J4M8 Distribution Park

Case Study

Author:

Neil Berwick, University of Abertay

Information kindly contributed by:

Chris Pittner, WSP UK, Development and Transportation, Edinburgh.

List of stakeholders

Stakeholder	Role				Interest										
					Regulators and interest groups						Planning bodies				
	Decision maker	Advisor	Developers	Long term ownership	Wild life	Heritage	Environment	Water quality	Water quantity	Local communities	Strategy planners	Development control	Building control	Road/Transport	Others
Strawsons J4M8 Limited	X		X												
WSP		X	X												
West Lothian Council	X			X					X	X	X	X	X	X	
Scottish Environment Protection Agency (SEPA)	X				X		X	X							

Contents

1 Aims and objectives

This case study investigates the use of sustainable urban drainage systems (SUDS) used within industrial settings.

In particular it demonstrates the concept of pipeless systems, i.e. where SUDS are used to convey, attenuate and treat runoff without the use of pipes. Pipeless systems are still fairly uncommon within the UK, predominantly due to the perceived footprint of the SUDS. This case study demonstrates how designs can be tailored to suit local conditions satisfying both space restrictions and levels of treatment

2 Learning points

- Treatment train for industrial areas: levels of treatment necessary
- Pipeless systems advantages and restrictions

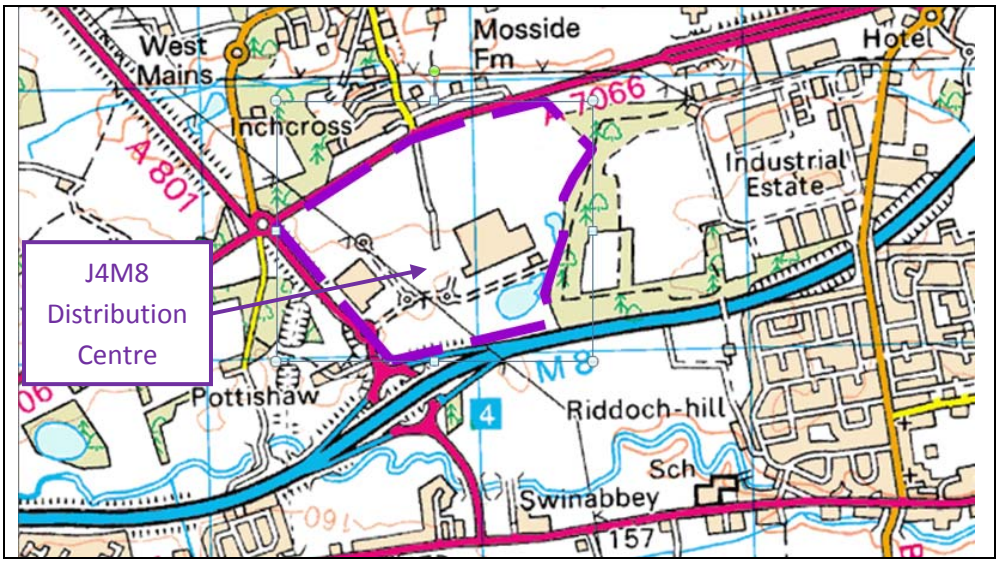
3 Site Overview

Figure 1. Aerial photograph of J4M8, 2007 (Image courtesy of WSP UK).

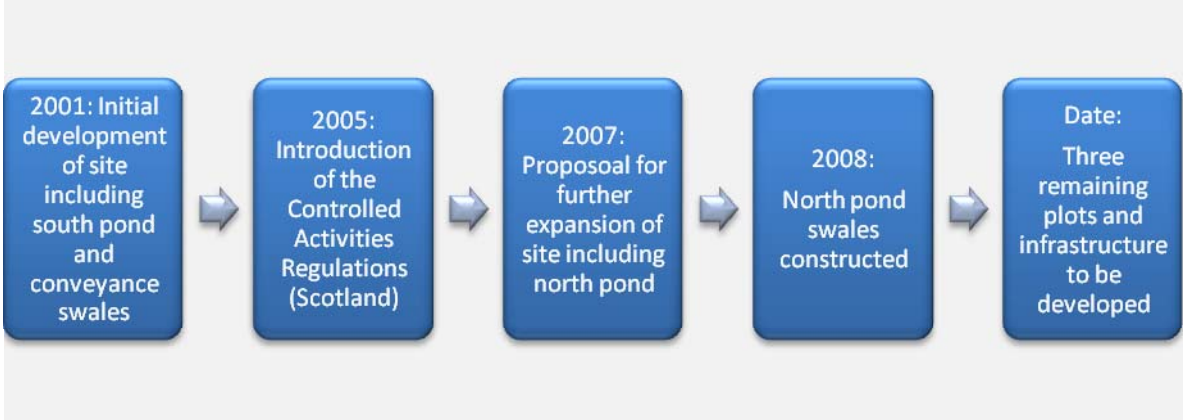
The J4M8 Distribution Park is located at junction 4 of the M8 motorway, linking Edinburgh and Glasgow, and is approximately 20 miles west of Edinburgh at National Grid Reference (NGR) NS968 664.

The site comprises of an area of 76 hectares and development has been undertaken in phases over (approximately) the past 10 years. The owner is Strawsons Property, a property development company which offers design and build commercial properties, for lease.

Box 1. J4M8 Distribution Park location (in purple) and the M8 motorway



4 Timeline and flow diagram



5 Regulations, procedures and standards

Initial development of the site involved consultation with SEPA, a statutory consultee in the planning process, to ensure that development did not have a negative impact on the local watercourses.

Subsequently, SEPA stipulated the use of SUDS to manage the pollution risk from surface water discharge from the site.

Later development of the site (post 2005) was regulated under the new Controlled Activities Regulations (CAR). CAR changed how surface water discharges were regulated in Scotland, introducing a risk based approach to regulation of activities that impact on the water environment. Low risk situations are governed by General Binding Rules (i.e. activities complying with specific conditions), however higher risk areas would require a licence issued under CAR.

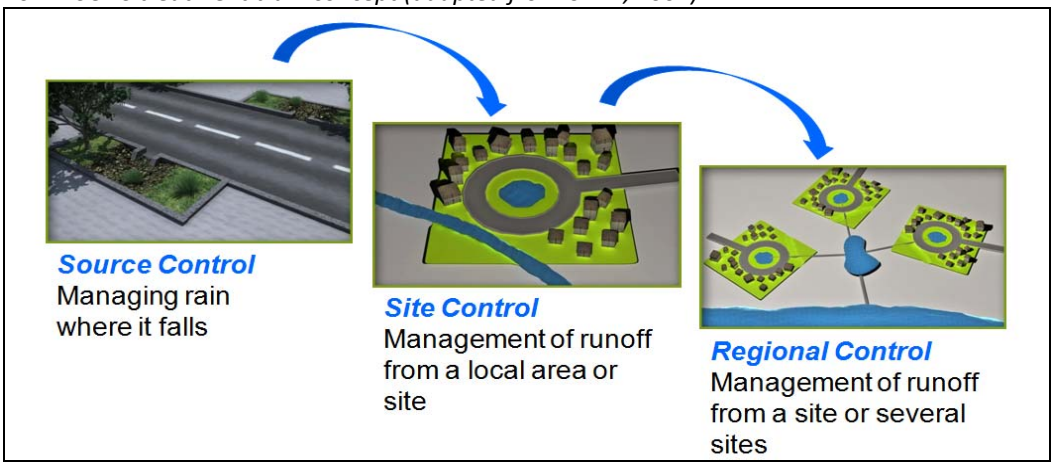
Under CAR industrial estates (defined as areas which have marshalling yards, lorry parks and distribution depots) are considered high risk and subsequently surface water discharges from development of the site post 2005 are subject to a simple licence under CAR.

6 Options considered

The SUDS treatment train methodology (Box 2) was used to determine the type and number of SUDS used for the site. The treatment train is a process that involves managing water quality (and quantity) using a series of controls. SUDS selection uses a risk based approach, taking into account local conditions including:

- Catchment land use
- Extent of land use
- Nature of the receiving water

Box 2. SUDS treatment train concept (adapted from CIRIA, 2007)



Catchment land use

[Ascending level of environmental risk for: residential, commercial or industrial catchments]

The site is predominantly a distribution hub, with some offices and ancillary retail units. Subsequently high levels of traffic (heavy goods vehicles and cars), loading, unloading and storage of a range of materials will be the primary activities; all of which can have a negative impact on water quality.

Extent of land use
[The area of development and the number of units and vehicles associated]
The site area is approximately 76 hectares, and within this three major (and five smaller) distribution centres accounting for 41 hectares of the site.

Nature of the receiving water
[The ecological characterisation / sensitivity of the receiving water]
The site discharges to the three sensitive watercourses; two low flow watercourses to the north of the site (Bog Burn and Boghead Burn) and to the Almond River (south of the site) which is classified as Freshwater Fish Salmonid waters by SEPA.

Due to the nature and extent of the land use (i.e. extensive industrial) the site is rated as high risk, and in accordance with guidance (CIRIA, 2000[1]), three levels of treatment were deemed necessary to mitigate the impact of the development on the quality of the receiving watercourses.

SUDS techniques shortlisted for each treatment stage are shown in Table 2 below:

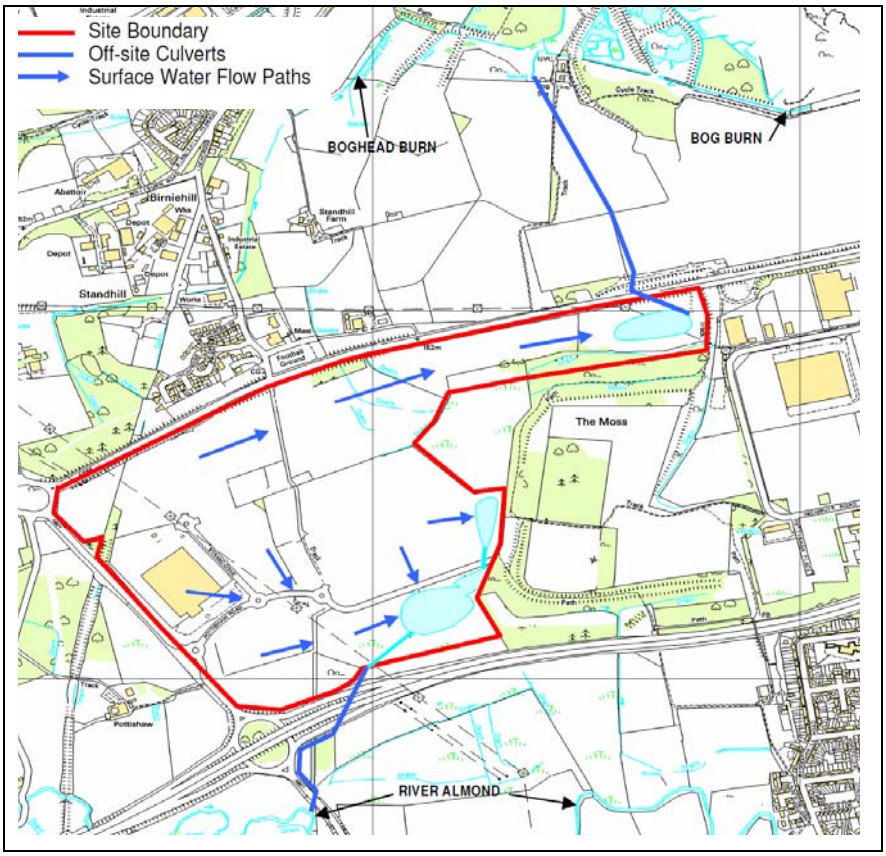
Table 2. SUDS matrix of possible options for J4M8 Distribution Park

Treatment Level	**SUDS Technique**							
	Filter drain	Swale	Porous paving	Permeable block	Buried filter	Detention basin	Pond	Wetland
Source Control	X	X	X	X				
Site Control					X	X	X	
Regional Control							X	X

[1] Sustainable Urban Drainage Scottish Working Party. (2000). *Sustainable urban drainage systems. Design manual for Scotland and Northern Ireland. C521*. CIRIA: London.

7 Selected option

Box 3. J4M8 Surface water drainage flow paths (Courtesy of WSP).



The selected SUDS option for the distribution park consisted of a range of SUDS techniques designed to provide three levels of treatment and onsite attenuation to satisfy the 1 in 200 year storm event.

The first level of treatment is located within the curtilage of each development plot and the owner is responsible for the implementation and aftercare. Techniques used vary by plot; examples include filter trenches, permeable paving for office car parks, gravel filter beds, small linear detention basins and mini wetlands.

Figure 2. ALDI Distribution Centre, J4M8. The centre has approximately 50 HGV loading bays and serves stores throughout central Scotland. Note: the surface of the yard is impermeable mono-blocks. Fall is away from the loading bays towards the source control SUDS.

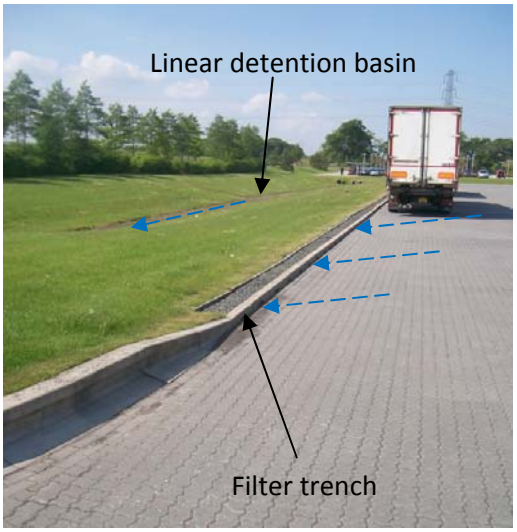


Figure 3. First level of treatment for ALDI Distribution Centre. There are in fact two levels of source control within the site, with runoff first entering the filter drain via kerb inlets, and then passed to the linear detention basin before discharging to the site conveyance system.

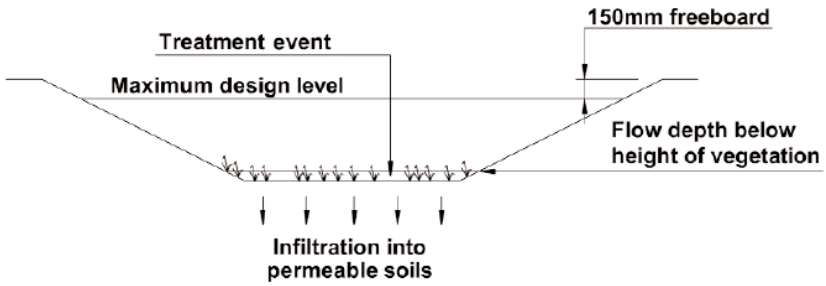
The second level of treatment is provided by the conveyance system which comprises a series of swales located within the road verges. The swales are grass channels designed to be normally dry (see Box 4a) until rainfall events when runoff is conveyed from the industrial plots, and directly from the roads as sheet flow, to the regional control. As there is little infiltration into the ground the swale base remains wet for most of the year (see box 4b), providing suitable conditions for water tolerant plant species such as wetland grasses and yellow flag iris.

The third level of treatment (regional control) for the site is provided by use of retention ponds. Pond 1 is located to the south of the site and manages runoff from the central and southern areas of the site.

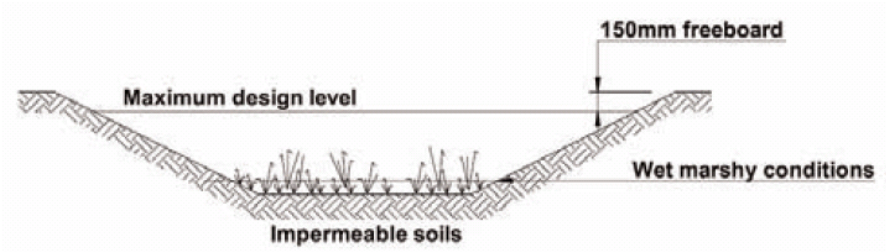
There is a smaller secondary pond which connects to Pond 1; this has been formed to make use of existing low levels within the site and is not included within the attenuation calculations for the site design. Outfall from the pond is via a culvert to the River Almond.

Pond 2 is located to the north east of the site and manages runoff from the northern section area of the development. Discharge is via a culvert to the Bog Burn to the north of the pond. The pond is located under the 275kV pylon line; this was approved by the national power company and assists maximising the use of space within the site.

Box 4. Sections through conveyance swale (a), dry swale (b) and wet swale (c). Source: CIRIA C697 The SUDS Manual.



(a)



(b)

Figure 4. Filter strip and roadside swale site conveyance system.

Figure 5. Pond 1 located at the south of the site.

8 Performance and effects of selected option

The treatment train for the site has been created as a 'pipeless' system; one where all surface water runoff is managed above ground using SUDS techniques.

This varies from the norm, where other sites use a combination of piped networks and SUDS to manage treatment, attenuation and conveyance. Pipeless above ground systems are advantageous in that;

- As all runoff is managed above ground it is easier to identify pollution such as wrong-connections (e.g. foul discharging into surface water systems), inefficient/ineffective chemical storage, illegal discharges, etc. Further to this, open pipe systems allow the source of pollution to be easily identified, and rectified helping to maintain the water quality of the receiving waterbody.

- Vegetated SUDS provide habitat for a range of flora and fauna; pipeless systems provide 'green corridors' for safe migration of species and if so designed can be intended to promote recreation and amenity benefit to local people.

- By removing piped sections and using above ground techniques, sediment can be removed at the correct stage of the treatment train; above ground in 'dry' SUDS such as swales or detention basins. This permits ease of monitoring and removal and is significantly more cost effective than removing silt from underground structures or permanent water SUDS such as ponds.

Image 6. Roadside swale at entrance of J4M8 providing conveyance of runoff and 'linking' the site, providing green corridors for biodiversity.

- Pipeless systems are more visible than end of pipe / underground techniques and can provide benefits in education of current water management methods, particularly where information signs and educational programs are used.

The SUDS treatment train used for the site provides a range of different treatment mechanisms throughout the levels of control, ensuring that there is adequate treatment of runoff commensurate with the land use risk.

Table 3 (below) shows the types of pollutant removal mechanisms by SUDS type for the distribution site. Permanent water SUDS (e.g. ponds and wetlands) provide removal mechanisms that are not possible within 'dry' SUDS, in particular, nutrient removal.

Given the high risk of pollution, the use of ponds was necessary to ensure discharge from the site did not impact on the water quality of the local watercourses.

Table 3. Water quality mechanisms by SUDS type (adapted from CIRIA, 2007). The yellow highlighted area shows pollutant removal mechanism offered by 'wet' SUDS.

SUDS Technique	Water Quality Mechanism							
	Sedimentation	Filtration	Absorption	Biodegradation	Volatilisation	Precipitation	Uptake by Plants	Nitrification
Filter trench / filter bed		●	●	●	●			
Filter strip	●	●	●	●				
Swale	●	●	●	●			○	
Detention basin	●	○	○	●			○	
Retention pond	●	●	●	●	●	●	●	●
Wetland	●	●	●	●	●	●	●	●

Key to symbols: • High/primary ○ Some opportunities subject to design

9 Discussion

Figure 7. J4M8 Current level of development (Source: Evander Properties Limited. Available from: http://www.novaloca.com/propertydocuments/15509_633444792838841250.pdf).

Pipeless systems can provide a range of operational benefits, however the land take required is considerably greater than a piped system with 'end of pipe' SUDS. This land requirement can negate the use of pipeless systems because:

- Insufficient land is available, particularly for road SUDS, or
- Land cost is paramount and maximising plot numbers/size is priority to secure financial return on the development.

Land availability for the J4M8 site was not a critical issue and development of a pipeless treatment train was deemed feasible. This did not mean that there was not attention paid to land take for the SUDS, rather the opposite. SUDS were selected that could be used within areas that would normally be regarded as non-developable.

This included making use of the roadside verges to accommodate swales and filter strips; by using road verges on the off-side of the road, an area that did not require pedestrian access, source control for the roads could be implemented and land take minimised.

Regional control ponds were a pre-requisite for planning approval (as specified by West Lothian Council and SEPA) given the pollution risk from within the catchment. Cost was considered when

selecting the locations for the ponds, with Pond 2 located at a section of the site where the ground was particularly peaty; had this been developed as an industrial unit then a higher cost than normal would have been incurred for building foundations.

Pipeless systems provide a range of benefits however they must be correctly designed, implemented and maintained.

There are elements of the conveyance system that vary in design and effectiveness. For the most part, filter strips are used to drain the road providing means to slow flow and reduce silt. This exemplifies good design, managing silt in easily inspected and maintained areas and protecting permanent water SUDS.

In certain areas of the site, where due to space restriction, filter strips are not used and gullies drain the road, discharging to the swale within the road verge. This point inflow can result in scour of the swale base.

General site topography is important to design (the system must be positively drained) and where levels vary greatly it may be difficult, or not cost effective to design and implement a pipeless system; piped sections may be necessary.

Figure 8. Direct discharge of road runoff to a roadside swale. Erosion of the swale base is evident; this can be easily rectified by placing loose stone at the inlet edge to spread flow and reduce velocity.

As the conveyance system has been designed to make use of road verges on the off-side of the road a means to convey runoff across road areas is necessary.

The swale conveyance system traverses the road by use of inverted siphons (Figure 9) which convey runoff under the road. Whilst inverted siphons are effective in conveying flow they present two issues:

- They act as a reservoir for the collection of silt/sediment and will require regular inspection / emptying using of specialist plant, typically vacuum tankers, and
- They offer limited migration routes for wildlife (i.e. amphibians) and are a barrier to mammals.

Maintenance of pipeless systems may involve additional inspection and maintenance regimes. The spine road of J4M8 drains laterally to filter strips connecting to swales, and at other areas of the site directly to roadside swales. The filter strips / swales are constructed at a level just below the road top layer (allowing the road to freely drain); however this increases risk of vehicle damage (Figure 10). Re-grading / re-seeding the filter strips and swales should be incorporated into the maintenance schedule to allow for this type of design).

Figure 9 Filter strip and roadside swale. Note the metal grid in the foreground; this is the inlet of the inverted siphon that conveys flow under the road to the regional control pond.

Figure 10. Vehicle damage to roadside filter strip. To remain effective the filter strip level must be below the road, allowing drainage of the road surface and providing adequate volume for settlement of silts.

Where in curtilage source control SUDS are used (as is the case for the plots within J4M8) the selected SUDS technique is usually at the discretion of the plot owner, subject to approval by the planning authority, and can range from purely functional to enhanced designs. J4M8 provides examples of both extremes:

- The majority of the distribution yards SUDS designed purely for function, with vehicle loading bays drained by use of a shallow fall concrete yard towards linear detention basins to provide first level treatment.

- The Kuehne + Nagel site has an enhanced source control, designed for function and appearance with a mini wetland/pond located to the front of the site. This has been designed predominantly for aesthetic reasons, however the use of permanent water SUDS as source control will also provide enhanced treatment.

Figure 11. Ornamental pond at entrance to J4M8. This pond is within the Kuehne + Nagel plot and has been designed for visual aesthetic in addition to treatment.

Image 12. Design for function: linear detention basin serving distribution centre and road located to the north of the site

10 Conclusions and Recommendations

Treatment train design is not a one size fits all solution; catchment conditions will dictate the number and type of SUDS that are suitable. Where there is a higher level of pollution risk and/or the receiving watercourse is environmentally sensitive then more extensive treatment trains will be necessary and will normally include a permanent water SUDS to provide higher pollutant removal.

As the complexity of treatment trains increases so does the land take necessary for SUDS and this can often impact on the (financial) feasibility of the development. Use of above ground pipeless treatment trains can further add to the land requirement, however by utilising areas that are considered as non-developable then pipeless design can be possible and cost effective.

J4M8 demonstrates this approach, by making use of road verges, an area that is often necessary for road design to provide adequate line of sight for vehicles, filter strips and swales have been accommodated.

Ground investigation identified suitable areas for regional control SUDS that would have been costly to develop otherwise.

Pipeless systems can provide a range of benefits, providing biodiversity rich green corridors and by keeping water above ground it is possible to easily monitor and maintain the surface water drainage system.