it difficult to ensure that drainage is

[5] Local authority split into different functions as the various departments may not necessarily act with one accord.

[6] If draining to public sewer

			Advice on Flood Risk C697 SUDS Manual C738 Designing for Exceedance Sewers for Scotland 3rd Ed. Ministerial Guidance on Delivering Sustainable Flood Management (Scottish Government 2011)	• SUDS required to manage runoff quality Roads (Scotland) Act: • Road Construction Consent required (assuming developer design) • (If draining to a public sewer) Section 7 agreement with Scottish Water • Powers to prevent flow of water etc onto carriageway Local authority road design guidance (if applicable): • Likely to require drainage designed for 1:1yr event and carriageway to be free from surcharge up to 1:5yr event Sewers for Scotland 3rd Ed.: • (If shared curtilage and road drainage) drainage system must protect site up to a 1:30yr event Designing Streets: • Aligns RCC and planning consent • Recommends consideration of layout and impact of (SUDS) when working on street and block layouts National Roads Development Guide: • Promotes holistic approach and early engagement between disciplines • Promotes use of SUDS and "best management practice" to manage discharges to sewers and watercourses • Provides Schedule of Agreement for SUDS to support vesting by roads authorities Ministerial Guidance: • Principles of sustainable drainage, including design for exceedance Other guidance: • Sustainable approach to flood risk • Use of SUDS for flow management (particularly SUDS for Roads) • Design to manage exceedance flows Private developers design roads as part of new development Planning permission required – SEPA and planning authority consulted Principles of SUDS for Roads generally applied	commits an offence. Road drainage recommended, but not required to be considered until latter stages of design – may miss opportunities to achieve cost efficiencies (and more sustainable solutions and multiple benefits) by combining road drainage with SUDS for wider development, aligning planning permission, RCC and Scottish water consent process. Exceedance flows should be planned for as part of overall development, and there is reference to this under SPP, but it is not clear and also appears to be contradicted by the requirement to keep infrastructure free from surface water up to a 1:200yr event. Ministerial Guidance and other best practice guidance recommends designing for exceedance but a clear legislative requirement is lacking.	constructed in accordance with approved design Challenges in getting agreement of shared SUDS between Scottish Water and roads authority Drainage may be left until latter stages of design by which stage it is too late to provide adequate space Difficulties with the vesting of SUDS in public land
Maintenance, repair and minor improvements to existing roads	Roads authority Private contractors	Transport (Scotland) Act Roads (Scotland) Act NRSWA	RWSC NMM National Roads Development Guide (may	WEWS/CAR: • SUDS required to manage runoff quality Roads (Scotland) Act: • Road Construction Consent required (assuming developer design)	No legislative requirement to consider flood risk when undertaking minor works to existing roads	Challenges in getting agreement of shared SUDS between Scottish Water and roads authority Lack of communication between roads authority, flood risk management

		Designing Streets (may apply) WEWS / CAR (if increasing impermeable area) Sewerage (Scotland) Act (if increasing impermeable area)	apply) SUDS for Roads Sewers for Scotland 2nd Ed. (if increasing impermeable area)	• (If draining to a public sewer) Section 7 agreement with Scottish Water • Powers to prevent flow of water etc onto carriageway Local authority road design guidance (if applicable): • Likely to require drainage designed for 1:1yr event and carriageway to be free from surcharge up to 1:5yr event Sewers for Scotland 3rd Ed. (if applicable): • (If shared curtilage and road drainage) drainage system must protect site up to a 1:30yr event Designing Streets (if applicable): • Aligns RCC and planning consent • Recommends consideration of layout and impact of (SUDS) when working on street and block layouts National Roads Development Guide (if applicable): • Promotes holistic approach and early engagement between disciplines • Promotes use of SUDS and “best management practice” to manage discharges to sewers and watercourses • Provides Schedule of Agreement for SUDS to support vesting by roads authorities SUDS for Roads: • Use of retrofit SUDS for flow management Road maintenance and minor improvement schemes (e.g. traffic management) are designed in isolation – no obligation to consult flood risk management department Some opportunistic SUDS retrofitting which contributes to flood risk management but not requirement and opportunities are missed Works may be inadvertently detrimental to flood risk (e.g. re-contouring could redirect flows, gullies could be filled in or blocked)		functions, and other related functions (e.g. parks and open spaces) of local authorities Organisational budgetary constraints (and silo thinking) can prevent departments/ organisations from contributing to schemes where benefits are not directly realised by themselves
Exceedance within existing urban areas	Local authority Lead authority (if different to local authority) Scottish Water	FRM(S)A Sewerage (Scotland) Act Roads (Scotland) Act Scottish Planning Policy Planning Advice Notes and online guidance	C635 Designing for Exceedance SUDS for Roads	FRM(S)A: • Issues should be identified by flood risk management plans and/or Scottish Water’s assessment of flood risk from sewerage systems SWMP Guidance: • Principles of sustainable drainage, including retrofitting SUDS Ministerial Guidance: • Principles of sustainable drainage, including design for exceedance • Local authorities expected to undertake SWMP identifying measures to address flooding Roads (Scotland) Act: • Powers to prevent flow of water etc onto carriageway Local authority road design guidance (if applicable):	Potential legislative blocker to use of roads to manage exceedance: Roads (Scotland) Act 1985 (Section 99) Legislation provides a ‘blunt instrument’, offering grounds for legal action against those responsible for inappropriate flows, but without offering any direction regarding possible solutions Institutional barriers prevent budget sharing	Although local authorities are required to identify flooding from all sources and propose sustainable measures to resolve it, multiple stakeholders, complex flooding mechanisms, constrained resources and low cost benefit ratios make resolution challenging Reluctance to share budgets or contribute to solutions which don’t bring direct benefits Perception of SUDS as being land-hungry Challenges in getting agreement of shared SUDS between Scottish Water and roads authority Scottish Water and/or roads authority design traditional sewerage or road drainage solutions in

				• Likely to require drainage designed for 1:1yr event and carriageway to be free from surcharge up to 1:5yr event SUDS for Roads: • Use of retrofit SUDS for flow management Road maintenance and minor improvement schemes (e.g. traffic management) are designed in isolation – no obligation to consult flood risk management department Some opportunistic SUDS retrofitting which contributes to flood risk management but not requirement and opportunities are missed Works may be inadvertently detrimental to flood risk (e.g. re-contouring could redirect flows, gullies could be filled in or blocked) Inconsistent levels of protection across different components of the urban drainage network, and level of protection eroded over time so often much lower than current design standards Depending on where the flow is coming from the solution may be different – some are more straightforward than others Sewerage (Scotland) Act allows Scottish Water to control rate of discharge into its sewers, and to serve notice on others to remove inappropriate flows (e.g. land drainage as in the case of Hamilton, South Lanarkshire), but in areas constrained by existing development there may be nowhere else for these flows to go, which creates an impasse C738 provides best practice guidance but it is not typically applied for existing roads Roads authorities object to using roads to store or route flows under Roads (Scotland) Act Section 99 and opportunities for more sustainable solutions are missed		isolation, because more sustainable solutions are perceived as being harder (they involve other parties, take longer, require more effort, and costs and benefits harder to apportion)
Land drainage "run-on" to roads		Roads (Scotland) Act FRM(S)A	None	Roads (Scotland) Act: • Powers to prevent flow of water etc onto carriageway FRM(S)A: • Issues should be identified by flood risk management plans and/or Scottish Water's assessment of flood risk from sewerage systems SWMP Guidance: • Principles of sustainable drainage, including retrofitting SUDS Ministerial Guidance: • Principles of sustainable drainage • Local authorities expected to undertake SWMP identifying measures to address flooding Land drainage arriving on the road may be entering the sewer network via road drainage systems and overloading downstream sewers, without causing a problem on the actual carriageway (e.g. Shetland, where use of Section 99 was proposed to resolve surface water flooding downstream, but resource constraints prevented the roads authority from prioritising this)	No legislation or guidance regarding appropriate standards to apply if a roads authority were to implement additional measures (e.g. enhanced maintenance or upgraded drainage) to contain flows that were not due to the road surface itself	Section 99 of the Roads (Scotland) Act could be used to prevent land drainage flows getting onto the carriageway, but roads authorities rarely use these powers due to resource constraints, and the risk of unrecoverable legal costs. Not considered a roads authority priority unless the flow is causing flooding on the carriageway itself

4.2 Discussion of issues identified in legislative review and scenario analysis

4.2.1 Different design standards (flood risk and road drainage)

With respect to the perceived difference in standards, this is a commonly observed issue which has been well-documented in other studies and reports including SUDS for Roads and CIRIA Research Project RP991. Road drainage design standards come from the guidance, not the legislation. Section 1.2 of SUDS for Roads provides an excellent summary of the historical context of roads and drainage, including a concise summary of responsibilities. Whether this variation in design standards creates a genuine problem, and whether it is realised in practice, is less apparent because of the complexity of the systems we are dealing with. We know that for new development the system as a whole has to meet a certain standard – i.e. no flooding up to a 1:200yr event plus climate change for fluvial and coastal flood risk, and also currently for surface water flooding – therefore the individual components must work effectively together to provide this standard of protection. In existing urban environments however, there is no such consistent target level of protection: the component parts have not been designed to work together to meet a set standard, therefore the individual components are not necessarily performing as a coherent whole to provide a set standard of protection.

4.2.1.1 New roads (and significant extensions)

All new roads are subject to current legislation, design standards and guidance, including SUDS for Roads, Designing Streets, the National Roads Development Guide and CAR. They must obtain both RCC and planning permission, and are therefore required to obtain approval by the local authority (as both planning authority and roads authority). The local authority is also the responsible authority for flooding so through this connection, as well as the requirement under the Town and Country Planning (Development Management Procedure) (Scotland) Regulations 2008 for statutory consultation with SEPA, the wider aims of flood risk management should accounted for as a material consideration of planning permission. As part of this process designers must demonstrate that the road design does not increase flood risk elsewhere and that the development as a whole meets appropriate flood protection standards. SPP paragraph 255 states that the planning system should promote avoidance of increased surface water flooding through requirements for Sustainable Drainage Systems (SuDS) and minimising the area of impermeable surface.

Trunk roads are the responsibility of Transport Scotland. Providing that the requirements of the DMRB and associated RWSC are followed, flood risk should already receive due consideration during the design, maintenance and improvement of trunk roads. In addition, under CAR any new or increased discharges from trunk roads, motorways and dual carriageways must either use SUDS (in accordance with GBR 10), or seek authorisation from SEPA. Most SUDS that provide pollution control require some level of retention, and will therefore make a positive contribution to flood risk management, although the impact of this benefit decreases as the severity of the storm increases. SEPA has the national overview for flood risk and so this process provides an additional link back to flood risk management objectives.

Historically road design has been focused almost solely on vehicle use, with other functions a secondary consideration. This led to a narrow, standards-based approach which discouraged any consideration of how the design of roads would, or could, support any other purpose (i.e. in this context, flood risk management). In addition, there was no nationally consistent standard for road development across the 32 local authorities. Published in 2014, the National Roads Development Guide (along with the Designing Streets policy document which it supports) represents a step change in road design by encouraging (roads within) developments to be designed on an individual methodology rather than following standard and rigid specifications where possible. This is a major step forward in the process of aligning the aims of road (street) design and flood risk management, and the uptake of this best practice guidance should help to bring road (drainage) design and flood risk management into closer alignment.

So, assuming that practice is in line with current legislation and best practice guidance, new roads should not pose any issues in terms of flood risk management. They should include SUDS for pollution control, in accordance with WEWS and CAR, and should consider flood risk as a material consideration of planning as required by SPP. Exceedance flows should be managed in line with CIRIA guidance C635. Best practice guidance is available which sets out how to design, construct, operate and maintain these SUDS (e.g. SUDS for Roads, DMRB, RWSC).

There is currently no clear legislate route by which to proactively manage the impact of urban creep.

4.2.1.2 Existing roads

The ministerial guidance on sustainable flood management states that, "The best solutions will be achieved when the full drainage system, from source to receiving water, is designed from the outset. This allows the optimum balance between source, site and regional controls to be achieved." This is achievable for new developments, but not easy to apply retrospectively where existing development has grown organically. For new development the system as a whole has to meet a certain standard – i.e. no flooding up to a 1:200yr event plus climate change for fluvial and coastal flood risk, and also currently for surface water flooding (SPP) – therefore the individual components must work effectively together to provide this standard of protection. In existing urban environments however, there is no such consistent target level of protection: the component parts have not been designed to work together to meet a set standard, therefore the individual components are not necessarily performing as a coherent whole to provide a set standard of protection.

Assuming that practice is in line with current legislation and guidance, new roads should not pose any issues in terms of flood risk management.

In addition, policy and design practices have changed over time. Existing roads have not necessarily been designed and constructed to the same standards (in terms of flood risk protection) that new roads are subject to. Problems can arise as the urban areas served by these roads; and their drainage systems; grow and/or other factors such as climate change increase pressure on existing capacity. A paper from the WaPUG Autumn Conference 2009 identified the average urban creep over 5 cities to add 0.749 m2/house/year to the impermeable area on curtilages. This is a significant problem, with the potential to have a greater impact on sewerage networks than climate change, but although there is a reactive route for addressing the impacts in terms of surface water flooding (i.e. through SWMP process under FRM(S)A), there is currently no clear legislative route by which to manage it proactively. This means that from the outset the individual components of the urban drainage system are not necessarily performing as a coherent whole to provide a set standard of protection.

Furthermore, as a system ages the standard of protection provided by its various components inevitably degrade over time, gradually eroded by a combination of asset deterioration, urban creep, population growth and climate change. Minor maintenance and repairs to existing roads (excepting extension schemes where significant impermeable area is being added) can be an aggravating factor as these are also not necessarily subject to the same standards as are applied across the trunk road network. The cumulative impact of these factors is that drainage for existing roads is likely to be inconsistent and significantly below design standards. Differing levels of protection are therefore likely to present a challenge for flood risk management within existing urban areas, and although local authorities are required to identify flooding issues and propose sustainable measures to resolve them, progression of schemes is resource dependent and there is no legal obligation to actually deliver the measures proposed. Issues around established single stream funding mechanisms as well as organisational silo thinking can hamper the effective sharing of resources

Differing levels of flood risk management protection are likely to occur in urban areas

and partnership funding which is necessary in many cases to resolve complex, multiple stakeholder urban flooding issues.

4.2.2 Alignment of processes

4.2.2.1 New roads (and significant extensions)

The Road Construction Consent (RCC) process required by Section 21 of the Roads (Scotland) Act 1984 is designed to ensure that appropriate development guidelines are followed, and to protect the future maintenance liabilities of the adopting roads authority. RCC is separate from the planning process, and new roads within a development are likely to require both. According to discussions with key stakeholders, small changes to road design are often made after outline consent is given, during the detailed design / construction process. Unless the road designer and RCC approver understand what constitutes a "material change" in terms of surface water management (and hence flood risk), this can lead to abortive work, and in the worst case, to the construction of road drainage systems which do not meet the wider flood risk management objectives for the development. There is also an issue in practice with ensuring that developments are constructed in accordance with the approved design. Although in theory this should be covered by the building control and vesting processes, a combination of limited resources (and budgetary constraints) within the adopting parties (local authorities and Scottish Water), tight timescales, and pressure from developers mean that the construction sign-off process can be difficult to police.

The National Roads Development Guide explicitly links the RCC process with the planning process, identifying how the stages of the two processes should run in parallel. Section 1.8 (The Need for Consultation) states that, "It is considered essential to ensure a holistic approach to the planning and the Roads Construction Consent (RCC) processes that developers consult with all officers at an early stage", and includes drainage and flood risk assessment within the items highlighted here. This is clearly intended to improve alignment between the two processes, highlighting where the links should be made between road drainage design (under RCC) and flood risk (as a material consideration of planning consent), and should help to resolve the above issue, but only if this best practice guidance is followed consistently: there remains a potential risk.

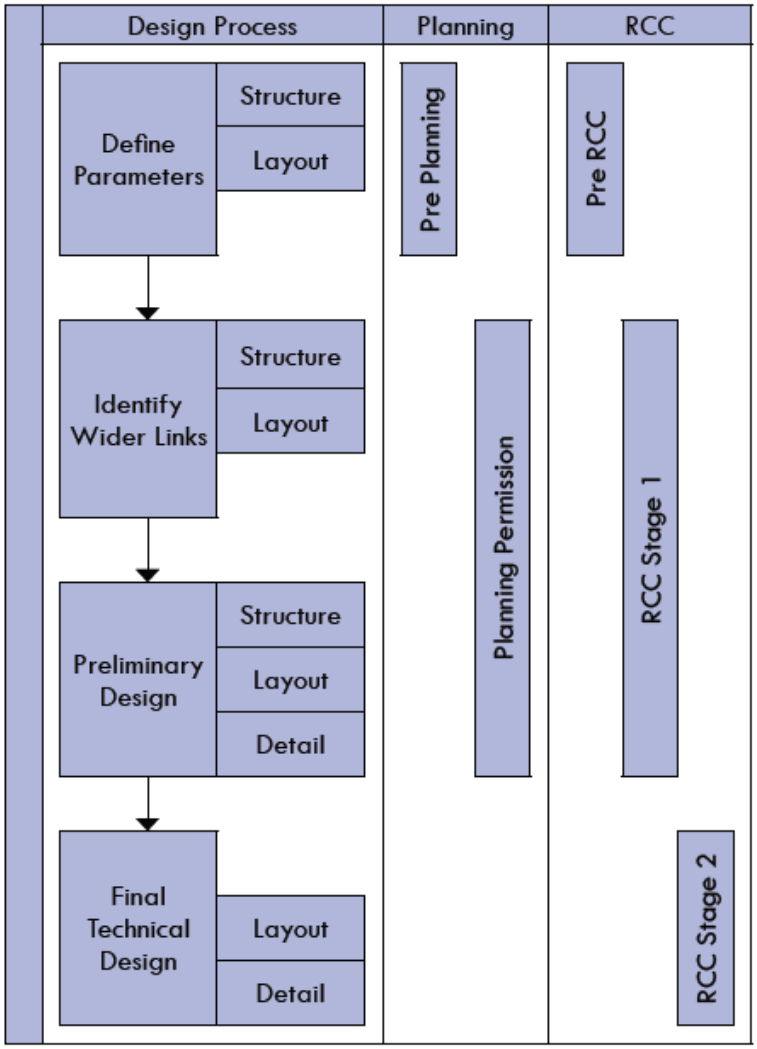


Figure 4-1: RCC and planning (The National Roads Development Guide)

The risk of disconnect between the road drainage detail and masterplanning and considering drainage late within the planning process could significantly limit the contribution of road drainage to sustainable surface water management.

Figure 4-2 places drainage within the final, "Street detail" stage of the design process. When considered in context with the RCC and planning processes as shown in Figure 4-1, this suggests that drainage would not be considered until the very end stages of, or possibly even after, planning permission and RCC stage. Leaving drainage to this late stage could create difficulties with land availability. In theory the developer should have already considered space for water within the earlier masterplanning stages of the development, and undertaken a flood risk assessment if required under SPP, and the earlier section on Block Structure states that: "Consideration should be given to the layout and impact of Sustainable Urban Drainage Systems (SUDS) when working on street and block layouts, as these can have determining effects on the overall urban structure." However, this is not as clear as it could be, and there remains a risk of a disconnect between the road drainage detail and the masterplanning, which could lead to road drainage systems being squeezed into the available space instead of maximising their contribution to sustainable surface water management by keeping water above ground to mimic natural systems.

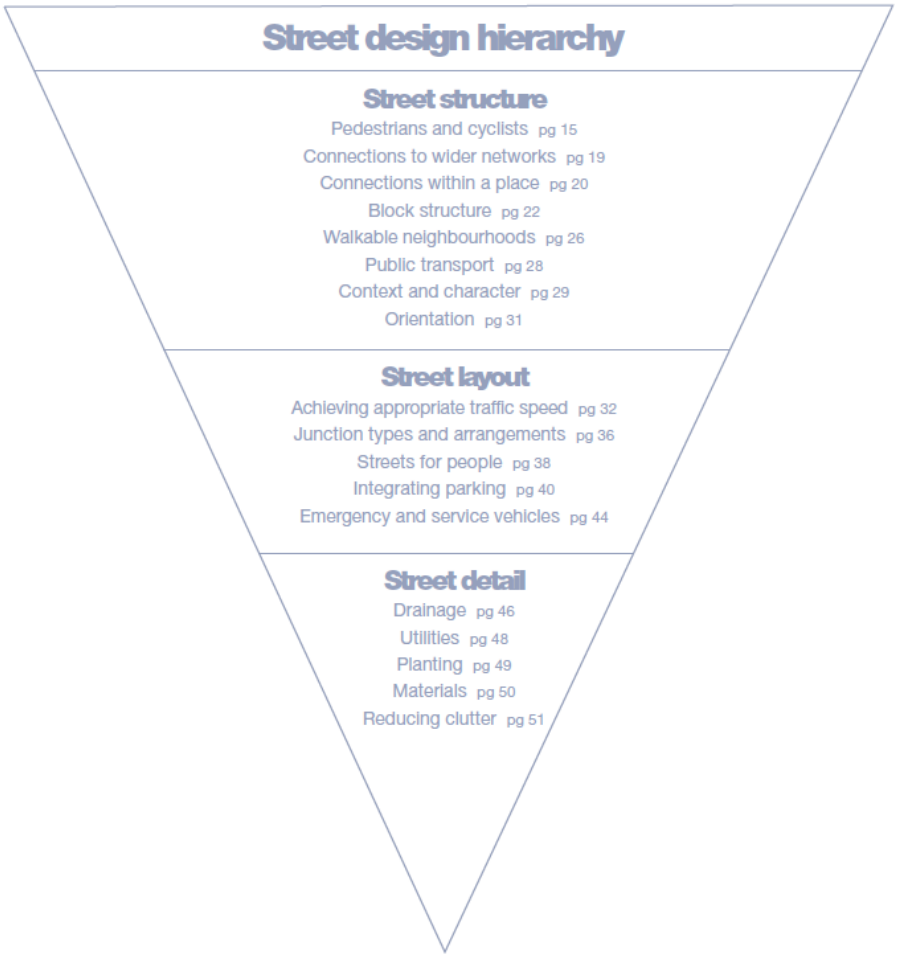


Figure 4-2: Hierarchy of street design (Designing Streets)

4.2.2.2 Existing roads

Maintenance and repair of existing roads is an area which presents opportunities to address legacy surface water issues, but this is not a factor addressed by existing legislation. The road design, construction and maintenance community in Scotland operates in a highly regulated environment, constrained by safety, performance and design specifications, codes of practice, public procurement rules, contractual agreements and warranties. Minimising risks to all road users is of fundamental importance. This narrow, standards driven approach does not encourage those with responsibility for operation and maintenance of existing roads to consider the bigger picture, and specifically the impact of their activities on flood risk management. Therefore whether or not people do so in practice is a subjective decision dependent on the individuals involved[7]. This leaves a potential gap between the two areas of practice which is likely to limit the realisation of opportunities to retrofit SUDS in the most cost beneficial way; i.e. by piggybacking on other works so that only the net additional cost of the SUDS over the traditional solution needs to be funded from sources other than road maintenance budget. These opportunities should, in the future, be picked up by the local authorities during the SWMP process.

Standards driven approach to maintenance and repair may limit the realisation of opportunities to retrofit SUDS in the most cost beneficial way.

[7] This position would change if the Roads Act is designated under the FRM Act

4.2.3 SUDS adoption

A key area of concern raised by stakeholders was the actual vesting (adoption) of SUDS. Despite huge steps forward in legislation and guidance, the practical experience of the stakeholder group is that adoption and maintenance of SUDS remains problematic in many cases. Factors identified through stakeholder discussions include:

- Lack of positive examples
- Lack of performance and cost evidence
- Reluctance to take on (perceived) risk of SUDS
- Behavioural blockers such as siloism (with respect to budgets and liability) and resistance to change

Policy provides for the adoption of SUDS by either the roads authority (where part of a road drainage system) or Scottish Water. Section 7 of the Sewerage Scotland Act 1968 allows Scottish Water to enter into agreements with roads authorities to receive flow from road drainage systems. Section 2.2.7 of the National Roads Development Guide states that, "All parts of a shared surface water system for road and curtilage water must be designed to allow future adoption/vesting by an in perpetuity regulatory body." Section 2.3.8 states that where any part of a road is drained into SUDS then that SUDS system will be subject to a (Road) Construction Consent, which must include a schedule of agreement setting out the detailed SUDS adoption agreements and indicating the various elements adoptable by the Roads Authority and/or Scottish Water. It states that the element of SUDS that is apportioned to the Roads authority will be adopted providing:

- *all elements of the SUDS for roads should be constructed in accordance with a Construction Consent;*
- *written evidence that the proportion of SUDS to be vested by Scottish Water is to be constructed to their standard.*

Despite all the efforts to close off this issue in terms of policy and guidance, according to feedback from key stakeholders the adoption and maintenance of SUDS remains in many cases a barrier to their successful implementation.

Section 3.10 of the same document contains a Schedule of Agreement for SUDS which is intended for use by roads authorities to facilitate the adoption process by making sure that key requirements are addressed during planning and RCC stages of the development. Scottish Water is obliged under WEWS to adopt other public SUDS, providing that its requirements for adoptable SUDS as set out in Sewers for Scotland 2nd Edition are met. Nonetheless, this remains a challenging issue in practice. So, between the roads authority and Scottish Water, all SUDS within public land should have a workable route for vesting established prior to approval of development proposals.

SUDS within private land, and those where ownership is not clearly established (e.g. residential and industrial / commercial developments where there is shared drainage between roads authorities and Scottish Water), remain a challenge. It has been identified that in many cases where SUDS are implemented they are not being owned and adopted by public bodies (i.e. the roads authorities and Scottish Water) but are instead in the ownership of the land / home owner and being maintained by private factoring companies. There have been no agreements to date on sharing SUDS between roads authorities and Scottish Water. It is generally considered less desirable to have SUDS in private (as opposed to public) ownership for the following reasons:

- Lack of transparency regarding maintenance of these systems where they are the responsibility of home owners and private factors.
- No authority has powers to require maintenance of a SUDS in private ownership (there may be an exception to this if lack of maintenance is causing flooding of a road, via Section 99 of the Roads (Scotland) Act 1984, but no provision relating to private SUDS causing flooding of a home).

- Lack of confidence regarding adequate maintenance of the drainage system may impact the ability of authorities to vest infrastructure which relies on the drainage system to function, e.g. public roads.
- Lack of transparency regarding funding mechanisms for surface water drainage infrastructure. In the majority of cases home owners would be paying Scottish Water rates (for waste water and drinking water) and council tax (these rates generally pay for surface water drainage of curtilage and roads as well), but if their property relied upon private SUDS for drainage then they would also be paying fees to a private factoring company for the maintenance of these.

To address these issues over the ownership and maintenance of SUDS, a working group has been set up with representation from Scottish Government, Scottish Water and the local authorities, to look at SUDS implementation. This work is on-going at the time of writing, and is concerned with the adequacy of the installation and subsequent on-going maintenance of SUDS installations. Attendance at the workshops includes Scottish Government Planning, Building Standards and Water Environment, together with representatives from SEPA and Scottish Water.

Despite all the efforts to close off this issue in terms of policy and guidance, according to feedback from key stakeholders there remains a general reluctance to adopt SUDS and agreement between roads authorities and Scottish Water under Section 7 of the Sewerage (Scotland) Act is the subject of ongoing debate. This means that SUDS are continuing to end up as the responsibility of private factoring companies (not the best route to ensure adequate long term maintenance), or in many cases not adopted at all. Work is ongoing by Scottish Water and SCOTS, as well as the SUDS Working Party, to resolve this as it constitutes a blocker to the wider application of SUDS techniques in Scotland.

UKWIR report 14/SW/01/8 notes in its review of international practice in sewer separation that both the USA and Australia have made significant progress in overcoming objections to SUDS, embedding their use as a key component of city- and catchment-scale sewer separation programmes. In both countries there are clear regulatory drivers that have pushed the sustainable drainage agenda forward more quickly than in the UK. In the USA this is driven by pollution control, as legislated through the Clean Water Act (CWA). A key element of the CWA is the requirement for municipalities to develop long term control plans (spanning 20 to 30 years) for CSO (combined sewer overflows). It has proved unaffordable in many US cities to meet the requirements of their CSO long term control plans through traditional sewage upgrade measures alone, and this has been a key factor in bringing low impact development (LID[8]) techniques into mainstream drainage practice.

In Australia, a holistic approach to water management (water sensitive urban design, or WSUD) has been largely driven by the need for water efficiency. The 2004 National Water Initiative (NWI), altered perception of surface run-off as largely a waste product to being viewed as a valuable resource requiring conservation. Previously in Australia, urban drainage planners had favoured hard-engineered, linear conveyance techniques designed to treat and remove stormwater from the system as quickly as possible. The 2007 Water Act also played a key role in driving Australia towards more sustainable approaches to water management. It is now widely accepted in Australia that holistic water management cannot be achieved through traditional urban water drainage approaches, and WSUD has become mainstream practice.

These international examples demonstrate the importance of a clear regulatory driver in the uptake of more sustainable, holistic approaches to water management. Within Scotland, the overall framework of legislation covering road drainage does promote, and in the case of new roads require, a precautionary approach to flood risk and the implementation of sustainable approaches; however, there is a lack of regulatory control and limited scope (or resources) for enforcement by the local authorities upon whom the burden generally falls. This weakens the overall case as the loop is not adequately closed.

[8] LID is an approach to land development (or re-development) that works with nature to manage stormwater as close to its source as possible (US EPA).

> "Experience…indicates that change is most likely to be delivered by effective regulation, appropriate monitoring and action by all concerned. In places where there is effective regulation, such as the USA, this drives best practice and the effective use of multi-beneficial Suds and creates a clear business case…"
>
> **UK sustainable drainage systems: past, present and future;** Ashley, Walker, D'Arcy *et al.*

4.2.4 Exceedance

Stakeholder discussions identified concerns over the management of exceedance flows as being an area where conflict occurs in practice. The issue revolves around the deliberate use of roads for storing and routing flows. Figure 4-3 illustrates the four domain design approach from CIRIA report RP991, with increasing levels of rainfall plotted against relative severity of consequence. This shows how designing for exceedance should form an integral part of the design process.

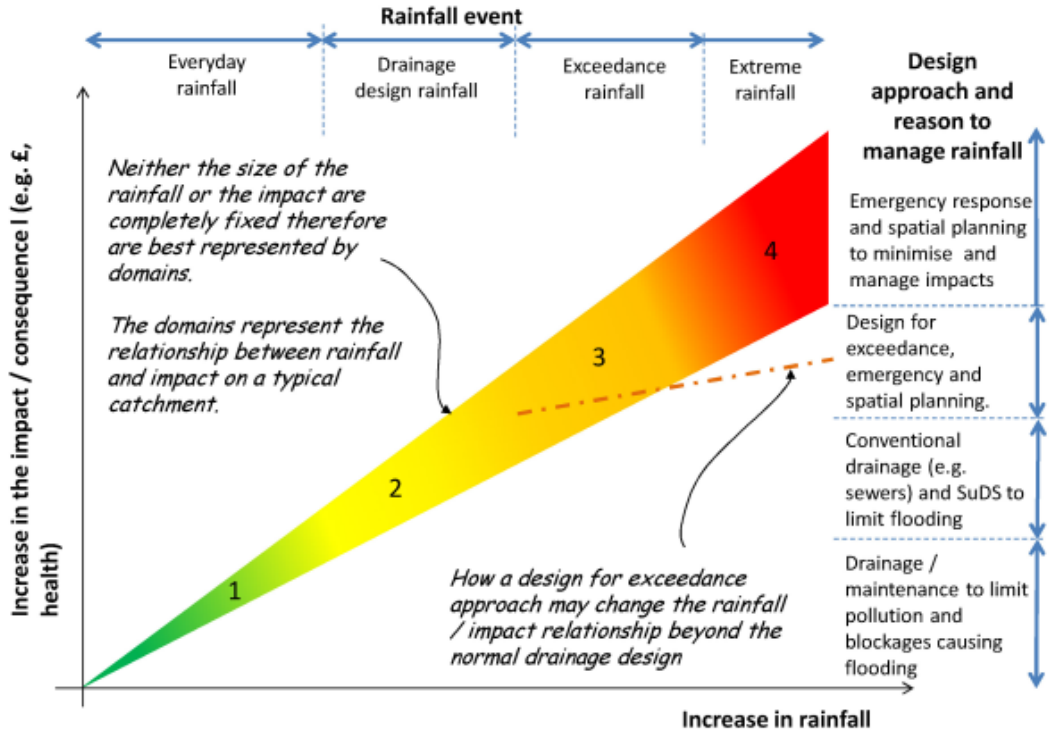


Figure 4-3: The 4 domain approach showing how designing for exceedance fits into the design process (CIRIA RP991)

4.2.4.1 New roads (and significant extensions)

Excellent guidance exists in the form of CIRIA publications C635 and C738 (which includes more practical support in the form of case studies). The Surface Water Management Planning Guidance (Feb 2013) highlights the importance of exceedance within the land use planning policy section of its Table 9 (Potential measures to address surface water flooding), stating the need to "ensure developments are designed for drainage exceedance events"; and it's principles of sustainable drainage include, "Design for exceedance by ensuring that existing and new developments have flood plains and safe flow paths.". SPP section 263 states that development planners should ensure that "Infrastructure and buildings should generally be designed to be free from surface water flooding in rainfall events where the annual probability of occurrence is greater than 0.5% (1:200 years)." This implies a requirement to design for exceedance, since drainage systems are only required to protect up to the 1:30yr event (Sewers for Scotland 3rd Ed.). However, it is not clarified whether the types of roads that might be used as exceedance routes are excluded from the definition of infrastructure, and thus from the requirement to be free from surface water flooding up to the 1:200yr event. The result is that it is not fully clear what is expected of developers on this front.

Since water on roads can present a hazard to road users and cause damage to the road itself, roads authorities tend to focus on evacuating water and may discourage the use of roads as flow pathways or temporary storage. In addition, there is a potential legislative blocker to exceedance design in that the Roads (Scotland) Act 1985 (Section 99) makes it an offence for landowners to allow "any flow of water or of filth, dirt or other etc. onto roads, offensive matter from, or any percolation of water through, the land onto the road", and gives roads authorities powers to address this. This may be interpreted as precluding the use of roads as exceedance routes. Clarification is needed on whether, and in what circumstances, it is acceptable to allow water to flow onto and along the road in a managed way as part of an exceedance design. For example, it is unlikely to be appropriate to use high speed trunk roads as exceedance routes for obvious safety reasons but there are many other circumstances where managed use of the road network for exceedance flows would offer benefits not only in terms of flood risk to other receptors, but also in terms of managing the impact on the road network itself. Unmanaged exceedance flows make emergency planning and recovery difficult, whereas managing exceedance allows roads authorities to plan alternative routes, forewarn road users, and focus resilient design and recovery-related maintenance to a limited number of routes thereby keeping costs down.

> Stakeholders identified the management of exceedance flows as being an area where conflict occurs in practice. Clarification is needed on whether, and in what circumstances, it is acceptable to allow water to flow onto and along the road in a managed way as part of an exceedance design.

4.2.4.2 Existing roads

Surface water flooding has become an increasing problem in our existing urban areas over the past decade. The National Flood Risk Assessment (NFRA) published by SEPA in December 2011 estimated surface water flooding accounts for around 38% of predicted impacts, i.e. an average annual damages cost of £300m plus. This is a fundamentally urban problem and road drainage is a key factor, with road runoff contributing around 50% of the flow in urban drainage networks under storm conditions, according to an industry expert.

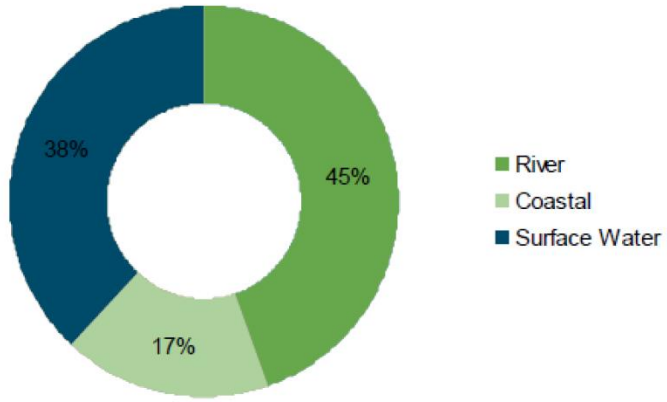


Figure 4-4: Main sources of flood risk in Scotland (NFRA, SEPA)

When surface water flooding occurs within existing urban areas flows bypass or surcharge drainage systems and emerge as overland flow, finding natural routes and often flowing around or through properties. It is not always clear where these exceedance flows originate from, and cause and effect may not be obviously linked: i.e. the people who suffer the consequences are often not the people causing the problem. Traditional "road only" solutions are often not effective in this situation, for instance re-contouring or adding extra gullies will not necessarily catch these flows, or if it does it may simply move the problem elsewhere. The situation is aggravated by the historical lack of clarity over ownership and maintenance responsibility for surface water assets: there are usually multiple stakeholders, with disparate objectives, and solutions often require input from organisations/people not

directly benefitting (or in the case of storing/routing flows on roads, potentially being inconvenienced). Behavioural issues such as siloism and reluctance to share budgets can prevent effective collaborative solutions from being progressed.

In addition, space is usually restricted within existing urban areas, meaning that opportunities to incorporate SUDS features are more limited than for new roads within new developments. Retrofitting SUDS is a recommendation of the SWMP Guidance, with additional best practice guidance available in the form of CIRIA's guidance C713, C738 and also C173 (Retrofitting to Manage Surface Water). With limited space, complex issues, multiple stakeholders, concerns regarding SUDS adoption (see above), and resource constraints, it is unsurprising that stakeholders raised this as an area where more could be done to encourage road drainage to support the wider aims of flood risk management.

The cumulative result is that management of exceedance flows within existing development is an area where there is significant potential for conflict between road drainage and flood risk management.

With limited space, complex issues, multiple stakeholders, concerns regarding SUDS adoption, a lack of funding, retrofitting SUDS to help manage exceedance flows has significant potential for conflict.

5 Conclusions and recommendations

5.1 Recommended measures

This project has highlighted a number of areas of conflict between road drainage design and flood risk management, as well as several areas where opportunities to achieve more cost effective and sustainable solutions are routinely being missed. The recommended measures are summarised in Table 5-1 with further explanatory text below.

Table 5-1: Suggested measures

Scenario	**Areas of potential conflict**		
	Regulatory	**Behavioural/organizational**	**Suggested solutions**
New build trunk roads (road only surface water) (and significant extensions)	None identified	Accountability issues, and risks to delivery timetables, may discourage Transport Scotland from implementing joint solutions, meaning opportunities to achieve cost efficiencies by partnering with other organisations in flood risk management schemes may be missed	Continued efforts by all flood risk and road drainage stakeholders on partnership working.
New build non-trunk roads (and significant extensions)	Potential legislative conflict to use of roads to manage exceedance: Roads (Scotland) Act 1985 (Section 99) section 99 of the roads states The owner and the occupier of any land, shall prevent any flow of water or of filth, dirt or other offensive matter from, or any percolation of water through, the land onto the road. A person failing to comply with this commits an offence. Road drainage recommended, but not required to be considered until latter	Road designers and roads authorities often don't understand what constitutes a material change to design from a flood risk perspective – risk of changes being made which are detrimental to flood risk aims Capacity constraints within roads authorities (and Scottish Water) make it difficult to ensure that drainage is constructed in accordance with approved design	More effective dissemination of existing best practice guidance Pilot projects to test different ways to share solutions A common register of some sort, perhaps of areas of interest for flood risk improvements, to facilitate the identification of joint opportunities Develop overarching drainage and flood risk policy to bring together the various existing policy and guidance requirements (signpost existing documents without re-producing them).

	stages of design – may miss opportunities to achieve cost efficiencies (and more sustainable solutions and multiple benefits) by combining road drainage with SUDS for wider development, aligning planning permission, RCC and Scottish water consent process. Exceedance flows should be planned for as part of overall development, and this is implied under SPP, but it is not clear and also appears to be contradicted by the requirement to keep infrastructure free from surface water up to a 1:200yr event. Ministerial Guidance and other best practice guidance recommends designing for exceedance but a clear legislative requirement is lacking.	Challenges in getting agreement of shared SUDS between Scottish Water and roads authority Drainage may be left until latter stages of design by which stage it is too late to provide adequate space Difficulties with the vesting of SUDS in public land	
Maintenance, repair and minor improvements to existing roads	No legislative requirement to consider flood risk when undertaking minor works to existing roads	Challenges in getting agreement of shared SUDS between Scottish Water and roads authority Lack of communication between roads authority, flood risk management functions, and other related functions (e.g. parks and open spaces) of local authorities Organisational budgetary constraints (and silo thinking) can prevent departments/ organisations from contributing to schemes where benefits are not directly realised by themselves	To address these issues over the ownership and maintenance of shared roads authority and Scottish water SUDS a working group has been set up with Scottish Government, Scottish Water and local authorities, looking at SUDS implementation. The workshop is on-going and is concerned with the adequacy of the installation and subsequent on-going maintenance of SUDS installations. Attendance at the workshops is restricted to legislators, with attendees from Scottish Government Planning, Building Standards and Water Environment, together with representatives from SEPA and Scottish Water. Need to align planning permission, building warrant, RCC and Scottish Water consent. Review guidance to ensure surface water drainage and drainage exceedance is considered at the first stages of planning e.g. make sure this is clear in designing streets,

			and roads development guide, requirements for different stages of the land use planning process. Recommend that Roads (Scotland) Act is designated as a flood risk related function under FRM(S)A – this would require construction of new roads and management of existing roads to be consistent with objectives of FRM(S)A. More effective dissemination of existing best practice guidance Training for roads authorities to help staff identify what type of changes affect flood risk Improved communication between road and flood risk functions within local authorities Roads and flood risk management authorities request a review of section 99 of Roads (Scotland) Act – what are the implications of this for the FRM Act and management of surface water flooding and does it need to be amended?
Exceedance within existing urban areas	Potential legislative blocker to use of roads to manage exceedance: Roads (Scotland) Act 1985 (Section 99) Legislation provides a 'blunt instrument', offering grounds for legal action against those responsible for inappropriate flows, but without offering any direction regarding possible solutions Institutional barriers prevent budget sharing	Although local authorities are required to identify flooding from all sources and propose sustainable measures to resolve it, multiple stakeholders, complex flooding mechanisms, constrained resources and low cost benefit ratios make resolution challenging Reluctance to share budgets or contribute to solutions which don't bring direct benefits Perception of SUDS as being land-hungry Challenges in getting agreement of shared SUDS between Scottish Water and roads authority Scottish Water and/or	Recommend that Roads (Scotland) Act is designated as a flood risk related function under FRM(S)A – this would require construction of new roads and management of existing roads to be consistent with objectives of FRM(S)A. More effective dissemination of existing best practice guidance Improved communication between road and flood risk functions within local authorities Decision framework identifying triggers for consultation between road and flood risk functions Pilot projects to build evidence base on retrofit SUDS costs and collect long-term performance data Strategic opportunity mapping of road schemes against

		roads authority design traditional sewerage or road drainage solutions in isolation, because more sustainable solutions are perceived as being harder (they involve other parties, take longer, require more effort, and costs and benefits harder to apportion)	flood risk areas – develop flood risk maps for roads, identify and prioritise action vs. flood risk hotspots Training for roads authorities to help staff identify what type of changes affect flood risk
Land drainage "run-on" to roads	No legislation or guidance regarding appropriate standards to apply if a roads authority were to implement additional measures (e.g. enhanced maintenance or upgraded drainage) to contain flows that were not due to the road surface itself	Section 99 of the Roads (Scotland) Act could be used to prevent land drainage flows getting onto the carriageway, but roads authorities rarely use these powers due to resource constraints Not considered a roads authority priority unless the flow is causing flooding on the carriageway itself	Roads and flood risk management authorities request a review of section 99 of Roads (Scotland) Act – what are the implications of this for the FRM Act and management of surface water flooding and does it need to be amended? Recommend that Roads (Scotland) Act is designated as a flood risk related function under FRM(S)A – this would require construction of new roads and management of existing roads to be consistent with objectives of FRM(S)A. Clarify SPP intention that roads can be used as part of a planned and sustainable approach to surface water flood management and do not necessarily need to be free from surface water flooding in the 1 in 200 year event Improved dissemination of existing guidance and of case studies from CIRIA RP991 Pilot projects to demonstrate and test space-saving SUDS solutions Training for staff on green/grey SUDS approaches New guidance or process showing what to do when private factoring companies fail to maintain SUDS, including test cases

We have grouped the situation-specific measures identified in Table 4-1 into the following more general categories:

- Dissemination and training
- Research and pilot projects
- Improved communication and collaboration
- Alignment of consent processes e.g. planning consent, building warrant, RCC and Scottish water consent for shared SUDS schemes.
- New / updated guidance and tools
- Regulatory measures

In the following sections we explore these recommendations in more detail and identify specific actions to take forward from this research.

5.1.1 Dissemination and training

In several cases this research shows that existing best practice guidance should be sufficient, but it is not being implemented in practice (for example in the case of designing for exceedance – CIRIA report C738 recognises and attempts to rectify this). Capacity building within local authorities would help to address this. The capacity building programme run by Defra in 2011-12 (to build capacity within local authorities to enable them to meet their responsibilities under the Flood and Water Management Act 2010) is a good example of how a coordinated programme of events could be organised.

The following dissemination and training measures are recommended:

- More effective dissemination of existing best practice guidance – rolling programme of capacity building events and training material organised and led by SCOTS, the SUDS Working Party or SEPA
- Training for roads authorities to help staff identify what type of changes to RCC might affect flood risk
- Training for staff on green/grey SUDS approaches
- Dissemination, training, and/or pilot projects, to support use of roads authorities' Section 99 enforcement powers to resolve flooding caused by land drainage entering the sewer system via road drainage
- Training within roads authorities (and other departments of local authorities with a role in SUDS vesting etc) to raise awareness of the FRM(S)A and its requirements

5.1.2 Research and pilot projects

This project has highlighted several issues which could be resolved or at least significantly improved by developing a more comprehensive evidence base. A lack of positive examples has been identified by the stakeholder group as a barrier to the implementation of more sustainable, holistic solutions to resolve exceedance flooding within existing urban areas. Poor perception of SUDS performance and costs causes a general unwillingness to adopt SUDS (Scottish Government working group is already set up, to try to resolve the Section 7 deadlock), and leads road drainage practitioners to stick to more traditional, tried and tested piped drainage solutions. CIRIA reports C713 and C738 include a range of case studies, but it is important to build up a country-specific evidence base and local pilot projects that focus specifically on the issues identified for Scotland.

Scotland is ahead within the UK, having made much progress over the past decade, but until the issue of adoption is resolved SUDS will continue to be perceived by many as a "nice to have" rather than a necessary weapon in the arsenal against surface water flooding.

SEPA has assessed the impact of flooding on roads and this information can be seen in the consultation on the draft flood risk management strategies available on line https://frm-scotland.org.uk/. These show the length of road at risk of surface water flooding in potentially vulnerable areas, but the statistics have not yet been interpreted on a national scale. The national data set is expected to be included in the final flood risk management strategies, due to be published in December 2015. As an example, in the Clyde and Loch Lomond Local Plan District (which includes Glasgow) a total of 391km of road is predicted to be at risk of surface water flooding. This demonstrates the importance of effective surface water management for roads authorities – proactively planning for exceedance, and opportunistic implementation of retrofit SUDS ("nibbling"), could enable roads authorities to realise a significant reduction in the length of road at risk of surface water flooding. Quantifying this reduction through a combination of further research and demonstration projects would confirm whether (and in what circumstances) the benefits outweigh the disadvantages, enabling roads authorities to make an informed choice regarding the use of roads for source control and exceedance routing. SCOTS has made a start towards understanding of the trade-off between inconveniencing road users and inconveniencing residents with sewer flooding, by conducting research into the acceptability of using certain roads for flood risk management. This research is investigating how much flooding is acceptable, and on what class of road, and what would be needed to make it acceptable, for example would demonstrating that road users would still be able to get from A to B (albeit via C to avoid flooded routes) without too much inconvenience be adequate?

Figure 5-1: Road re-profiled to route exceedance flows (St. Blazey case study, CIRIA C738)

The following research and pilot project measures are recommended:

- Encourage or incentivise new projects to test different collaboration approaches
- Encourage or incentivise new projects to demonstrate and test space-saving retrofit SUDS solutions
- Ensure new projects provide evidence base on SUDS costs, long-term performance and multiple benefits

5.1.3 Improved communication and collaboration

Some issues, such as resistance to budget sharing, are both institutional and behavioural. There are some genuine organisational and legislative barriers which make it difficult to spend money from one department's (or organisation's) budget on addressing the concerns of another. However, this also filters down into a general reluctance to risk spending budgets on "other people's problems". This is a

particular problem in existing urban areas where it can be difficult to apportion the costs and benefits of solutions in an equitable manner. For example the potential exists for roads authorities to use their powers under Section 99 of the Roads (Scotland) Act to support wider flood risk management aims, by preventing land drainage from entering Scottish Water's sewer network via road drainage and causing flooding remote from the source of the flows. This is not happening in practice though, possibly because those in roads authorities who deal with these types of schemes are not aware of the potential to contribute to flood risk betterment, or because even pre-enforcement negotiations can be resource intensive, so unless the flows are causing unacceptable disruption or damage to the road network roads authorities are unlikely to prioritise investment in this area. Test cases of Scottish Water and/or local authority flood risk management teams funding roads authorities to pursue negotiations and enforcement under Section 99 are needed to show how this could work in practice.

In the case of road drainage causing sewer flooding downstream, an honest discussion is needed between Scottish Water and the roads authority to assess what is needed to alleviate the problem (e.g. what level of attenuation would be required to give the timelag needed to resolve the sewer flooding), versus what level of ponding on the carriageway is acceptable and for how long. An holistic cost benefit analysis would be needed to support the business case for a roads authority to undertake works to resolve sewer flooding. The appropriate vehicle for this is the local authority SWMP process.

The following communication and collaboration measures are recommended:

- Improved communication and collaboration between road and flood risk functions within local authorities, and Scottish Water (supported by research and decision support tools – see sections 5.1.2 and 5.1.4)

5.1.4 New guidance and tools

Some of the areas of potential conflict identified would benefit from the development of good practice guides and/or decision support tools. An example is provided in Appendix A of what one such decision support matrix might look like.

The following new guidance and tools are recommended:

- Decision framework identifying triggers for consultation between road and flood risk functions
- Strategic opportunity mapping of road schemes against flood risk areas – this should be done as part of the SWMP process
- New guidance or process showing what to do when private factoring companies fail to maintain SUDS, including test cases
- New guidance or decision support tool to help assess cost benefit of enforcement and identify under what circumstances it might be more cost effective compared to the cost of additional maintenance and repair necessitated by water ingress
- Review guidance to ensure surface water drainage and drainage exceedance is considered at the first stages of planning e.g. make sure this is clear in designing streets, and roads development guide, requirements for different stages of the land use planning process

5.1.5 Regulatory measures

Discussions with practitioners suggest that although Section 99 of the Roads (Scotland) Act could theoretically get in the way of using roads for storage and routing runoff; this is more of a threat than a reality since enforcement is expensive and time consuming, and resource constrained local authorities don't have adequate resources to prioritise it. This is enough to make it a perceived blocker, but it may be beneficial to run some test cases to demonstrate that it can be overcome in practice. Different types of solutions are appropriate for different classes of road, clearly, but if exceedance is not proactively

managed it will find its own route in an unmanaged way which could prove far more dangerous. Practitioners need to take a risk-based approach and develop the best fit solution for each individual set of circumstances.

Local authorities have also suggested that other legislation (e.g. around equal opportunities and access) make it harder to use roads as channels for water, but this has been overcome in other areas where shared spaces are already being implemented (e.g. the Dings, Bristol[9]).

The following regulatory measures are recommended:

- Recommend that the Roads (Scotland) Act is designated as a flood risk related function under the FRM Act – this will require construction of new roads and management of existing roads to be consistent with objectives of FRM(S)A.
- Roads and flood risk management authorities request a review of section 99 of Roads (Scotland) Act – what are the implications of this for the FRM Act and management of surface water flooding and does it need to be amended?
- Clarify SPP intention that roads can be used as part of a planned and sustainable approach to surface water flood management and do not necessarily need to be free from surface water flooding in the 1 in 200 year event

9 http://www.futurecommunities.net/case-studies/retrofitting-home-zone-dings-bristol-2004-2006

Appendix A – Overview of relevant legislation and guidance

A.1 Legislation and guidance – at a glance

	Road drainage	Flood risk management
Legislation	• **Transport (Scotland) Act 2005** – Overarching transport legislation – Provides for setting up and functions of new transport bodies and enables Scottish Ministers to discharge certain transport functions • **Roads (Scotland) Act 1984** – Primary legislation affecting roads – Main purpose is to enact similar provisions to those encompassed in the various Highways Acts of England and Wales – Duty (and powers) to drain roads & prevent water flowing onto them (S.30, S.31 & S.99) • **Water Environment and Water Services (Scotland) Act 2003** – Interpretation of Water Framework Directive – Established river basin management planning approach – Amended the Sewerage (Scotland) Act 1968 to include SUDS – Gives Scottish ministers powers to introduce regulatory controls over water activities, in order to protect, improve and promote sustainable use of Scotland's water environment (see Water Environment Controlled Activities (Scotland) Regulations) • **Water Environment (Controlled Activities) (Scotland) Regulations 2011** – Interpretation of the European Water Framework Directive into Scottish Law – Practical embodiment of Section 20 of the WEWS Act introducing regulatory controls over water activities, in order to protect, improve and promote sustainable use of Scotland's water environment – Applies to any activity which may affect Scotland's water environment, including discharges, disposal to land, abstractions, impoundments and engineering works • **New Roads and Street Works Act 1991** – Code of Practice for the Co-ordination of Works in Roads – ***Part II – New Roads in Scotland*** – ***Part VI – Road Works in Scotland***	• **Flood Risk Management (Scotland) Act 2009** – Established a new approach – New responsibilities for SEPA, Scottish Water and Local Authorities – Introduced flood risk management plans (SEPA), and local flood risk management plans (Local Authorities) – Duty for local authorities and other responsible authorities to reduce overall flood risk when undertaking their flood risk related functions • **Scottish Planning Policy (SPP)** – Sets policy for the preparation of development plans and the determination of planning applications and appeals • **Town and Country Planning (Development Management Procedure) (Scotland) Regulations 2008** – Establishes SEPA and Scottish Water as a statutory consultees for development

	Road drainage	Flood risk management
	• **Sewerage (Scotland) Act 1968** – Set functions for the former sewerage authorities (now Scottish Water), including the requirement for consents to discharge to sewers in Scotland – Section 7 concerns agreements between roads authorities and Scottish Water to discharge surface water from roads into sewers	
Guidance	• **SUDS for Roads** – Collaborative framework for a more integrated drainage approach – SUDS application overview, practical design and construction guidance – Accompanying Whole Life Costing tool: SUDS for Roads Whole Life Cost and Whole Life Carbon Toolkit • **Design Manual for Roads and Bridges** – Comprehensive manual system which accommodates all current standards, advice notes and other published documents relating to the design, assessment and operation of trunk roads (including motorways) • **Network Maintenance Manual** – Describes the processes for the management of the maintenance service • **Routine and Winter Service Codes** – Performance requirements for highways and structures and the operational winter service on the motorway and trunk road network • **Designing Streets** – Produced by SCOTS with Transport Scotland and the Scottish Government to support the placemaking agenda – Raises the importance of street design issues from that of guidance and advice to policy – Enshrines in policy the concept that roads within certain environs cater for wider functions than just the movement of people and traffic • **The National Roads Development Guide** – Supports Designing Streets and expands this to address the interface with other roads – Intended as the technical enabler to the Designing Streets policy document	• **Ministerial Guidance on SFM** – Sets out the principles of sustainable drainage • **Flood Risk Management (Scotland) Act 2009: Surface Water Management Planning Guidance, Feb 2103** – Guidance to assist responsible authorities in preparation of Surface Water Management Plans (SWMPs) – best practice by which to identify the most sustainable measures to manage urban drainage and the risk of surface water flooding – Developed by the Scottish Advisory and Implementation Forum for Flooding (SAIFF) which includes representatives from Scottish Government, local authorities, Scottish Water and SEPA • **CIRIA C697 The SUDS Manual** – Best practice guidance on planning, design, construction, operation and maintenance of SUDS to facilitate effective implementation in developments • **CIRIA C713 Retrofitting to Manage Surface Water** – Framework for more effective retrofitting of surface water management measures • **SEPA regulatory process (RM-08)** – Sets out SEPA's guidance on SUDS and the planning consultation procedure for new developments – SUDS are a legal requirement for all developments except single dwellings and those which discharge to coastal waters • **PAN61: Planning and Sustainable Urban Drainage Systems** – Good practice advice for planners and the development industry on

<table>
<tr><th></th><th>Road drainage</th><th>Flood risk management</th></tr>
<tr><td></td><td>• Local Authority road development guidelines (various)
– Conventional road drainage for local roads designed to 1 in 1 year design frequency (Road Note 35)</td><td>SUDS

• Online Planning Advice on Flood Risk (replaced PAN69)
– Background information and best practice advice in support of Scottish Planning Policy (SPP) 7: Planning and Flooding

• Land Use Planning System SEPA Guidance Note 8
– SEPA standing advice for planning authorities and developers on development management consultations</td></tr>
<tr><td></td><td colspan="2">• CIRIA C738 Designing for exceedance
– Provides best practice guidance on enabling better management of local flood risk and surface water by creating safe and resilient flood routes, temporary storage areas, and making use of other measures to reduce the impact of flooding

• CIRIA Research Project RP993: Demonstrating the multiple benefits of SuDS – A business case (Phase 2), Draft Literature Review (October 2013)
– Literature review describing current practice in relation to using valuation tools and approaches to assess the value and distribution of the wider benefits of SuDS.

• Sewers For Scotland 3rd Edition
– Definitive guide for use by developers in Scotland for the provision of sewerage
– Details the procedures and provides guidance for the design and construction of sewerage infrastructure
– Consistent with the Sewerage (Scotland) Act 1968
– 2nd Edition was published in 2007 to incorporate SUDS

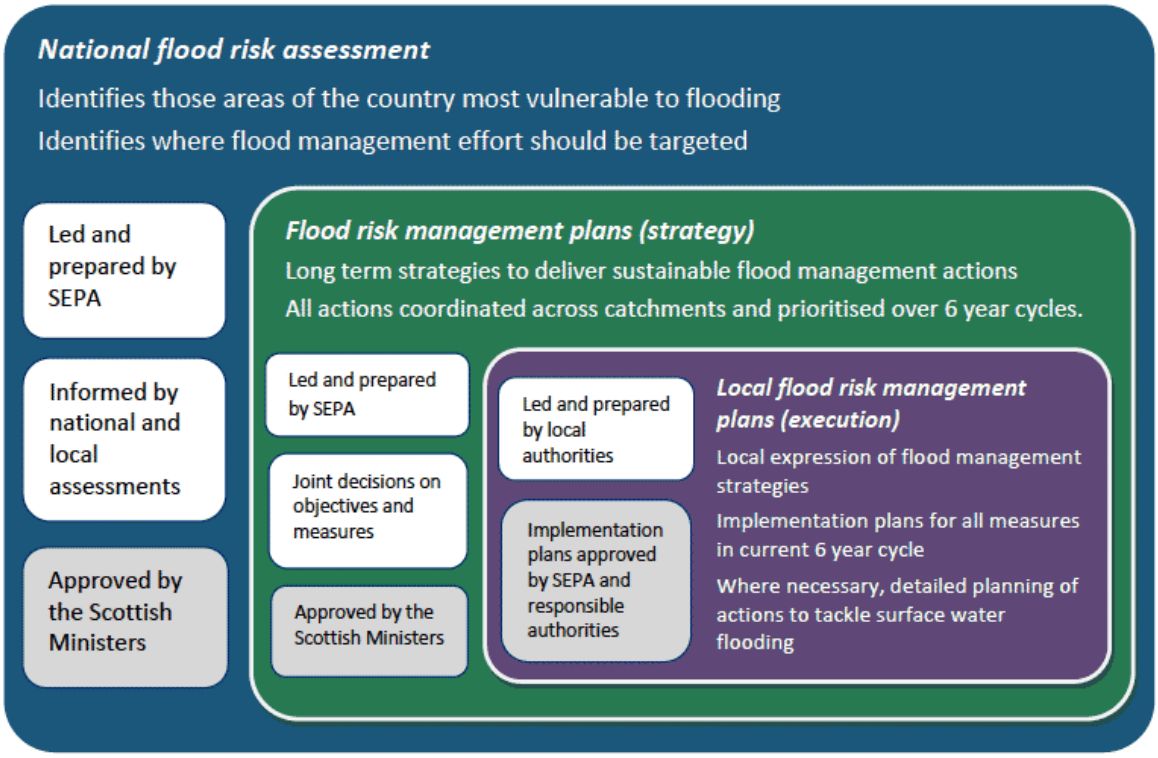
• SUDS Vesting Guide (Scottish Water) Nov 2014
– Guide to the vesting process explaining what types of SUDS will be eligible for vesting by Scottish Water, setting out application process, construction criteria and assessment details.

• PAN79: Water and Drainage
– Clarifies role of planning authority in setting direction of development to inform co-ordinated planning and delivery of new water infrastructure
– Explains the roles of Scottish Water and SEPA and encourages joint working</td></tr>
</table>

A.2 Flood risk management
A.2.1 Legislation

The Scottish Environment Protection Agency (SEPA) is Scotland's environmental regulator. Its purpose is to protect and improve the environment, including the sustainable management of natural resources. SEPA is the flood warning authority in Scotland and also has a strategic role in managing flood risk.

For Flood Risk Management purposes, Scotland is divided into 14 Local Plan Districts (LPD) identified within the National Flood Risk Assessment. The LPD were identified through a collaborative approach via the Scottish Advisory and Implementation Forum for Flooding (SAIFF) which has representatives from Scottish Government, local authorities, Scottish Water and SEPA. Under the Flood Risk Management (Scotland) Act 2009 each LPD requires the production of a Flood Risk Management Strategy (by SEPA) and Local Flood Risk Management Plan (by local authorities). There are 32 local authorities in Scotland, each with a responsibility to manage flood risk in their area. One lead local authority has been identified for each LPD to coordinate the preparation of its Local Flood Risk Management Plan, and the other local authorities covering each LPD have a responsibility to assist.



The **Flood Risk Management (Scotland) Act 2009** (**FRM(S)A)** is the main flood risk management legislation for Scotland. Local authorities are required under the FRM(S)A to undertake local flood risk management plans which identify priority areas, and set out potential schemes and other measures for managing flood risk within potentially vulnerable areas. These strategies will direct local approaches to flood risk management over the coming years, helping to determine the location and nature of new development.

There is no specific reference to roads in the FRM(S)A other than a minor amendment to the Roads (Scotland) Act 1984 to update the policy reference. Roads are included in general development however, and Part 3, Section 42 amends the Town and Country Planning (Development Management Procedure) (Scotland) Regulations 2008 to state that where an application relates to, "a development that is likely to result in a material increase in the number of buildings at risk of being damaged by flooding", an assessment of flood risk is required. This means that flood risk would be considered for roads within new developments, which is likely to cover the majority of new roads other than trunk roads.

Part 1, Section 1 (1) imposes a general duty on Scottish Ministers, SEPA, local authorities, Scottish Water and other responsible authorities to exercise their flood risk related functions with a view to managing and reducing flood risk and to promote sustainable flood risk management. This could be interpreted to include local authorities' functions as roads authorities, but the designation of flood risk related functions has not been fully defined by the Scottish Government as yet so this is not confirmed. Other pieces of legislation (in particular the Roads (Scotland) Act 1984 and Sewerage (Scotland) Act 1968) could potentially be designated as flood risk related functions, but this has not been determined at the time of writing.

Part 3, section 16 requires Scottish Water to assess flood risk from sewerage systems for each area identified by SEPA as a "potentially vulnerable area"[10], and for any other area identified by SEPA. Scottish Water is progressing these assessments, and in addition has already undertaken five Integrated Catchment Studies (ICS), with a further 15 scheduled to commence from 2015-2021. ICS are joint projects between Scottish Water and Local Authorities to look at all components of flooding and develop the models which will be required to inform future Surface Water Management Plans (SWMP).

The Water Framework Directive was transposed in Scotland into primary legislation, by way of the **Water Environment and Water Services Act (WEWS) 2003**. Sections 29, 30 and 33 of the WEWS Act amend the Sewerage Scotland Act 1968 and the Water Industry (Scotland) Act 2002 to include for the connection and adoption of SUDS by Scottish Water, making Scottish Water responsible for SUDS that receive run-off from impermeable surfaces within a property boundary. In order to be vested by Scottish Water, such SUDS must be designed to Scottish Water's specifications as set out in its manual "Sewers for Scotland 3rd Edition" (and the appropriate technical specification). Section 20 of the WEWS Act gave Scottish Ministers powers to introduce regulatory controls over water activities, in order to protect, improve and promote sustainable use of Scotland's water environment. This has been achieved by the introduction of the **Water Environment (Controlled Activities) (Scotland) Regulations (CAR) 2011** (originally introduced in 2005, with various amendments and additions since). WEWS (via CAR) makes SUDS obligatory for managing surface water drainage from all new developments excepting single dwellings and those draining to coastal waters. See roads section below for more details on what CAR means for road drainage design.

Scottish Planning Policy (SPP) (June 2014) directs that the planning system should promote a precautionary approach to flood risk from all sources, promote flood avoidance, flood reduction and the use of SUDS to minimise impermeable surface areas. This applies to all development including roads, thereby ensuring that all new roads and road schemes requiring planning permission should be designed with the aims of flood risk management and reduction in mind. SPP states that infrastructure and buildings should generally be designed to be free from surface water flooding in rainfall events where the annual probability of occurrence is greater than 0.5% (1:200 years)[11].

The **Town and Country Planning (Development Management Procedure) (Scotland) Regulations 2008** establishes SEPA as a statutory consultee for development which "is likely to result in a material increase in the number of buildings at risk of being damaged by flooding", and Scottish Water where the development is "likely to require a material addition to or a material change in the services provided by that authority". This links flood risk management and surface water drainage as a material consideration of development planning, and thus of the design of any new roads included within such developments.

The **Sewerage (Scotland) Act 1968** is not specific to flood risk or road drainage but bridges the divide because sewers are a link between road drainage and fluvial flood risk. Sewers receive flows from road drainage which can affect flood risk downstream, and conversely, surface water sewers often drain to watercourses so fluvial flooding can cause them to back up and affect road drainage. The Sewerage (Scotland) Act set functions for the former sewerage authorities (now Scottish Water), including the

[10] Defined in the FRM(S)A as any area for which SEPA considers that significant flood risk either exists, or is likely to occur.

[11] This would appear to rule out the use of developed areas as exceedance flow routes or temporary storage, although the use of the term "generally" provides an opportunity for negotiation. No further clarification has been issued on this point.

requirement for consents to discharge to sewers in Scotland. Under this Act, Scottish Water is required to "effectually drain" surface water from roofs and paved areas within the curtilage of premises, and Part 1, S1 sets out the duty and powers (originally of local authorities but now Scottish Water) to provide such public sewers as may be necessary for this purpose. Scottish Water has no obligation to drain roads, footways or paved surfaces outside property curtilages (i.e. public roads and footpaths), or to drain groundwater or accept land drainage connections. However, Part 1, Section 7 states that "a roads authority and Scottish Water may agree, on such terms and conditions as may be specified in the agreement, to the provision, management, maintenance or use of their sewers or drains for the conveyance of water from the surface of a road or surface water from premises." Clause 3 of this same section notes that a roads authority or Scottish Water shall not "unreasonably refuse" such an arrangement, or insist on unacceptable terms. Part 1, Section 12(3) states that Scottish Water has the right to impose reasonable conditions on any flow which enters into Scottish Water system, which covers road runoff.

A.2.2 Guidance

In addition to the main legislation there are various guidance documents with relevance to flood risk management.

The **Ministerial Guidance on Delivering Sustainable Flood Management (Scottish Government 2011)** sets out statutory guidance to SEPA, local authorities and Scottish Water on fulfilling their responsibilities under FRM(S)A 2009 and, in particular, on the steps that should be taken to manage flooding in a sustainable manner. It establishes five overarching outcomes for Scotland, of which the two listed below relate specifically to the complimentary role which road drainage can play in flood risk management:

- Rural and urban landscapes with space to store water and slow down the progress of floods.
- Integrated drainage that decreases burdens on our sewer systems while also delivering reduced flood risk and an improved water environment.

It states that SEPA and the responsible authorities must work across traditional institutional boundaries to deliver an integrated approach to flood risk management. The Guidance identifies Surface Water Management Plans as the best practice approach for local authorities to meet their responsibilities under FRM(S)A 2009, stating that, "local authorities will be expected to lead on the preparation of surface water management plans for inclusion in the local flood risk management plans, and to do so in a way that respects the principles of integrated drainage (BOX 2)".

BOX 2 Principles to support integrated drainage

- increase the percentage of new surfaces that are permeable;
- aim to deal with storm water runoff from impermeable surfaces as close to source as possible;
- replace existing impermeable surfaces with permeable surfaces where possible;
- minimise the amount of drainage going underground as this is often an inflexible solution that cannot deliver wider benefits or be easily adapted to future conditions;
- maximise opportunities to manage surface water before it enters the sewer system;
- design for exceedence by ensuring that existing and new developments have flood plains and safe flow paths.

There is a series of **Planning Advice Notes (PAN)** and online guidance under SPP which provide more detailed guidance on specific areas of planning policy. The ones with relevance for flood risk and drainage are:

- **PAN61: Planning and Sustainable Urban Drainage Systems** – Good practice advice for planners and the development industry on SUDS. Can be used by local authorities to help ensure that flooding matters are considered at pre-application meetings with developers.
- **Online Planning Advice on Flood Risk** (replaced PAN69) – Background information and best practice advice in support of Scottish Planning Policy (SPP) 7: Planning and Flooding (previously a separate policy document but now incorporated within SPP)
- **PAN79: Water and Drainage** – Clarifies the role of the planning authority in setting direction of development to inform co-ordinated planning and delivery of new water infrastructure, explains the roles of Scottish Water and SEPA and encourages joint working

SEPA has published guidance on planning, comprising:

- **SEPA regulatory process (RM-08)** – Sets out SEPA's guidance on SUDS and the planning consultation procedure for new developments. SUDS are a legal requirement for all developments except single dwellings and those which discharge to coastal waters.
- **Land Use Planning System SEPA Guidance Note 8** – SEPA standing advice for planning authorities and developers on development management consultations

Developed by the Scottish Advisory and Implementation Forum for Flooding (SAIFF), which includes representatives from Scottish Government, local authorities, Scottish Water and SEPA, **Surface Water Management Planning Guidance, Feb 2013** provides guidance to assist responsible authorities in the preparation of Surface Water Management Plans (SWMP). SWMP are currently considered best practice by which to identify the most sustainable measures to manage urban drainage and the risk of surface water flooding as required by the FRM(S)A. It is expected that the FRM Strategies and LFRMP will identify the production of SWMP as a measure to manage the risk of surface water flooding. This guidance establishes the principles of integrated drainage (as listed below) and sets out best practice for identifying the most sustainable measures to manage surface water flood risk. Principles of integrated drainage (from Surface Water Management Planning Guidance, Feb 2013):

- Increase the percentage of new surfaces that are permeable
- Aim to deal with storm water runoff from impermeable surfaces as close to source as possible
- Replace existing impermeable surfaces with permeable surfaces where practicable
- Minimise the amount of drainage going underground as this is often an inflexible solution that cannot deliver wider benefits or be easily adapted to future conditions
- Maximise opportunities to manage surface water before it enters the sewer system
- Design for exceedance by ensuring that existing and new developments have flood plains and safe flow paths.

Scottish Water updated its technical guide for developers involved in the design and construction of sewerage infrastructure in response to new obligations imposed by WEWS for the vesting of public SUDS. **Sewers For Scotland 3rd Edition**, published in April 2015, specifies Scottish Water's requirements for adoptable sewerage systems as a whole, including in Section 2B the requirements for SUDS systems.

There is a range of relevant good practice guidance available from CIRIA including:

- **CIRIA C697 The SUDS Manual** – Best practice guidance on planning, design, construction, operation and maintenance of SUDS to facilitate effective implementation in developments.
- **CIRIA C738 Managing urban flooding from heavy rainfall - encouraging the uptake of designing for exceedance** – Provides best practice guidance on enabling better management of local flood risk and surface water by creating safe and resilient flood routes, temporary storage areas, and making use of other measures to reduce the impact of flooding. Report C738a summarises key findings from CIRIA project RP991 to support the delivery of drainage exceedance and refers to examples of good practice obtained from case studies, literature review and consultation with industry.

- **CIRIA C713 Retrofitting to Manage Surface Water** – Provides a framework to help more effective retrofitting of surface water management measures, to address surface water flooding and pollution within existing urban areas.
- **CIRIA Research Project RP993: Demonstrating the multiple benefits of SuDS – A business case (Phase 2), Draft Literature Review (October 2013)** – Literature review describing current practice in relation to using valuation tools and approaches to assess the value and distribution of the wider benefits of SuDS.

A.3 Road drainage design

A.3.1 Legislation

Transport Scotland, on behalf of the Scottish Ministers, has responsibility for the operation and maintenance of Scotland's trunk roads and motorway network. They manage the network by having contracts in place with Operating Companies who ensure the network is safe, efficient and well maintained. The Operating Company contracts are based on DMRB and its associated suite of design standards (including the Network Maintenance Manual and Routine and Winter Service Codes). Local authorities are the roads authorities for main, district and local distributor roads which make up the majority of the overall road network. There are 32 road authorities in Scotland. Private roads are the responsibility of the landowner(s) or "frontagers" (i.e. those whose properties front onto the road), either directly or through a management company. As these roads have not been adopted, they have not necessarily been designed in accordance with the DMRB or any relevant local standards, and the frontagers may not apply the same standards as the publicly accountable roads authorities. Private roads are not common in Scotland and are not specifically addressed in this project.

Road drainage design is generally driven by guidance rather than legislation. Of the suite of primary roads legislation for Scotland, the only one which makes any direct reference to flood risk management is the **Roads (Scotland) Act 1985.** Section 30 of this Act provides roads authorities with powers to provide and maintain barriers or other works to protect roads from flooding (amongst other things). Section 31 establishes powers for roads authorities to drain roads & to prevent water flowing onto them from surrounding land. Section 32 enables roads authorities to contribute to any drainage works under the Land Drainage (Scotland) Act 1958 or flood protection work under section 56 of the Flood Risk Management (Scotland) Act 2009 (that "are desirable for the protection or enjoyment of an existing or proposed public road". Section 99 states that "The owner and the occupier of any land, whether or not that land is such as constitutes a structure over or across a road, shall prevent any flow of water or of filth, dirt or other offensive matter from, or any percolation of water through, the land onto the road", and makes non-compliance an offence. Section 99 also gives roads authorities powers to prevent the flow of water (etc) onto the road from adjacent land, including the power to serve notice on landowners in breach of this, requiring them to undertake any necessary preventative works. Section 21 of the Roads (Scotland) Act 1984 describes the process of construction consent which governs the construction of new roads (and extensions to existing roads). This applies to all roads constructed by persons other than the roads authority. The purpose of the Road Construction Consent (RCC) process is to ensure the road is constructed in accordance with appropriate development guidelines and protect the future maintenance liabilities of roads authorities. RCC is separate from Planning Permission and most developments where a road is to be constructed will require both.

The **Transport (Scotland) Act 2005** (including accompanying **Explanatory Notes)** makes no direct reference to flood risk management. It makes provision for the Scottish Ministers to set up various bodies concerned with the regulation of Scotland's Roads, and the most significant provision is for the regulation of roadworks, including setting up a register of roadworks and creating the post of Scottish Roadworks Commissioner. By requiring undertakers to be authorised and qualified, and works to be undertaken to certain standards and within set timescales, this Act helps to prevent damage to road drainage infrastructure. The organisation and effective management of roadworks is relevant in that poorly regulated works to existing roads could lead to damaged sewers and where present, poorly or incorrectly reinstated SUDS features, which could have knock-on implications for flood risk.

The other primary legislation for roads in Scotland is the **New Roads and Street Works Act 1991**, which again bears no direct relevance to flood risk management other than the points made above regarding effective control of roadworks. Other, secondary legislation for roads is not considered relevant to the scope of this research.

Controlled Activities Regulations (CAR) requires authorisation for any activity liable to cause pollution of the water environment. This includes discharge of surface water run-off and construction and maintenance of roads and tracks, amongst other activities. There are differing levels of authorisation, the lowest of which are the General Binding Rules (GBRs) for specific low risk activities. Providing an activity complies with the relevant GBR, consultation with SEPA and formal authorisation are not required. Schedule 3 (Part 1): General Binding Rule 10 effectively makes SUDS compulsory for all development other than single dwellings or where the discharge is to coastal water, although this is primarily for pollution control purposes rather than flow control.

CAR also states that drainage from new or modified motorways, trunk roads or dual carriageways should be licensed if any one outfall drains a length of >1km. The requirement for licensing also covers drainage from major intersections from such roads. 'Modified' in this context means major work, such as the addition of an extra lane and would not cover more minor maintenance and repair activities such as re-surfacing of roads. Each outfall draining a length of >1km needs a licence.

The **Sewerage (Scotland) Act 1968** is not specific to flood risk or road drainage but bridges the divide between the two. See flood risk section above for information.

A.3.2 Guidance

SUDS for Roads was commissioned and guided by SCOTS and the SUDS Working Party (in partnership with other public and private sector organisations) to address the concerns of roads practitioners that roads legislation has not kept up with the significant advances in water management legislation made over the past decade. SUDS for Roads aims to provide "appropriate advice and direction for practitioners involved in the design approval and adoption of SUDS within the road network boundary." It provides best practice guidance on the design, construction, adoption, maintenance, performance, applicability and whole life cost of SUDS associated with the treatment and attenuation of surface water runoff from roads and footways. This guidance, if followed, should help to bring road drainage into much closer alignment with the wider aims of flood risk management. It also highlights the need to design for exceedance, stating that, "The road surface may provide an important contribution in providing a drainage path for flood risk management by overland flood flow where the return period of the storm exceeds 30 years." SUDS can be used to capture and store runoff at source and to attenuate the outputs from carriageway drainage capture systems up to much larger events, and SUDS for Roads shows roads practitioners how to apply them optimally within a road drainage context. SCOTS has subsequently published an accompanying whole life costing tool, which provides roads authorities and their consultants with a consistent method for estimating the whole life cost (and carbon) for a range of SUDS features for road drainage.

The **Design Manual for Roads and Bridges (DMRB)** applies to all trunk roads since it is a requirement of Transport Scotland's contracts with its Operating Companies. Of the suite of documents under DMRB, the most relevant for this project are:

- HD 33/06 (Surface and sub-surface drainage systems for highways) – design standard which provides guidance on the selection of the types of surface and sub-surface drainage for trunk roads including motorways. It describes the various alternative solutions that are available to drain trunk roads in the UK, including their potential to control pollution and flooding.
- HD 45/09 (Road drainage and the water environment) – design standard which provides guidance on the assessment and management of the impacts of discharges to water bodies from the development and/or improvement of trunk roads and motorways in the UK. These include possible impacts on the quality of water bodies and on the existing hydrology of the catchments through which roads pass.

Of particular interest is HD33/06 section 1.4, which lists the three major objectives in the drainage of trunk roads as:

- the speedy removal of surface water to provide safety and minimum nuisance;
- provision of effective sub-surface drainage to maximise longevity of the pavement and its associated earthworks; and
- ***minimisation of the impact of the runoff on the receiving environment.***

These objectives juxtapose the speedy evacuation of water (as noted in section 2.1 above) with consideration of the impact on the receiving environment, at once placing consideration of flood risk management within the primary objectives of trunk road design and introducing potential conflict.

HD45/09 also contains important requirements for road designers to address flood risk issues, for example, Section 2.37 states that transport infrastructure in the functional (fluvial) floodplain must be designed and constructed to:

- remain operational and safe for users in times of flood;
- result in no net loss of floodplain storage;
- not impede water flows; and
- not increase flood risk elsewhere.

Section 3.35 of HD45/09 requires (road) designers to satisfy the evironmental regulator that there is no increase in flood risk, and should be prepared to demonstrate this as part of their design. Section 5.3 describes the procedures that must be used when assessing the potential impacts from road projects on the water environment. Chapter 6 sets out guidance for appropriate levels of assessment, including flood risk assessment.

In terms of design standards, HD33/06 Ch6.2 states that longitudinal sealed carrier drains and channels must be designed to accommodate a one-year storm in-bore without surcharge, and such that surcharge levels for a five-year storm intensity do not exceed the levels of chamber covers or encroach into the carriageway. Rainfall intensities are required to include an allowance for climate change, or where inadequate data exists the design must be sensitivity tested for a 20% increase in rainfall intensities.

There is no guidance within DMRB regarding the management of flows from design exceedance events, i.e. when designed capacity is exceeded but not through any fault of the system. The standards leave it open to judgement that in certain circumstances the designer may choose to consider larger design events, but only suggest up to 1 in 20 or 1 in 30. This seems to be an important omission and there is an argument that trunk road design guidance should be brought up to date with planning practice and the National Roads Development Guide which both highlight the need to design with exceedance in mind.

The **Network Maintenance Manual (NMM)** and **Routine and Winter Service Codes (RWSC)** guidance documents together set out the requirements and advice for the management of maintenance on the motorway and trunk road network. There is clearly an emphasis on keeping the carriageway free from standing water in these documents, as can be seen from the following statements:

- Paved areas are to provide a safe, even and comfortable surface for all users…The surface should not allow standing water as this may be hazardous to traffic. In freezing conditions, standing water can be a hazard to all road users. (RWSC Ch2.2)
- The purpose of drainage is to remove water from trafficked surfaces, where it may represent a hazard and disrupt the free flow of traffic, and from sub-layers of the pavement and adjoining earthworks, where its presence may damage the pavement or other structures. In removing the water, the drainage system must be maintained to its design performance or similar to prevent pollution of ground and surface water, and flooding of adjoining property or services. (RWSC Ch2.3)

However, within the same chapter (RWSC Ch2.3) it is stated that the requirements for drainage also relate to the ***prevention and mitigation of the effects of flooding***. Maintenance and repair of existing roads is an activity which also presents opportunities to contribute to the wider aims of flood risk management by addressing legacy surface water issues, but this is not a factor addressed within the NMM or RWSC.

For non-trunk roads (excepting private roads) the roads authority is the relevant local authority. Local authorities have historically had their own **local authority road development guidelines**, and prior to the National Roads Development Guide there were no standardised development guidelines across the 32 roads authorities in Scotland. Some used the former Strathclyde Regional Council guidelines (last published in 1996) and others had their own roads development guidelines. However, conventional road drainage has historically been designed in accordance with Road Note 35, which states that suitable design frequency for design of road drainage is 1 in 1 year for separate surface water drainage in estate roads.

Designing Streets (2010) is a policy and guidance document for practitioners in Scotland involved in the planning, design, provision, approval and adoption of all new streets, and modifications to existing ones. It was produced by SCOTS (supported by Transport Scotland and the Scottish Government) to support the placemaking agenda, by raising the importance of street design issues from guidance and advice up to policy status. Although it is aimed primarily at non-trunk roads, it does acknowledge that, "There are some locations, however, where a more sensitive design that follows the principles of Designing Streets may well be appropriate, such as where a small burgh High Street is also a trunk road." Designing Streets aims to establish the concept that roads within certain environs cater for more important functions than just the movement of people and traffic, and shift the focus onto the broader purpose of roads as streets. Importantly, it states that street design should run planning permission and Road Construction Consent (RCC) processes in parallel, and that street design guidance, as set out in Designing Streets, can now be a material consideration in determining planning applications and appeals. Some key points from this policy document are:

- *Streets should use appropriate SUDS techniques as relevant to the context in order to minimise environmental impacts.*
- *Consideration should be given to the layout and impact of Sustainable Urban Drainage Systems (SUDS) when working on street and block layouts.*

The National Roads Development Guide (2014) was developed by SCOTS (supported by Transport Scotland and the Scottish Government), to provide a consistent national standard for road design. It follows the same principles introduced in Designing Streets, with a change in policy to move away from a standards-based approach to one where designers, planners and roads engineers collaborate to develop a design-led solution. Its purpose is to be the technical enabler to the Designing Streets policy document, providing a consistent, accessible and relevant source of information that links related detailed and complex infrastructure requirements in one place. It includes updated guidance on how to obtain a Road Construction Consent, supports the principles of adopting a multi-disciplinary approach and early engagement to achieve a balanced outcome based on the wider function of the road as a street for all its users, and is designed to accommodate local authority variances through a suite of locally specific appendices.