

## Albion Close, Lincoln



### SuDS used

- Rainwater harvesting system supplying each dwelling's toilets – (PREVENTION)
- Permeable paving and sub-base storage serving private surfaces – (SOURCE CONTROL AND TREATMENT)
- Grass filter strips – (SITE CONTROL AND TREATMENT)
- Grass swales for flow conveyance, and stone filled wire basket check dams – (SITE CONTROL, CONVEYANCE AND TREATMENT)
- Bio-retention basin outflowing into public surface water sewer – (SITE CONTROL AND TREATMENT)

### Benefits

- Water quantity:
  - Reduced flood risk provided by point source interception i.e. rainwater harvesting and infiltration, and by sub-base storage, grass filter strips, grass swales, stone check dams and bio-retention basin.
- Water quality:
  - Improved quality of surface runoff due to a three-treatment process provided by the SuDS components and devices used in the management train stated above.
- Amenity:

- Enhanced amenity at all SuDS areas, designed to be “open space” accessible and safe for “all year-round” public access.
- The natural sloping area around the bio-retention basin and adjacent to the woodland area provide quiet areas for dog walking and other quiet recreation.
- Biodiversity:
  - All grassed SuDS areas are sensitively maintained for biodiversity and provide a natural habitat to attract related flora and fauna.
  - The area within and around the bio-retention basin provides a mixture of natural short and tall flora, attracting a variety of small mammals, birds, insects and butterflies.
  - Circa 50 native species trees planted.
- Multiple benefits:
  - In particular, the area in and around the bio-retention basin, and adjacent to the woodland area together provide multiple benefits including: surface water retention, water quality improvements, wetted ground habitat for flora and fauna, public open space, adult quiet recreation and children’s natural play area

## 1. Location

Albion Close, Lincoln LN1 1ED

Grid Ref: E496509 - N372684

## 2. Description

This competition considers SuDS completed since 2016. However, whilst the SuDS scheme at Albion Close was designed in 2012/13, it was not formally adopted by Lincolnshire County Council (LCC) and Anglian Water Services Ltd. (AWS) until 2017. This development is considered by LCC to be a prime example of an **early good practice** SuDS site, as it’s well thought out, incorporates the principles of a SuDS Management Train and demonstrates where, over subsequent years, important lessons have been learned that have influenced **current good practice** in Lincolnshire.

Albion Close is a sloping site with character in the city of Lincoln. Its development potential was constrained by several factors including multi-directional surface land slopes, its irregular long and narrow shape, surrounding woodland and green space, plus being an extension to an existing urban area with vehicle access by a cul-de-sac road. The site is approximately 160m long and 50m wide with a 2.5m cross slope and a 7.5m longitudinal slope. The bedrock is Jurassic Middle Lias Clay and Shale and evidence gathered at two trial pits shows groundwater at 1.2m deep at the lower end of the site, and no groundwater encountered (at a maximum trial pit depth of 2.1m), at the middle/upper end. The development provides 13 detached, 3 and 4-bedroom houses, each with garages, arranged predominantly along the southern edge of the site with two properties located on its northern side. The main access into the site is a continuation of Albion Close (where it previously terminated at the head of the cul-de-sac), up the hillside and across an area of grass land and a belt of trees and hedging, used as amenity space by local residents. The dwellings are of a contemporary design and achieve Code Level 5 of the Code for Sustainable Homes. The development layout was designed to maximise the southerly aspect of the site and to serve the dwellings, a 160m long concrete block estate road was constructed with drainage infrastructure, public open space and circa 50 trees were planted.

The planning application was dated July 2012 and the planning reference numbers are: 2012/0410/F, PP-2092591 and 2013/0131/RD. Information can be found at

<https://development.lincoln.gov.uk/online-applications/applicationDetails.do?activeTab=map&keyVal=ZZZV0RJFSK442>

### 3. Main SuDS components used

The overall surface water drainage strategy ensured that the Government's non-statutory SuDS standards were met, whilst going beyond those to also provide increased local amenity, natural habitat and biodiversity. The sloping topography and other natural characteristics of this constrained site determined the zoning of specific drainage areas, and the most effective and desirable SuDS components making up the management train and associated landscape. Starting at the highest level of the site, the drainage zones and SuDS components constructed are:

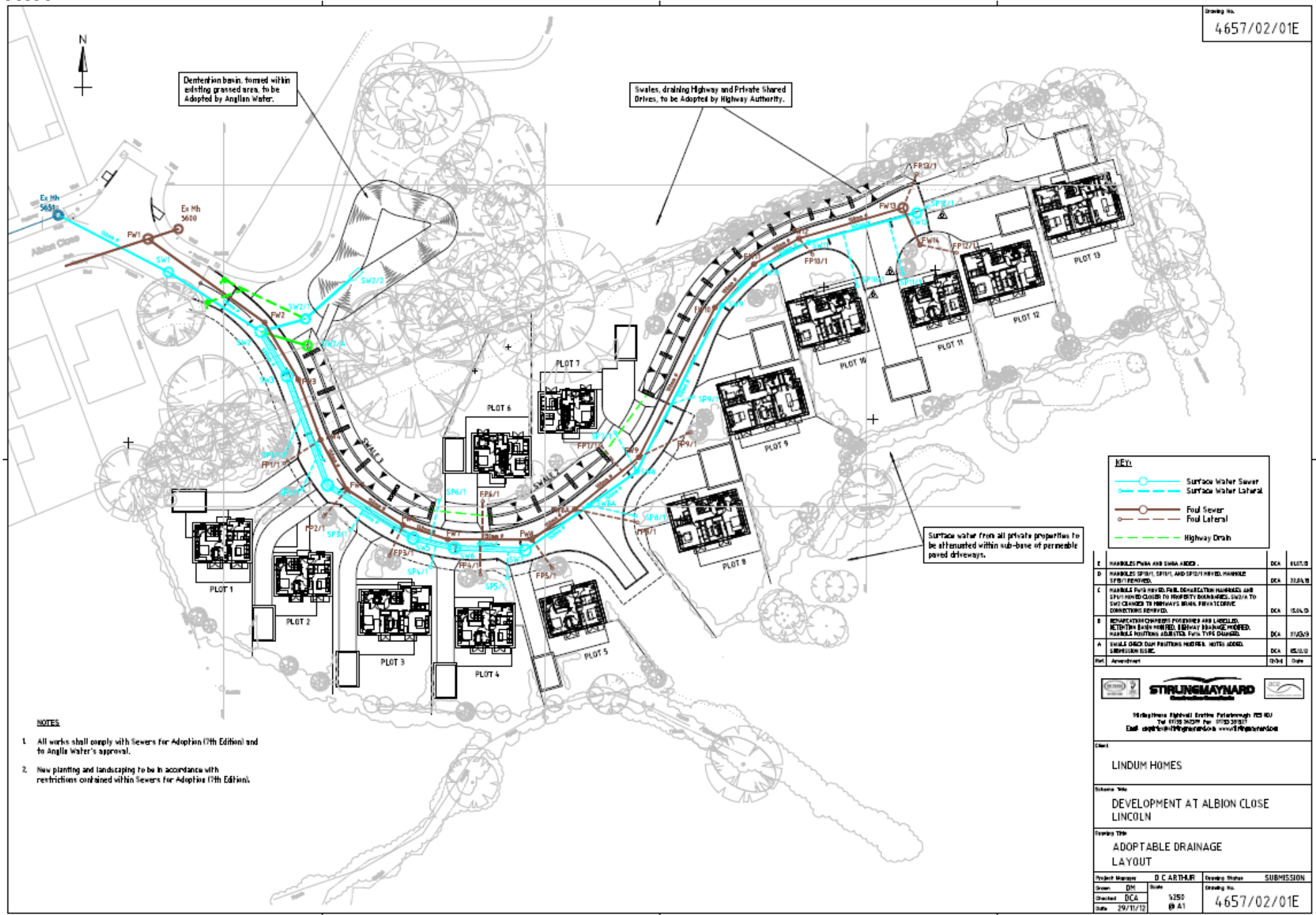
- Rainwater harvesting system supplying each dwelling's toilets (householder responsibility) – roof water is collected in a tank buried under the private driveways.
- Infiltrating permeable paving and tanked sub-base storage serving private driveway surfaces (householder responsibility) – excess stormwater flows over the paving surface, across grass filter strips and into flow conveyance grass swales.
- Traditional vitrified clay (VC) pipes carry infiltrated and stored private surface water to the existing public sewer and bio-retention basin (adopted by AWS) – 150mm laterals and 600mm oversized storage pipe run with drop manholes beneath the highway.
- Grass filter strips (adopted by LCC Highway Authority) – formed at the rear of concrete kerb edgings to the road surface.
- Grass swales for flow conveyance, plus stone filled wire basket check dams (adopted by LCC Highway Authority) – continuous flow pipes through check dams and under driveways.
- Bio-retention basin for sewer capacity exceedance flows, which outflow back into the public sewer when capacity returns (adopted by AWS) – open and unfenced earth basin formed with gentle side slopes and varying bed levels/depths, close to a woodland area, and natural native flora and fauna species dominate.



The SuDS drainage plan is shown below:



Drawn No. 4657/02/01E



**KEY:**

- Surface Water Sewer
- Surface Water Lateral
- Foul Sewer
- Foul Lateral
- - - Highway Drain

Surface water from all private properties to be attenuated within sub-base of permeable paved driveways.

- NOTES**
- All works shall comply with Sewers for Adoption (7th Edition) and to Anglia Water's approval.
  - New planting and landscaping to be in accordance with restrictions contained within Sewers for Adoption (7th Edition).

E	MANHOLE PIPES AND CHAM ADDED.	DCA	16/01/13
D	MANHOLE SPIRIT, SPIRIT, AND SPIRIT/PIVET, MANHOLE SPIRIT/PIVET/ADDED.	DCA	17/01/13
C	MANHOLE PIPES AND CHAM, DEMONSTRATION MANHOLE AND SPIRIT/PIVET ADDED TO PROPERTY BOUNDARIES, SPIRIT TO SWG CHANGED TO HIGHWAYS BRAND, PRIVATE DRIVE CONNECTIONS REVISED.	DCA	15/01/13
B	RECONSTRUCTION CHANGES PROPOSED AND LABELLED, SECTION BOUNDARIES, (BRAIN) DRAINAGE, PROPOSED, MANHOLE POSITIONS ADJUSTED, PIPES TYPES CHANGED.	DCA	11/05/13
A	SMALL DRAIN DRAIN POSITIONS AND PIPES ADDED, SUBMISSION ISSUE.	DCA	05/12/12
Rev	Amendment	D/14	Date

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<b>Client:</b> LINDUM HOMES			
<b>Site Name:</b> DEVELOPMENT AT ALBION CLOSE LINCOLN			
<b>Project Title:</b> ADOPTABLE DRAINAGE LAYOUT			
<b>Project Manager:</b> D. C. CARTER	<b>Drawn By:</b> SUBMISSION	<b>Drawn Date:</b>	<b>Drawn No.:</b>
<b>Client:</b> DCA	<b>Date:</b> 29/11/12	<b>Scale:</b> 1:250 (9 A1)	<b>Drawn No.:</b> 4657/02/01E

## 4. How it works

“Source, Surface and Green” were the three overriding principles to be incorporated into the early conceptual design, with as much runoff as possible being managed within the site. Reflecting elements of Code Level 5 of the Code for Sustainable Homes requirements, the developer and local planning authority incorporated rainwater harvesting for water re-use in each dwelling house. Roof water storage tanks under private driveways supply household toilet systems.

The whole site discharges into the pre-development off-site public sewer adopted by AWS and the SuDS management train comprises and serves two distinct areas of runoff, each with its separate drainage components:

Private hard surfaces – these are served by a traditional underground positive piped system where excess roof water (i.e. not collected for domestic re-use) flows through lateral VC pipes with connections to the AWS surface water public sewer through the site.

Rain falling on private driveways’ drains through permeable concrete block paving, into a “tanked” coarse aggregate sub-base storage layer (i.e. pervious paving system Type C), before draining through the lateral VC pipes and into the surface water public sewer. This underground public sewer is designed not to surcharge up to a 1 in 30-year rainfall event and is constructed of oversized VC pipes for part of its length and drop manholes. It provides for flows and storage of runoff from both roofs and private drives (i.e. public runoff), which then outfalls into the pre-development off-site adopted public sewer via a vortex control chamber.

When the pre-development public sewer capacity is taken up, excess flow and volume from the developed site are throttled and stored in the off-line bio-retention basin, until sewer capacity returns. This is to avoid downstream flooding for up to and including a 1 in 100 year plus climate change design rainfall event.

Public surfaces – all runoff from public surfaces (i.e. within the highway corridor) is managed by a sustainable drainage system which incorporates grass filter strips, grass swales, stone check dams, open ended pipe, a bio-retention basin and associated multiple use open spaces for amenity and biodiversity. Rain falling on the Lincolnshire County Council (LCC) adopted highway, which is constructed of non-permeable concrete block paving, flows over the sloped surface to grass filter strips along the lowest verge, before entering a series of grass swales. Collected runoff then flows along and within the swales to a piped connection into the pre-development off-site adopted public sewer via the vortex control chamber mentioned above. Similar to the private hard surfaces, when the pre-development public sewer capacity is taken up, excess flow and volume from the swales is diverted to the off-line bio-retention basin, via an open exceedance channel from the lowest end of the swale, and stored until downstream sewer capacity returns. In addition, due to the sloping nature of the site, and in accordance with CIRIA’s early SuDS guidance, stone filled wire basket check dams are provided to reduce the flow velocity in the swales and to also encourage some degree of natural infiltration to the underlying strata (although this has not been allowed for in the hydraulic design of the scheme). Where driveways to dwellings cross the swales, VC pipes have been laid to ensure continuity of flow.

The scheme has been carefully designed taking into account the site constraints, whilst also incorporating the good practice principles of SuDS as existed in 2012/13 when the drainage scheme was

approved by the LPA. Then, following construction and a maintenance period, the SuDS components were adopted in 2017.

The initial runoff from impermeable surfaces is intercepted and partially retained by the rainwater harvesting system for each individual dwelling, along with the permeable paving for private driveways. In addition, vegetated surfaces of grass filter strips and swales with stone check dams, manage early runoff from public space hard surfaces.

- **Flows and volumes**

The SuDS scheme was designed in accordance with the Defra 2010 Draft National SuDS Standards i.e. restricting both the peak flow rate and volume of runoff from the site. The peak flow rate allowed into the pre-development off-site adopted public sewer was 4 litres per second at a design head of 2.1m. Therefore, flows and volumes in excess of this figure, calculated for the 1 in 1-year rainfall event, and the 1 in 100-year, 6-hour rainfall event, have been restricted and are held in the bio-retention basin.

With regard to managing flood risk to and from the site, flooding from the drainage system does not occur:

- a) On any part of the site for a 1 in 30-year rainfall event; and
- b) During a 1 in 100-year rainfall event in any part of a building (including a basement); or a utility plant susceptible to water (e.g. pumping station or electricity substation); or
- c) On neighbouring sites during a 1 in 100-year rainfall event.

A climate change allowance of +30% has been included in design rainfall events, plus design rainfall exceedance flood flows, volumes and flow routes were taken into account by the design and being directed to areas of existing public highway.

The drainage system has been predicated on restricting the volume and speed of surface water to the pre-development off-site adopted public sewer to ensure it does not exceed 4 litres per second. AWS stated this figure to be the remaining capacity within the surface water sewer.

- **Water quality**

Private hard surfaces – hydrocarbons from parked vehicles are captured in the concrete block joint spacing media and also in the infiltration/storage sub-base before runoff enters the AWS adopted 600mm dia. and 59m length of storage pipe under the highway; prior to base flows entering the pre-development off-site adopted public sewer. Excess storm flows are taken off and stored in the bio-retention basin where further filtering by natural vegetation takes place.

Public surfaces – hydrocarbons from vehicles using the highway and general silt and dust, is flushed from the surface of the non-permeable concrete blocks, and caught by the grass filter strips alongside the grass swales running for the whole length of the site. Further treatment takes place when runoff enters the 0.35m – 0.45m deep grass flow conveyance swales and in times of low flow, is filtered through the small stone core wrapped with geotextile, within the check dams, prior to a third treatment stage where water is stored in the heavily vegetated bio-retention basin before draining back into the public surface water sewer.

- **Biodiversity**

Prior to development commencing on site, a full arboriculture report was submitted with the planning application, to minimise the impact of the development and recommend various measures to ensure protection and management of the existing trees, hedges, and woodland area. Surface areas of grass filter strips and grass swales have been maximised, allowing natural vegetation to seed and flourish wherever possible. Also, sensitively maintained reed growth in the bio-retention basin, provides a mixture of natural short and tall flora attracting a variety of small mammals, birds, insects, and butterflies. In addition, the existing woodland area at the lower end of the site was protected during construction so as not to unduly disturb the natural flora and fauna.

- **Amenity**

Amenity at all SuDS areas is designed to be “open space” accessible and safe for “all year-round” public access. The natural sloping area around the bio-retention basin and adjacent to the woodland area provide quiet areas for dog walking and other quiet recreation.

## 5. Specific project details

Traditional highway surface water drainage on this site would take the form of gullies at 15-20m spacing along the downslope edge of the highway against concrete drop kerbs; oversized underground pipes (for water storage), laid underground along the full length of the road; and drop manholes to take account of the natural gradient of the site. The infrastructure would be very much “out of site and out of mind” as far as the residents are concerned, and the benefits to water quality, amenity and biodiversity, along with the pleasing landscape features would not exist. Routine inspection and maintenance of the underground infrastructure would be far more difficult than it currently is for the filter strips, swales, and check dams.

In terms of comparison between capital and revenue cost of the adopted highway and surface water drainage; LCC have undertaken a recent Lincolnshire SuDS implementation review that considers this issue. The review has shown that taking an initial broad brush approach to comparing the “whole life” costs of highway SuDS systems alongside traditional highway drainage systems, (having the same rainfall design event and allowable discharge criteria), indications are that by taking an appropriate risk based approach to the maintenance and asset replacement of SuDS systems, they can provide greater benefit at lower cost than traditional highway drainage construction methods.

Key disciplines involved in the planning and development of the site included:

- Developer, Main Contractor and Sub-contractors
- Design Consultant
- Environmental Consultant
- Local Planning Authority (LPA)
- Water and Sewerage Company (WaSC)
- Lead Local Flood Authority (LLFA)
- Highway Authority (HA)
- Highway Laboratory (HL)

Stakeholder engagement and interactions between organisations were not constrained in any way but were greatly assisted by early consultation in the local planning process. Early SuDS concept designs and variations were discussed widely (and at the appropriate detail), at the pre-planning stage via multi-agency group meetings convened by the LPA. This enabled all the relevant statutory consultees to collectively provide a focus on this one project, and work with the developer and design consultant to arrive at an appropriate development layout and agreed SuDS solution for this site. For example, initially, these discussions included the consideration of grass swales being located on both sides of the adoptable highway to keep runoff from private impermeable surfaces above ground. However, due to site layout constraints, land-take, and early concerns over WaSC adoption of open channels to convey domestic surface water runoff, this solution was not taken forward. Hence the two-surface water systems being constructed on the site.

Community engagement took the form of that normally required by the local planning process (i.e. planning notices, discussion with and letters to and from local residents', Lincoln Civic Trust and Council Member meetings and discussions etc.). With specific regard to SuDS, it was obvious to prospective purchasers of the dwellings that the green landscaped areas comprising grass filter strips, swales, stone check dams and the bio-retention basin were there for managing the rainfall falling onto their property. However, to help highlight the importance of this infrastructure, a prominent SuDS information board was erected alongside the bio-retention basin.

## 6. Maintenance & operation

In working with the developer, LCC adopted the highway and related surface water drainage infrastructure by agreement in accordance with Section 38 Highways Act 1980.

In addition, AWS has adopted the domestic surface water infrastructure (including the bio-retention basin), using Sec 104 Water Industry Act 1991.

LCC's operational team maintain the adopted highway and related SuDS (i.e. non-permeable concrete blocks, concrete kerbs, filter strips, swales, and check dams).

AWS maintain the adopted underground pipes and manholes serving excess surface water from dwellings, and the bio-retention basin and associated pipework.

Private property owners operate and maintain the rainwater harvesting pipework and underground tank, along with the private parking surfaces, infiltration media and lateral pipework up to the AWS on-site adopted main sewer collector pipework.

City of Lincoln Council maintain the remaining green public open spaces.

All maintenance and operation is carried out in accordance with industry good practice. However, site inspections have shown that due to the nature of this specific site, the generic recommended tasks and frequencies of operation and maintenance given in the CIRIA SuDS Manual C753 (2015) are not all essential to ensure good SuDS performance. Therefore, both LCC and AWS have adopted a risk based approach, and based on regular inspections, have reduced these ongoing revenue costs by undertaking tasks less frequently than recommended in the SuDS Manual. This risk based approach will be monitored and documented over the coming years as part of a joint LCC and AWS "Good SuDS" initiative as mentioned below.



## 7. Monitoring and evaluation

As with other LCC highway adopted assets, area staff undertake a yearly inspection to check the need for any emergency work or maintenance defects to be carried out. If required, these are planned into a works programme and completed on a priority basis. In addition, LCCs term contractor undertakes annual maintenance inspections, prior to “evidence based” cyclic maintenance tasks being carried out. This approach to monitoring and subsequent maintenance activities ensures good SuDS performance.

Further to the recent Lincolnshire SuDS implementation review, a joint LCC and AWS initiative is being established to review “Good SuDS” implementation across a small number of ongoing and completed development sites in Lincolnshire. The key objectives being to gather evidence and agree “Good SuDS” practice and outcomes within the County and establish both joint understanding and processes to ensure these are delivered and adopted on future development sites. This work will embrace the full spectrum of delivering SuDS from pre-planning, through all stages of planning decision making, to adoption, operation, and maintenance.

## 8. Benefits and achievements

This is a well developed site with 13 detached dwellings built to Level 5 of the Code for Sustainable Homes. Although being at the higher end of the property market in Lincoln, the properties sold very quickly, due to the quality of build and the site landscaping incorporating the green SuDS features and open multiple use public spaces. Recognising that the SuDS design was carried out in 2012/13 by the forward thinking developer, design consultant and planning team, the greatest achievement is the outcome and adoption of a “Source, Surface and Green” surface water management infrastructure on a challenging non-infiltrating sloping site. This being achieved prior to publication of the Ministerial Statement, the Government’s non statutory SuDS standards, CIRIA’s updated SuDS Manual (2015) and associated guidance, and before the development and publication of LCCs own Development Roads and Sustainable Development Design Approach, and related Specification and Construction requirements. Following adoption of the SuDS by LCC and AWS in 2017, the management train has performed as designed and the constituent surface water drainage components continue to enhance the local environment and the residents’ quality of life. The successful partnership working between LCC and AWS achieved during this scheme, paved the way to many further SuDS schemes across Lincolnshire where the two organisations share ownership and maintenance of SuDS infrastructure.

## 9. Lessons learnt

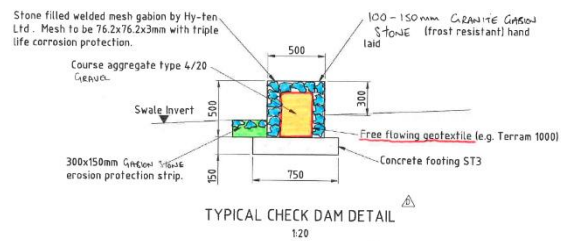
### Lesson 1 – Filter strips, swales and check dams are a viable SuDS solution on a sloping site

The most challenging aspect of adopting a SuDS solution on this site was its relatively steep gradient and sloping levels, being approx 2.5m crossfall and approx 7.5m longitudinally. In 2012/13, when the concept of a SuDS solution was first being considered, the use of filter strips, swales and check dams on sloping sites was quite rare, and in effect, LCC was breaking new ground in discussions with the developer, the design consultant and the LPA, by promoting this type of solution. However, with close attention in the design to synergies and reliance between design flows, flow depths and flow velocities, and landscape management, the developer team designed and delivered a very successful

scheme; acknowledging that some lessons have subsequently been learned from this early application, as indicated below.

### Lesson 2 – Keep check dam construction as simple as possible

Due to the steep site gradient and the resulting longitudinal bed slopes of the swales, stone filled wire basket check dams were installed. However, these check dams were designed with a 20-40mm aggregate core, wrapped in a permeable membrane to slow down the water flow through the leaky dams. The actual construction of these wire basket dams involved inserting 100-150mm granite lining to the basket, within which the wrapped aggregate stone core was placed. This all proved to be quite challenging, but was overcome by the contractor setting up a trial construction area in his yard and undertaking a series of test constructions, prior to installing the check dams on site. In hindsight, the benefits of having the two types and sizes of fill forming the dams is questionable, and any future application would likely just include the larger stone without the use of a filter membrane.



### Lesson 3 – Design a reverse kerb bullnose detail to provide a 25mm kerf face check to swale edge

As can be seen from the photos attached, the grass filter strips were constructed at a level either equal to or slightly raised above the level of the flat concrete edge kerbs. Subsequent site observations have shown that, even with the favourable surface flow approach slopes of the road, in times of low velocity and shallow depth, the surface runoff is sometimes prevented from easily flowing over the grass filter strips and into the swales. This reduces the effectiveness of this first water quality treatment stage and can turn the runoff back onto the road causing increased surface flows down the road and a build up of surface silt and other contaminants downstream. As a result of this learning, LCC's standard specification and construction has been modified to require a reverse kerb bullnose for all filter strips abutting a road. This detail provides a 25mm drop at the rear of the kerbs down to the surface level of the grassed filter strip, which has a surface slope of between 2% - 5% to take runoff away from the back of the kerb. This reverse kerb bullnose design has been a game changer as it caters for sheet runoff from roads and in many cases, can avoid the use of conventional gully pots and underground pipework.

### Lesson 4 – A stone sub-base to a grass filter strip helps prevent vehicle parking and over-run causing surface damage to the filter strip, and can avoid the need for low level kerbside fencing

Grass filter strips can be soft and prone to damage by vehicle wheel rutting due to roadside parking and/or vehicle over-run. Where this occurs the effectiveness of the grass filter strip can be severely impacted. LCC experience has shown that where this is an issue, and low level kerbside fencing is undesirable, the placing and compaction of a 150mm thick layer of Type 1 sub-base beneath the 100mm thick grassed topsoil forming the filter strip, can prevent damage from most vehicles in most weather conditions. Again, the LCC standard specification and construction for kerbside filter strips has been modified to require this method of construction.

**Lesson 5 - Consider lifetime maintenance requirements when designing simple SuDS solutions**

There are two LCC adopted access crossings of the grass swales and to maintain continuity of flow conveyance, each crossing has a 150mm dia VC pipe (with stone filled wire basket headwalls), passing underneath. This pipe appears to have been laid with its upstream invert level at the same level as the excavated bed of the swale, thus enabling sufficient depth of cover to prevent damage and/or deformation by vehicles passing over. Inevitably, there is an ongoing risk of partial or complete blockage at the upstream end of the pipe, due to debris being washed off upstream areas. In hindsight, there are possibly two preferred solutions here. The first being to use a strong cast iron pipe to allow the depth of cover to be reduced and hence raise the upstream invert of the pipe above the bed of the swale, so reducing the risk of blockage and ongoing maintenance activity. The second being to omit the pipe altogether and design the vehicle access with a shallow surface level depression along the centre line of swale, thus enabling continuity of flow conveyance over the surface of the access instead of underneath. Depending on the invert level of the shallow depression, it is likely that some water would be held upstream in the swale for a period of time and may naturally infiltrate into the underlying strata.



**Lesson 6 – At SuDS design concept stage, allocate appropriate room for grass filter strips and swales**

As can be seen from the photos opposite, the width of the grass filter strips is narrow and the effectiveness of this component would be improved with a longer surface water flowpath between the back edge of the kerbs and the edge of the swales. Accepting though, that the adopted highway in this scheme isn't heavily used and the risk of high pollution loading (and silt) is relatively low, it's important to ensure that in early discussions with the developer at the concept and pre-planning stage, filter strips of at least 1.0m wide are initially allowed for, pending the results of the detailed design of the filter strip (based on the performance outcome required). All too often, LCCs experience has shown that initial surface areas allocated to filter strips and swales can get squeezed and reduced as the overall scheme design progress becomes more detailed.



**Lesson 7 - Developer to provide SuDS construction method statement prior to commencing on site**

Back in 2012/13, there was little emphasis placed on the importance of a detailed and transparent SuDS construction method statement being produced prior to commencement of work on site. As was the norm then, this site was no exception and the construction methods and sequencing proposed generally followed traditional positive drainage practice. However, it was soon realised that having constructed and completed the stone filled wire basket check dams, relatively early on in the overall site development programme, they then needed to be protected from contamination and damage due to silty/muddy surface water runoff whilst construction and building work carried on upstream. As can be seen from the adjacent photo, all of the check dams were completely wrapped with a protective membrane which was removed in the final stages of the site development. In hindsight, and with the benefit of a SuDS construction method statement prior to commencing work on site, the check dam construction could have been programmed for the latter end of the works, so avoiding much of this temporary work.



**Lesson 8 – Instead of the AWS adopted underground pipework (i.e. laterals and main on-site surface water sewer, including 600mm storage pipes), excess private roof water and rain water falling on private driveways could be managed on the surface, so avoiding much of the current underground surface water drainage infrastructure**

Again back in 2012/13, positive piped drainage systems serving new development were still quite common. Whilst the early SuDS Manual promoted the principles of “Source, Surface and Green” and the use of filter strips and swales, many asset adopting organisations were still nervous about taking on the long-term asset liability of this relatively new approach to surface water drainage infrastructure. As has been previously mentioned, Albion Close was no different in this regard. However, the technology, experience and learning associated with filter strips and swales has progressed significantly since the drainage design for this site was carried out in 2012/13. In hindsight, and even taking account of the constrained nature of the site, it’s felt that much of the underground drainage infrastructure might be avoided if this site had commenced its journey through the planning system more recently.

Alternative “Source, Surface and Green” approaches to managing rain falling on private hard surfaces could take the form of additional grass filter strips and swales along the higher side of the adopted highway (utilising the current green verge areas); or by increasing the capacity of the current grass swales to accept either direct discharge from the lateral pipework, or receiving overland flow from across wider grass filter strips. This could accommodate rain falling on private driveways not infiltrating but running off as “sheet flow” and crossing the surface of the highway on its journey to the filter strips. Not only could this be likely to avoid costly excavation and construction of the underground assets, but below ground inspection and maintenance access wouldn’t be required either. In addition, water quality treatments would be provided by the additional and widened filter strips, enlarged swales and check dams.

**Lesson 9 – On-line attenuation ponds in the future will provide additional water quality treatment**

With LCCs’ increased SuDS knowledge, experience and partnership working with AWS, plus the recent release of Water UK’s Design and Construction Guidance 2020; AWS now adopt on-line attenuation ponds. In future this will provide better treatment of all runoff, compared to the off-line scenario in this early scheme. An on-line attenuation design solution in any future scheme, means that all upstream flows will get treatment, and in a similar development to Albion Close, highway runoff for all rainfall events would get at least two treatment stages, via filter strips/swale and then the bio-retention pond.

**Lesson 10 – Careful consideration of attenuation pond design can eliminate the requirement for costly and unsightly safety fencing, and encourage multiple use of the SuDS asset open space.**

The design of the off-line bio-retention basin having wet and dry benches, a maximum water depth of around 600mm, and safe side slopes (1 in 3 and 1 in 4) meant that there was no requirement for safety fencing. As is the case at Albion Road, the need for fencing around ponds can be designed out, and the open SuDS space lends itself to also achieving amenity, biodiversity and recreation objectives.

**10. Interaction with local authority**

As indicated in Section 5 above, engagement and interactions between all stakeholders listed were very positive and constructive, aided by their commitment to attending and participation in the multi-agency group meetings. To reach agreement to incorporate SuDS into the design and layout of a new development site back in 2012/13, was still quite rare in Lincolnshire. However, this was successfully achieved at Albion close, due not least to open and honest discussion about concerns, constraints and various options affecting the planning and overall viability of the development.

City of Lincoln Planning Team (the LPA), has commented that it was “great” to be involved with this development as the applicant fully engaged from the outset with the SuDS approach, as did all statutory consultees and other interested parties. Also, that it is testimony to the quality of the environment that has been created, as the houses in Albion Close are extremely sought after when they come onto the market.

**11. Project details**

LCCs’ adoptable highway and related SuDS went onto maintenance in September 2015 and these assets were fully adopted in April 2017. This was also the date when AWS adopted the relevant drainage infrastructure.

Unfortunately, costs for this scheme are not available.

The overall site area is approximately 0.8 hectares and of this, the area taken up by “Source, Surface and Green” SuDS is approximately 1010 square metres. Therefore, the area of SuDS per hectare is in the region of 1250 square metres (12.5%)

## 12. Project team

Client/Funder/Developer	<ul style="list-style-type: none"> <li>Mark Foster &amp; Chris Brown, Lindum Group, Jubilee Place, Lindum Business Park, Station Road, North Hykeham, Lincoln. LN6 3QX Tel: 01522 500300</li> </ul>	
Contractor	<ul style="list-style-type: none"> <li>Dan Ingall, Daniel Charles Construction Ltd., Honeywood Barn, Honeyholes Lane, Dunholme, Lincoln. LN2 3SU Tel: 01673 860444</li> </ul>	
Environmental Consultant	<ul style="list-style-type: none"> <li>Delta Simons Environmental Consultants, The Lawn, Union Road, Lincoln. LN1 3BL Tel: 0870 0400012</li> </ul>	
Design & Construction Consultant	<ul style="list-style-type: none"> <li>Stirling Maynard Consulting Engineers, Stirling House, Rightwell, Bretton, Peterborough. PE3 8DJ Tel: 01733 262319</li> </ul>	

<p>City of Lincoln Council</p>	<ul style="list-style-type: none"> <li>• Simon Cousins, City of Lincoln Council, City Hall, Beaumont Fee, Lincoln. LN1 1DD Tel: 01522 881188</li> </ul>	
<p>Lincolnshire County Council Lead Local Flood Authority &amp; Highway Authority</p>	<ul style="list-style-type: none"> <li>• Warren Peppard &amp; Liz Burnley, Lincolnshire County Council, Lancaster House, 36. Orchard Street, Lincoln. LN1 1XX Tel: 01522 554637</li> </ul>	
<p>Water &amp; Sewerage Company</p>	<ul style="list-style-type: none"> <li>• Matthew Vickers &amp; Douglas Mlambo, Anglian Water Services Ltd., Lancaster House, Lancaster Way, Ermine Business Park, Huntingdon. PE29 6JY Tel: 0345 791 9155</li> </ul>	
<p>LCC Lincs Laboratory</p>	<ul style="list-style-type: none"> <li>• Steve Betteridge, Lincs Laboratory, St. Georges Lane, Riseholme, Lincoln. LN2 2LQ Tel: 01522530355</li> </ul>	



Aerial photo showing final development (Google Earth)



Location plan showing site layout (City of Lincoln Council)



Location Plan showing surface water flood risk (Environment Agency)





Highway adopted non-permeable block paving, abutting permeable block paving serving private driveway (householder responsibility). Note grass filter strips, flow conveyance swales and check dams, plus different patterns in block paving with slender concrete edging indicating change in responsibility. Photo taken April 2017.



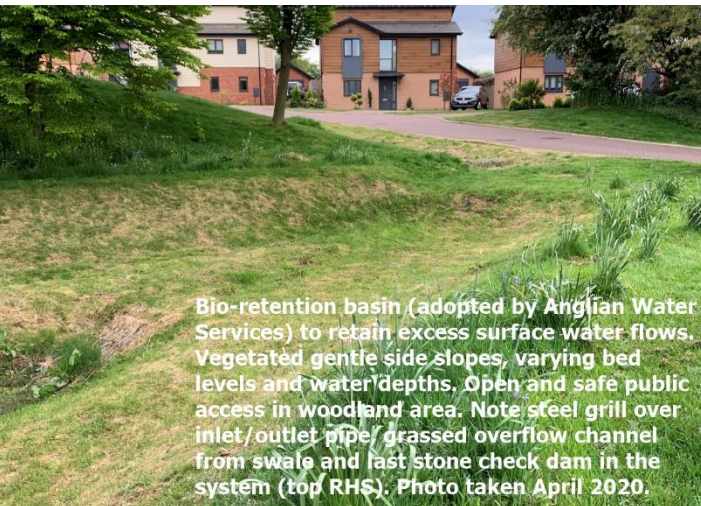
Grass swales for flow conveyance with leaky stone filled wire basket check dams, and flow continuity pipes under highway adopted vehicle access areas. Note upstream pipe inlet, plus square concrete markers at groundlevel indicating extent of adopted highway. Photo taken April 2017.



Private permeable block paving on garage driveway, plus LCC adopted non-permeable block paving to driveway and highway over piped section of swale. Note upstream check dams in swale. Also, stone basket headwall and vegetation growth obstructing pipe outlet (bottom LHS). Photo taken April 2017.



Access road with grass filter strips, swales and stone check dams managing surface runoff from LCC adopted highway. Note manhole lids showing lines of underground pipework serving separate public surface water runoff and foul drainage systems (adopted by Anglian Water Services). Photo taken April 2020.



Bio-retention basin (adopted by Anglian Water Services) to retain excess surface water flows. Vegetated gentle side slopes, varying bed levels and water depths. Open and safe public access in woodland area. Note steel grill over inlet/outlet pipe/ grassed overflow channel from swale and fast stone check dam in the system (top RHS). Photo taken April 2020.