SKINT WATER SERIES

SUSTAINABLE URBAN WATER PLANNING ACROSS BOUNDARIES

J. de Beer, A. Christensson, F. Boogaard (eds.)

Drainage Improvements to Facilitate Expansion of Eastern Dunfermline

A. Duffy[*,a], N. Berwick*, C. Jefferies**
* Urban Water Technology Centre, University of Abertay Dundee, Bell Street, Dundee, DD1 1HG, United Kingdom.
Tel.: (44) 1382 308170
Fax: (44) 1382 308117.
Contact: a.duffy@abertay.ac.uk , n.berwick@abertay.ac.uk , c.jefferies@abertay.ac.uk
[a] corresponding author

INTRODUCTION

This case study investigates the drainage strategy within the development of the eastern area of Dunfermline, a historic town located in eastern Scotland. The development, known as Dunfermline Eastern Expansion (DEX), is located within an area of what was formerly predominantly Greenfield land, comprising some 350 hectares, within which 3500 houses, schools, commercial and industrial areas were to be developed over a ten-year period.

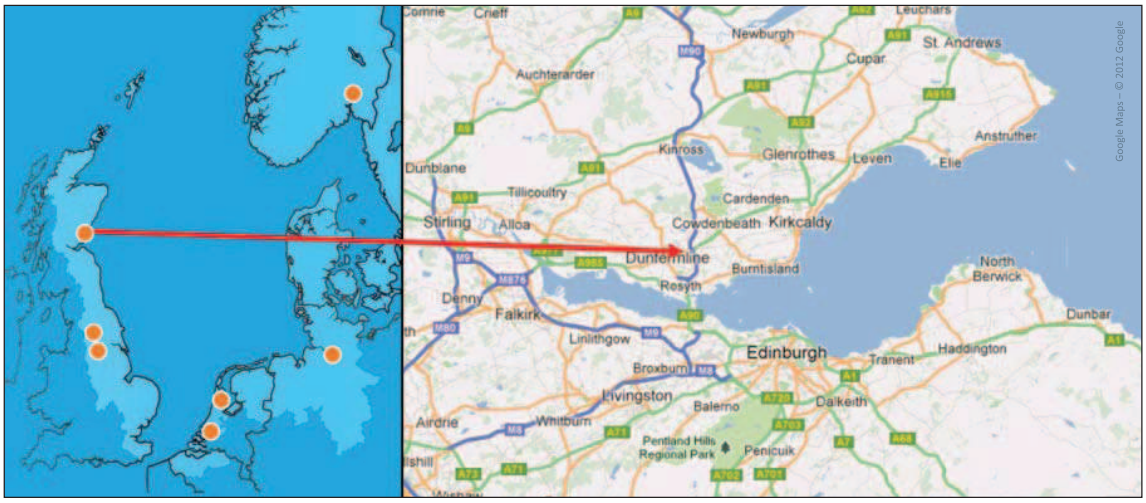

FIGURE 1. NORTH SEA REGION, AND THE DEX DEVELOPMENT, FIFE, SCOTLAND

The development, highlighted within the Local Authority's 1994 development plan for the region, was intended to regenerate the area's economy following the demise of the coalmining and shipbuilding industries as well as catering for an increase in demand for housing as a result of rising house prices in the nearby capital city, Edinburgh.

Concern was raised regarding the drainage of the development area and its impact on the receiving watercourses both in terms of flood risk and water quality.

The site master-planning coincided with the emergence of new "green" technologies for managing surface water drainage in the UK. These were being actively promoted by the Environmental Regulator; the principal driver of this was the imminent Water Framework Directive (2000/60/EC). This new surface water management process would eventually be known as sustainable urban drainage systems (SUDS) within the UK.

MAIN STAKEHOLDERS AND THEIR INVOLVEMENT

Planning consent was granted in 1995 to Wilcon Homes and Alfred Stewart Properties for a development area. A planned total of 3,500 new homes, a leisure park, industrial units, schools, library, and a shopping centre were to be built over 15 years.

FIGURE 2. AERIAL IMAGE OF PART OF THE DEX DEVELOPMENT.

The main decision-making consortium comprised Fife Council (parks and environment, transportation and planning), Fife Enterprise Board (the local development agency) and two statutory bodies: East of Scotland Water (now Scottish Water) and the Scottish Environment Protection Agency (SEPA). These statutory bodies would play a key part in drawing up the drainage master plan for the site.

Technical design was carried out by two local consultants (W.A. Fairhurst & Partners and Ironside Farrar Ltd.) under the expert guidance of Larry Roesner from Camp Dresser McKee, an American consultancy. Meedhurst Project Management (now CEIMA Ltd) was the project manager for the design and construction process for site infrastructure.

Two Scottish academic institutions, the University of Abertay Dundee and the University of Edinburgh, were contracted to carry out condition and performance monitoring of the development. This was required as a condition of the planning consent. Other stakeholders included the local community and wildlife organisations including the World Wildlife Fund (WWF) and the Royal Society for the Protection of Birds (RSPB). All stakeholders and their roles are summarised in Table 1.

Stakeholder	Role				Interest										
					Regulators and interest groups						*Planning bodies*				*Others*
	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	
Taylor Wimpey Homes	x		x	x						x				x	
Alfred Stewart Properties	x		x							x				x	
Fife Council	x			x		x			x	x	x	x	x	x	
Scottish Enterprise		x									x				
Scottish Water															
Scottish Environment Protection Agency (SEPA)		x					x	x	x						
Fairhurst and partners		x					x	x	x		x			x	
Ironside Farrar		x					x	x	x						
Camp Dresser McKee		x					x	x	x						
CEIMA Ltd		x		x											
University of Abertay Dundee		x					x	x	x	x					
University of Edinburgh		x			x		x	x	x	x					
Local community		x			x	x	x	x	x	x				x	
World Wildlife Fund (WWF)		x			x		x	x							

TABLE 1. STAKEHOLDERS AND THEIR ROLES

WATER MANAGEMENT PROCEDURES

In the mid-1990s the Forth River Purification Board (FRPB, now SEPA) actively promoted surface water BMPs as an alternative to traditional drainage methods. This change in approach was predominantly driven by a realisation that a change in drainage paradigm was needed to address chronic long-term downgrading of receiving water bodies.

In 1994 a review of river water qualities within the Forth catchment was published by the FRPB. This report identified that diffuse pollution from storm water runoff was responsible for 22% of degradation to classified watercourses. Amongst the recommendations of this report, which coincided with the master planning of DEX, was that "Best management practice must be adopted, comprising source control and treatment".[21]

[21] Forth River Purification Board (1994), A Clear Future for Our Waters, FRPB, Edinburgh.

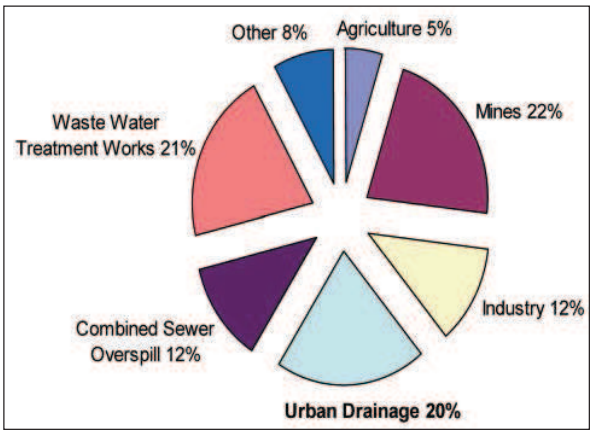

FIGURE 3. CAUSES OF LOW WATER QUALITY IN SCOTLAND (FRPB 1994)

This heralded a change in thinking for drainage design in Scotland. DEX became the first major development where BMPs (SUDS) were stipulated within planning consents.

MAIN PROBLEMS RELATED TO THE INTEGRATION OF LAND AND WATER MANAGEMENT

The DEX catchment included a number of small rivers that already received runoff from built-up areas, industry, motorways and arterial roads. Downstream watercourses were already heavily modified with existing flooding problems which would be exacerbated by further large scale development. The rivers were also nutrient-rich due to intense upstream agricultural farming practices, as was the Forth Estuary to which the watercourses all drained.

In addition to the issue of water quality and flood risk, other problems that would have to be overcome to gain approval for the development included:

- There were no statutory design criteria for retention and treatment structures;
- There were no agreements as to who would pay construction and maintenance costs;
- There were also unexpected problems, such as political issues and the media regarding safety of the ponds and basins which fill with water during higher return storms;
- One pond was close to existing housing and was not welcomed by the local residents;
- Some of the developers did not want to allocate enough land area for the SUDS features.

WATER MANAGEMENT SOLUTIONS

SELECTED SOLUTIONS

Master planning of the drainage design at DEX challenged the norm. In previous developments, areas were drained by piping runoff via a surface water sewer to the nearest watercourse. However, due to the existing poor water quality of the local rivers and subsequent risk of flooding this was not acceptable. Another option was to pipe surface water directly to the Firth of Forth, a large estuary with a high dilution factor. However, the cost of such an option was prohibitive due the distance involved. This solution was also not acceptable because it removed water from local streams.

Alternative surface water management techniques were being used in other countries, particularly the USA, using above ground, predominantly soft engineered drainage structures. These techniques were referred to as best management practices (BMPs) but would later become commonly known as sustainable urban drainage systems (SUDS) within the UK.

INTEGRATION OF WATER MANAGEMENT SOLUTIONS IN THE PLANNING PROCESS

Stakeholder consultation was a critical part of the implementation process, with more than 40 different people and organisations involved including: statutory bodies, consultants, private developers, landscape architects, NGOs and the public. SUDS were an almost unheard-of concept within the UK and education would play an important part in breaking down barriers within the various stakeholder groups.

A series of workshops was organised over a period of six months to promote the SUDS approach, how they function and how they can integrate and benefit communities. Since SUDS were an imported technology and the process driven by an American consultant, one of the first tasks of these workshops was to agree on the definitions and technical terminology to be used, translating terms used in US English to UK English. For example, in the US the area contributing surface water runoff to a drainage system or watercourse is referred to as the watershed, whereas in the UK it is known as the catchment.

Other decisions made in these workshops included items such as determination of catchment areas, derivation of (local) pre-development runoff rates, acceptable forward flow rates and volume from the new (developed) catchments, impervious areas, return storms, practicality of porous surfaces, treatment volume calculations, design criteria for each SUDS technique, etc. An interim output from the consortium workshops was the development of a “rule book” for the drainage design.

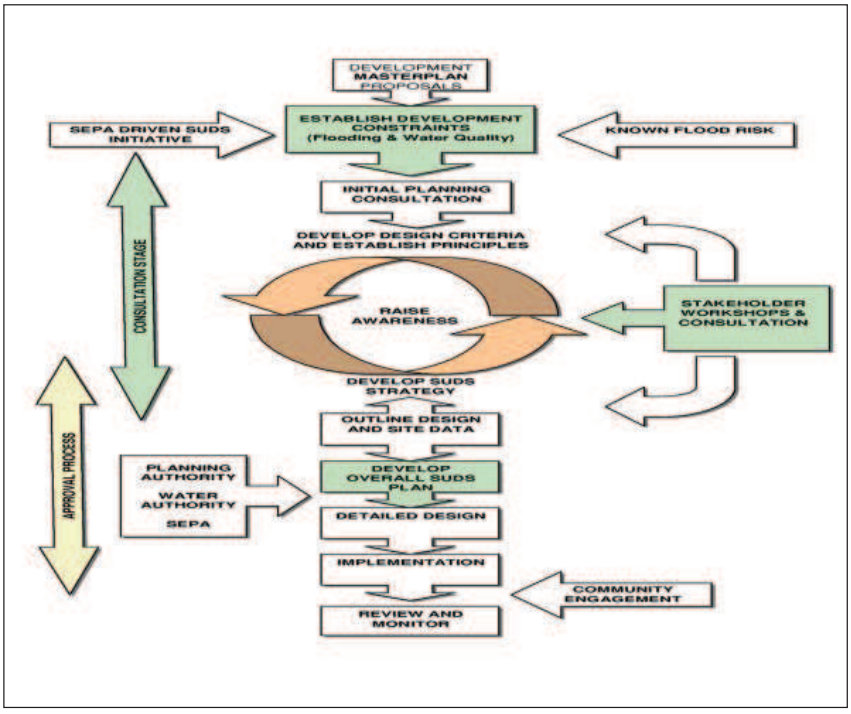

FIGURE 4. IMPLEMENTATION OF THE DEX PROCESS (SOURCE: W.A. FAIRHURST & PARTNERS).

The location of the SUDS within each catchment was carefully considered so that they would provide attractive features, integrating within public open space (both parkland and residential areas). SUDS were designed so that they could be accessed and enjoyed by local residents. Where SUDS, particularly ponds, were located in close proximity to housing they were designed so that they were overlooked by houses or public roadways, so that anyone in difficulty could be easily seen (Figure 4).

Local media and politicians were initially concerned over the risk of children drowning within the proposed ponds and criticised the drainage design. The perceived level of risk was raised by negative publicity, ignoring common sense, in contrast to examples of similar schemes or water features used in other parts of the UK and the world at the time.

Subsequently, a safety audit of the design was agreed with local planning officials. Recommendations included encouraging local schools to use the SUDS areas for practical "show and tell" classes and specifying dense low lying vegetation to deter access to permanent water SUDS. However, despite these measures, there was still much concern over safety voiced by local Councillors. As a result, Fife Council insisted that 1m high metal fences be erected around the SUDS to prevent access by young children but be low enough in height to allow an adult to gain access in the case of an emergency.

The most contentious item of the process was not in fact safety, but cost, in particular where the balance would lie between involved parties. The question of who should pay for the design, construction and aftercare of the scheme presented a significant challenge and one that to date is not fully resolved.

An initial agreement was reached whereby East of Scotland Water would adopt all underground drainage and Fife Council would adopt all above ground drainage, with the developer contributing to the overall cost. Under the Roads (Scotland) Act 1984, Fife Council as the Roads Authority was responsible for maintenance of road drainage (pipes or above ground structures). Similarly, under the Sewerage (Scotland) Act 1968, there was an obligation for East of Scotland Water (now Scottish Water) to finance in part or total the surface water and foul drainage from the site within reasonable costs.

FIGURE 5. CASCADE BASIN AND HALBEATH POND – BOTH OVERLOOKED BY RESIDENTIAL HOUSING.

The consultation process for did not fully address the question of cost, ownership and ongoing responsibilities. The lead developer had agreed to provide land for the SUDS and to finance the initial implementation costs and did not think that any further contribution (commuted sum) was necessary. The developer was also of the opinion that as the SUDS drained different areas of responsibility (i.e. road, residential and commercial areas) it was reasonable to expect that the public bodies should be responsible for future maintenance. Legal arguments ensued, the outcome of which has not been fully resolved to date.

Fife Council has adopted road drainage for the site, and two SUDS: a wetland and the landscaping area of one pond. Both adopted structures have public obligations in that the wetland is the central attraction of a district park and the pond was implemented at a location where council owned homes already existed. Developers either continue to maintain the SUDS within their ownership or contract the work to factoring agents. There

are also a small number of SUDS (and surrounding public open space) which have been legally transferred to private owner-maintainers within the site.

FIGURE 6. HALBEATH POND; LOCATED WITHIN A LOCAL AUTHORITY HOUSING AREA AND CONSEQUENTLY MAINTAINED BY FIFE COUNCIL

Knowledge gained from DEX has since informed changes in ownership and maintenance responsibilities within Scotland. This, together with legislative changes and the amendment to the legal definition of sewer to include SUDS now means that there is an obligation for Scottish Water to adopt SUDS. As of November 2007 Scottish Water will adopt SUDS which are designed in accordance to the new technical standard Sewers for Scotland 2nd Edition.

DIFFICULTIES AND HOW THEY WERE OVERCOME

In a number of locations, local residents have taken "ownership" of the SUDS, and one detention basin is maintained like a garden by people living in the adjacent houses. This shows that barriers to social acceptance can be overcome with careful consideration of design and planting specifications.

It is still an ongoing question who should be responsible for owning and maintaining SUDS in Scotland. Scottish Water will now adopt a range of SUDS if designed in accordance to the revised technical standard, but is only responsible for in-curtilage drainage, i.e. water from within the property boundary, and not road drainage which is the responsibility of the Local Authority.

To overcome the potential problem of separate drainage systems (to drain different areas) within new developments there has been an amendment to the Sewerage Scotland Act (1968), referred to as a Section 7 Agreement. This agreement "makes provision for Scottish Water to enter into agreement with the Roads Authority to allow the use of their sewers for the conveyance of water from the surface of a road or to allow the use of road drains for the conveyance of surface water from premises".[22]

KEY SUCCESS FACTORS

The drainage master planning at DEX was achieved through a flexible and pragmatic approach. Cooperation between, and education of, the statutory bodies, authorities and the developers was key to the success of the holistic approach to sustainable urban drainage. Early consideration of SUDS in the master plan was also crucial to the success of the strategy.

SUSTAINABILITY ASSESSMENT

At the time the drainage issues of DEX were first considered (about 1992), the extent to which SUDS were sustainable was not known. However, what was certain was that the problems caused by inadequate urban drainage systems were not compliant with the emerging legislation (Water Framework Directive). It was clearly not socially or economically acceptable to continue to pollute a major estuary (Firth of Forth) which supports a salmonid fishery and contact-based water sports through badly operating combined sewer overflows or diffuse pollution. The FRPB report (1994) led to a policy drive to address the problems of diffuse pollution in a more sustainable way.

Rather than focusing merely on drainage issues, DEX was seen as being a showcase to encourage greater sustainability in a wide range of construction and development activities. There was much debate about whether SUDS were actually sustainable or just how much "more sustainable" they would be, but there was little evidence at the time to answer the question. It was decided to use DEX as a large scale test site which would be intensively monitored by a range of universities to try to establish the extent to which the new drainage systems were sustainable. In this way, the full range of sustainability issues – environment, economy, responsibility, social value – could be evaluated in the long term. Knowledge gained from the design and implementation, and importantly from the post-project monitoring, has informed legislation and current best practice for SUDS within the UK.

DISCUSSION AND CONCLUSIONS

Although DEX is by no means perfect, it is accepted as a success dating back to a time when there were no precedents. This showcase development set a standard for drainage master planning on a large scale in Scotland and the rest of the UK. Design philosophy has progressed since the implementation of DEX, and some of the structures implemented are now not considered best practice. However, the SUDS designed and implemented at DEX, and subsequent monitoring of their operation and performance, have informed what we now consider best practice.

An example of this is the concept of treatment volume and method of volume calculations for ponds, which were derived during the workshop process. The treatment volume (the permanent pond volume) is a function of local hydrological characteristics, soil type and the level of impermeability of the catchment.[23] Ponds were initially designed to a treatment volume of 4Vt to ensure adequate treatment of runoff. However, subsequent studies have shown that residential catchments are generally considered low risk (for nutrient and contaminants) and a treatment volume multiple of one (1Vt) is acceptable. This change in hydraulic design is replicated in the new Scottish Water technical standard which stipulates 1Vt ponds.

Other large-scale developments in the UK have built upon the success of the DEX example. These include:

- Edinburgh South East Wedge development, Scotland.
- Ravenscraig re-development in Lanarkshire, Scotland.
- Waterlooville development in Hampshire, England.

All of these developments would have been seriously constrained without the use of SUDS drainage to achieve both water quality and flood attenuation criteria.

---

[22] SUDS Scottish Working Party (2010), SUDS for Roads [online]. Available from: http://scots.sharepoint.apptix.net/suds/General%20Publications/Forms/AllItems.aspx

[23] Woods-Ballard, B. et al. (2007), The SUDS Manual, C697, CIRIA, London.