# Gartloch Hospital

Case Study

## Author:

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**Information kindly contributed by:**

Dougall Baillie Associates on behalf of New City Vision.

Greenbelt Group Ltd.

# Contents

**CASE STUDY: GARTLOCH HOSPITAL**

**Location**: Glasgow, Scotland
**Development type:** Residential (approx 450 new build houses and 150 new houses from existing building refurbishment)
**Area**: 40 Hectares

**Key Topics:**
***Construction best practice:*** Erosion and sediment control plan, temporary works, monitoring
***Sustainable Drainage:*** Three independent SUDS treatment trains
***Legislation****:* Surface water discharge licensed under Controlled Activities Regulations (CAR)
***Environment****:* Nutrient sensitive receiving water and surrounding fen classified of environmental importance

## 1. Aims and objectives

This case study investigates the planning, implementation and supervision of construction best management practices (BMPs) to minimise the impact on:

- The water environment during the construction phase, and
- The SUDS treatment train, intended to manage the (post-construction) pollution and flood risk from the development.

## 2. Learning points

- The impact of construction on the water environment
- Risk based regulation
- Temporary works to manage erosion and sediment

## 3 Site Overview

In 1889, the City of Glasgow bought Gartloch Estate, located on the outskirts of the City of Glasgow, for an estimated £8,600. In 1896 Glasgow City District Lunacy Board elected to build an asylum for the poor within the grounds. The hospital was closed in 1994 and the site sold for private development.

The main hospital building, classified as a protected grade 'A' listed building[1], is located within the centre of a hillock with surrounding ground to the east, south and west sloping towards open fen, marsh and ultimately the Bishop Loch. The surrounding areas (to the north, east and west of the site) are open farmland.

The Bishop Loch is one of seven small lochs within the area which are interconnected by a number of water courses, drainage ditches and lochans. The Bishop Loch and surrounding fen is classified as a Site of Special Scientific Interest (SSSI), Local Nature Reserve (LNR) and as a Site of Importance for Nature Conservation (SINC).


*Figure 1. Gartloch location & existing site and Bishop Loch Receiving water (Image produced from the Ordnance Survey Get-a-map service. Image reproduced with kind permission of Ordnance Survey and Ordnance Survey of Northern Ireland).*

## 4. Stakeholders & regulatory requirements

Approval of the development involved consultation with a range of stakeholders as indicated in Table 1 (below).

The environmental importance of the site necessitated both the Scottish Environment Protection Agency (SEPA) and Scottish Natural Heritage (SNH) to be key consultees in the planning process.

SNH raised particular concern about soil disturbance during construction and the potential impact on water quality and habitat of the Loch and surrounding areas. The Bishop Loch area provides habitat for many species of biological interest including; 14 species of water shrimp,13 species of

[1] Listed building is a term for a building which has been placed on the Statutory List of Buildings of Special Architectural or Historic Interest. It has three grades: A, B and C, A being of statutory list quality. To be the subject of notification to Heritage and/or the serving of a Building Preservation Notice if imminently threatened.

water snails, the nationally notable water beetle *Agabus unguicularis* and the moth *Limnaccia phragmitella* which is rare in Scotland [2].

*Table 1. Gartloch Development Stakeholders & Interests*

| 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 |
| New City Vision | X | | X | | | | | | | | | | | |
| Dougall Baillie Associates | | X | X | | | | | | | | | | | |
| Local Authority | X | | | | | | | | X | X | X | X | X | X |
| Scottish Environment Protection Agency | X | | | | X | | X | X | | | | | | |
| Scottish National Heritage | X | | | | X | X | X | X | | | | | | |
| Scottish Water | | X | | X | | | | | X | | | | | |
| Greenbelt Group Ltd | | | | X | | | | | | | | | | |

Dougall Baillie Associates (DBA) was commissioned as the water management consultant by the developer, New City Vision. DBAs involvement in the project spanned from the master planning feasibility, to detailed design and supervision of the construction phase.

The SUDS drainage strategy was developed during the period off 2004-2006 in consultation with the stakeholder group. This timescale is of particular importance as the development coincided with the introduction of the Water Environment (Controlled Activities) (Scotland) Regulations 2005, commonly referred to as the Controlled Activity Regulations (CAR). CAR introduced changes in how surface water discharges were managed within Scotland.

Two key concepts of CAR are of relevance to the development:

1. CAR introduced a risk based approach to regulation of water related activities, including discharge of surface water from developments. This involved three tiers of regulation; compliance with predetermined conditions (called General Binding Rules, GBRs), registration and licensing.

[2] Scottish Natural Heritage (2000). SSSI Management Statement: Bishop Loch SSSI. [online]. Available from: http://gateway.snh.gov.uk/pls/portal/Sitelink.Show_Site_Document?p_pa_code=210&p_Doc_Type_ID=3

2. CAR required that Sustainable urban drainage systems (SUDS) are used for all new developments in Scotland (with the exception of where run-off is from a single dwelling and its curtilage, or if the discharge is to coastal water).

Due to the environmental sensitivity of the Bishop Loch and surrounding area, the surface water discharge from the development was escalated to a simple license under CAR; believed to be the first to be issued in Scotland by SEPA.

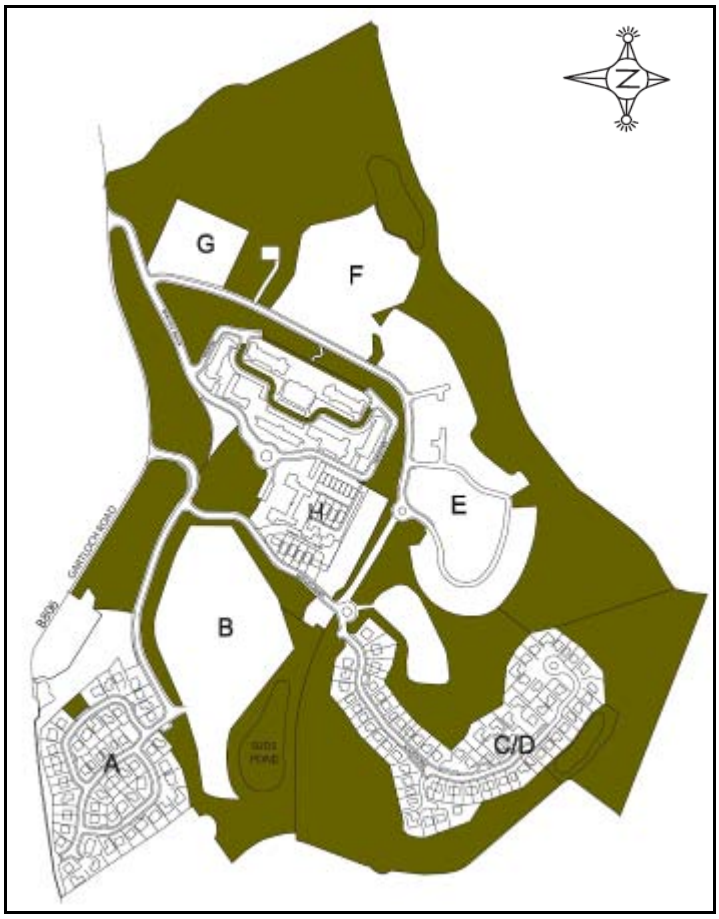



*Figure 2. Gartloch development (current status) (Image courtesy of Greenbelt Group Ltd).*

The CAR License stipulated that the water environment must be protected:

- The water environment was protected during the construction phase by means of suitable ***temporary works*** and that a monitoring regime was implemented,

- Post-construction that the water environment was protected using a ***SUDS treatment train***, commensurate with the level of pollution risk to the water receptor, was designed and implemented.

When the site was developed legislation governing adoption (and maintenance) of SUDS had yet to be introduced within Scotland.

Planning conditions stipulated that long term maintenance of the SUDS was catered for to ensure the treatment train operated as designed; this was initially overcome by agreeing transfer of ownership and responsibility of the open space areas (following completion of all phases) including the SUDS, to a private management company. This process has been used for the first of the ponds to be constructed (Pond A).

A change in conditions for SUDS adoption within Scotland[3] has arisen since the initial planning consent. At time of writing the construction of the site is not completed; Pond B has been implemented but Pond C and the contributing phases have not yet begun.

Confirmation has been given by Scottish Water that the pond(s) design is satisfactory and that they will be vested[4] within Scottish Water subject to the conditions for vesting in Sewers for Scotland 2nd Edition.

## 5. SUDS Treatment train design

The selected SUDS strategy for Gartloch was agreed with SEPA during the consultation period. A higher level of treatment than would normally be necessary (for a residential development of this size) was required for the site due to the environmental importance of the Bishop Loch and surrounding fen areas. The design included a three treatment stage treatment train to ensure runoff discharging to the water receptor had been adequately treated.

**Pond A**: 4Vt pond (2240m$^3$) plus attenuation to the 1:200 year storm + 20% allowance for climate change

**Pond B**: 2Vt pond (410m$^3$) plus attenuation to the 1:200 year storm + 20% allowance for climate change

**Pond C**: 2Vt pond (1400m$^3$) plus attenuation to the 1:200 year storm + 20% allowance for climate change

*Figure 3. Gartloch pond layout (Image: ©2010 Google - Imagery ©2010 Infoterra Ltd & Bluesky, The GeoInformation Group, TerraMetrics, Map data ©2010 Tele Atlas).*

[3] The legal definition of the term 'sewer' was amended under the Water Environment Water Services (Scotland) Act (2005) to include SUDS. Subsequently Scottish Water was obligated to adopt SUDS designed and implemented in line with the new technical standard (Sewers for Scotland 2nd Edition) published in 2007, providing a formalised means for SUDS adoption in Scotland.

[4] The process of vesting, or to vest, is the terminology used by Scottish Water for the process of adopting new infrastructure.

In addition to the three levels of treatment SEPA stipulated the final control in the treatment train was to be either a pond or a wetland as permanent water SUDS, providing a higher level of water quality improvement.
The topography of the site played a large part in the final SUDS design. The existing buildings are situated at the top of a hillock in the middle of the site, with the surrounding areas falling away; this necessitated splitting the site into three sub-catchments, each of which was to be served by a SUDS treatment train before discharging to the Bishop Loch.
Each management train consisted of three controls; permeable paving within each property curtilage, filter areas and retention ponds.

The ponds were located to suit both the topography of the site and to limit loss of existing woodland areas and habitats. They were designed with different water quality volumes (Vt); this was agreed during the consultation process with SEPA. Pond A was the first to be implemented and was designed to 4Vt; the water quality design standard at the time[5].

When Ponds B & C were designed the consultant negotiated with SEPA to reduce the water quality volume from 4Vt to 2Vt, primarily to reduce the land take needed for the ponds. This negotiation coincided with a change in approach (within Scotland) to treatment volume, whereby it was considered that for low risk catchments[6] one treatment volume multiple (1Vt) was acceptable. However given the sensitivity of the receptor SEPA required additional treatment to ensure it's protection and stipulated that 2Vt ponds would be adequate for the remainder of the site.

To date, development of the site is ongoing with two of the three ponds implemented: Pond A located to the west of the site and Pond B located to the south west of the site.


*Figure 4. Pond A plan illustrating varying depths of water to promote biodiversity (Courtesy of Dougall Baillie Associates on behalf of New City Vision).*

[5] Wilson, S. Bray, R. & Cooper, P. (2004) *C609 Sustainable drainage systems. Hydraulic, structural and water quality advice.* CIRIA: London.

[6] Low risk areas as stipulated by the Controlled Activities Regulations, typically residential areas of less than 1000 houses and water bodies not under significant environmental impact

*Figure 5. Pond A after construction and initial planting of emergent vegetation. Note the exposed 'high marsh' berm; this image is prior to the pond being brought 'on line'. The pond level is low as the flow control has yet to be installed. (Image: ©2010 Google - Imagery ©2010 Infoterra Ltd & Bluesky, The GeoInformation Group, TerraMetrics, Map data ©2010 Tele Atlas).*

## 6. Protection of the water environment during construction

The construction process can have a detrimental impact on the water environment if not adequately planned for. The process of building can involve stripping the land of vegetative cover, excavating ground, temporarily stockpiling materials, and re-grading the site levels.

Exposed soil and earth is easily washed off during rainfall events making its way to the nearest watercourse; by overland flow or via the drainage system used for the development site. This silt-laden water, if not treated, can significantly reduce water quality, destroy important habitats and kill local animal and plant species.

Best practice for construction is to use a series of measures and processes to ensure that polluted water does not reach the local water; referred to as erosion and sediment control techniques. These control measures form part of the construction planning process and should be implemented prior to the commencement of any site works.

As part of the stipulations of the simple CAR license issued by SEPA, and in order to gain planning approval, adequate means to protect the Bishop Loch and surrounding areas had to be prepared.

DBA prepared mitigative measures for the construction phase in the form of an erosion and sediment control plan (ESCP). This plan also served to protect the SUDS which were to be implemented alongside other infrastructure at the beginning of the build.

The ESCP communicated the key control measures within a series of simple drawings; the main document is shown overleaf (Courtesy Dougall Baillie Associates on behalf of New City Vision).

The plan was prepared in three stages:

1. Identification of pollutant sensitive receptors; an overview of the site topography and overland flow paths to receptors (Loch and low lying fen).
2. Erosion and sediment control drainage masterplan; sub-division of the site and calculation of contributing areas, location and sizing of temporary control measures necessary.
3. Erosion and sediment control plan; single page summary of measures used to communicate the process.

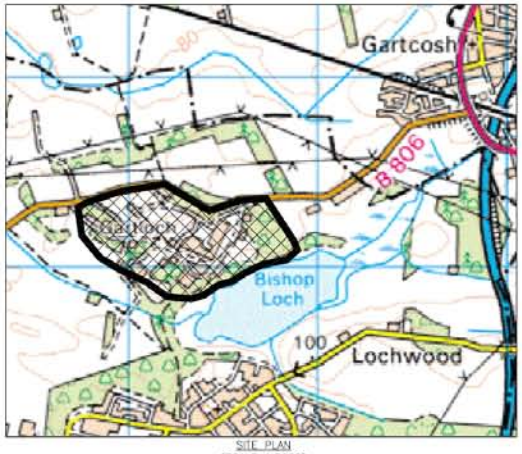
The key aim of the plan was to provide measures to ensure all construction runoff from the site would be treated prior to discharge to the receiving water / surrounding area.

The plan involved the use of an assortment of *temporary* best management processes (BMPs) for the construction phase; these scheduling of these were communicated using a simple matrix (Table 2).

Construction of the site was phased to minimise exposed areas and reduce risk of erosion and silt wash out. Areas under construction where exposed areas or stockpiled materials were at risk of being washed out were covered using matting/plastic sheeting or seeded.

# EROSION AND SEDIMENT CONTROL PLANS

SITE PLAN
(SCALE 1:5000)




SITE PLAN
(SCALE 1:5000)

**PROJECT LOCATION**
Land off the B806 Gartloch Road, Gartcosh, Glasgow. National Grid Reference NS 682 671.

**REGULATORY REQUIREMENTS**
Discharge of surface water run-off from a surface water drainage system to the water environment including wetlands, rivers, lochs, transitional waters, coastal waters and groundwater from construction sites, buildings, roads, yards and any other built-up areas must comply with the Water Environment (Controlled Activities) (Scotland) Regulations 2005, under General Binding Rule 10. A full copy of the Regulations can be obtained from SEPA's website at www.sepa.org.uk.

**DEVELOPER**
Bishoploch (Gartloch) Limited
Gartloch Village
Gartloch Road, Gartcosh
G69 8FA
Tel: 0141 771 4631

**CIVIL ENGINEERING CONTRACTOR**
Reilly Groundworks

## NARRATIVE DESCRIPTIONS

**Existing Site Conditions**
The site forms a rounded hillock, generally flat over the central region that is dominated by the former hospital buildings. The raised plateau slopes east, south and west towards the low-lying marshland and Bishop Loch SSSI. The northern side of the site is gently undulating with shallow a depression running across the site from the northeast to the southwest. The topography comprises of open grassland, mature woodland and semi-natural ponds.

**Developed Conditions**
Residential development, community facilities, public open space with associated infrastructure and utilities.

**Estimated Construction Timetable**

| | | | |
|---|---|---|---|
| SUDS System A | (Febuary 2007 | – | March 2007) |
| Hamlet C/D | (February 2007 | – | March 2009) |
| Hamlet E | (July 2007 | – | May 2009) |
| Hamlet B | (January 2008 | – | September 2009) |
| Hamlet F | (July 2008 | – | November 2009) |
| Hamlet G | (March 2009 | – | December 2009) |

**Site Soil Classification**

| | |
|---|---|
| Topsoil | Brown clayey sandy top soil recorded at all exploratory investigations across site except under foot print of former buildings. |
| Made Ground | Soft to firm sandy slightly gravelly silt/clay including porcelain, burn shale, slate and brick fragments encountered across central region of site. |
| Weathered Glacial Till | Soft to firm sandy slightly gravelly silt/clay encountered in pockets across the site. |
| Glacial Till | Firm to stiff sandy gravelly clay recorded across site. |

The on-site soils have a low permeability classification and a moderate to low erosion potential. All fill material will be generated on site from earthworks excavations.

**Receiving Water Bodies**
Unnamed land drainage ditches and Bishop Loch (SSSI).

**BMP SITE INSPECTOR**
Name: Water Management Team
Company: Dougall Baillie Associates
Phone: 01355 266480
Fax: 01355 221991
email: rene.dobson@dougallbaillie.com

**Inspection Frequency**
Once per week on active areas
Once every two weeks on inactive areas
Within 24 hours of storm event exceeding 12mm
Daily when storm water runoff is occurring

## SEDIMENT AND EROSION CONTROL NOTES

**General Notes**

1. Bishoploch Limited will be responsible for the proper installation and maintenance of all erosion and sediment control measures, in accordance with the Water Environment (Controlled Activities) (Scotland) Regulations 2005, under General Binding Rule 10.
2. All construction activities should be carried out in accordance with the current best practice guidance as outlined in the appropriate SEPA Pollution Prevention Guidelines. A copy of the Guidelines can be obtained from the SEPA website www.sepa.org.uk.
3. **In the event of spillage of any polluting substance and / or pollution of any Controlled Waters or temporary SUDS feature, the Contractor must notify SEPA and the engineer immediately by telephone. SEPA Contact telephone numbers relevant to Marchfield would be SEPA Dumfries 01387 720 502. SEPA can also be contacted 24 hours-a-day on an Emergency Hotline number 0800 807 060.**

**Site Set-up and Clearing**

4. Prior to any land disturbing activities the clearing limits, vegetated buffers and any sensitive areas shown on the plan must be clearly delineated on the site. During the construction period no disturbance will be permitted beyond the clearing limits. Bishoploch Limited will maintain the delineation for the duration of the project.
5. All vegetated buffer zones are to be delineated with high visibility orange construction fence.
6. Prior to any ground disturbance activities a gravel construction entrance, perimeter sediment control and all erosion and sediment controls not in the direct path of work must be installed for each phase of the development and maintained for duration of each phase.
7. The Erosion and Sediment Control Plan must be kept on site. Procedures should be in place to ensure contractors and other personnel which could pollute are aware of their statutory responsibility not to "cause or knowingly permit" water pollution. All such persons should be aware and should make their employees aware of the likely causes and consequences of environmental pollution and should be familiar with the erosion and sediment control plan and emergency procedures to be employed.
8. Cut-off drains must be installed to intercept uncontaminated surface water to prevent it from entering the working area and channelled to a suitable location for dissipation.
9. Materials which may cause pollution shall not be stored near drainage ditches, nor shall they be stored in such a manner that they may fall or be carried into drainage ditches or the temporary SUDS. All refuse and debris arising from the site in the vicinity of temporary SUDS shall be collected and removed as required, in accordance with The Duty of Care, so that none may fall or be carried into the controlled waters or temporary SUDS.
10. The use of construction plant in water is a clear pollution risk and must only be considered as a last resort. In the event of there being no feasible alternative (i.e. land based plant), the plant must be cleaned thoroughly and must be checked for the potential for oil leaks. SEPA should be consulted for further advice on appropriate pollution prevention measures.
11. Where construction plant has to cross a watercourse or diversion ditch a temporary bridge or culvert should be installed, incorporating suitable mud splash guards.
12. Construction plant washing facilities should be designed to operate on a recirculation system wherever possible. Where this can not be achieved effluent arising from such activities should not be discharged into any temporary SUDS measures without pre-treatment and prior agreement with SEPA.

**Earthworks and Stockpiles**

13. All earthworks to be undertaken in accordance with BSI Code of Practice for Earthworks, BS6031:1981 or current best practice and schedules and staged to limit the area and period of time that soil will be exposed. Complete stabilisation of each stage should be undertaken using synthetic fabrics, hydroseeding or other quick stabilisation/re-vegetation techniques before progressing next stage of works.
14. Temporary storage of topsoil and subsoil in heaps and stockpiles created after land stripping should be located as far away as possible and a minimum of 5m from any drains or controlled waters to prevent any collected materials from either falling or being integrated with run-off into controlled waters. All heaps and stockpiles to be seeded or bound with a suitable sediment fence as soon as practicable after deposition to ensure quick stabilisation.
15. Surface water or groundwater from excavations or other parts of the working area must not be pumped or be allowed to issue directly into controlled waters or drains. All surface water or groundwater from excavations should be pumped to or intercepted by diversion drains and channelled to the nearest treatment facility to receive appropriate treatment and ensure removal of pollutants prior to surface water dissipation

**Haul Roads**

16. Haul roads to be of permeable construction and are to be constructed where feasibly possible to follow the contour of the natural terrain not exceeding gradients of 15% to reduce excessive rainfall runoff.
17. All haul roads are to be designed in crossfall to drain the shortest distance across the road. Run-off arising from haul roads is to be intercepted by diversion ditches and channelled to the nearest treatment facility to receive appropriate treatment and ensure removal of pollutants prior to surface water dissipation.

**BMP MATRIX FOR CONSTRUCTION PHASES**

| | Site Set-Up and Clearing | Mass Earthworks | Utility Installation | Roads Construction | Final Stabalisation | Wet Weather |
|---|---|---|---|---|---|---|
| **EROSION PREVENTION** | | | | | | |
| Preserve Natural Vegetation | X | X | X | X | X | X |
| Ground cover | | | | | X | X |
| Hydraulic Applications | | | | | X | |
| Plastic Sheeting | | | | | | X |
| Matting | | | | | X | X |
| Dust Control | X | X | X | X | X | X |
| Temporary/Permanent Seeding | | X | X | X | X | X |
| Buffer Zone | X | X | X | X | X | X |
| **SEDIMENT CONTROL** | | | | | | |
| Sediment Fence (internal) | X | X | X | X | X | X |
| Sediment Fence (external) | | | X | X | X | X |
| Straw Bales | | | X | X | X | X |
| Filter Berms | X | X | X | X | | |
| Inlet Protection | X | X | X | X | X | X |
| Dewatering | | | X | X | | |
| Sediment Trap | X | X | X | X | | |
| **RUNOFF CONTROL** | | | | | | |
| Construction Entrance | X | X | X | X | X | |
| Pipe Slope Drain | X | X | X | X | X | |
| Outlet Protection | X | X | X | X | X | |
| Surface Roughening | | X | | | X | |
| Check Dams | X | X | X | X | X | |
| **POLLUTION PREVENTION** | | | | | | |
| Proper Signage | X | X | X | X | X | X |
| Waste Management | X | X | X | X | X | X |
| Spill Kit Onsite | X | X | X | X | X | X |
| Concrete Washout Area | X | X | X | X | X | X |

**Diversion Drains and Bunds**

18. Where feasibly possible temporary diversion drains should not intercept run-off from areas greater than 2ha and should be laid at a gradient of 1%, but not more than 15%.
19. Any drain that conveys sediment-laden runoff must be diverted to a settlement basin or provided with some other treatment prior to dissipation.
20. All bunds and channels to be compacted by earth moving equipment to prevent erosion during storm events.
21. Construction vehicles should not operate across diversion drains unless a stabilised crossing is provided.

**Land Drains**

22. Where land drains are truncated during construction works, flows should be intercepted and diverted using solid pipes with inline filters and sumps where applicable, to a suitble outfall downslope and in a controlled manner.
23. It should be noted that the main contractor can be held responsible for the quality of diverted water during construction. Investigations should be carried out to determine the source of the land drainage as activities upstream may cause water pollution to enter diverted land drains within the site.
24. All land drains identified as redundant should be suitably and permanently decommissioned.

**Sediment Basins**

25. All sediment basins shall be designed to achieve a minimum 30 minute retention time for a 10 year storm event using on-site investigation results in conjunction with industry standard Flood Estimation Handbook, rainfall depth-duration-frequency model and hydrology of soil types (HOST) data. (Retention time reduced to 30min with use of anionic flocculants)

| | | |
|---|---|---|
| Predominant Soil Type | – | Sandy Clay |
| Typical settling time 1.0m | – | Greater than 7 days. Flocculant acceleration required. |
| Factor of Safety | – | Design to achieve 30 minute retention for 10 year event. |
| SPR HOST | – | 40% |
| 10 year 30 minute rainfall | – | 13mm |

Volume to be retained per hectare of contributing area = 0.013x0.40x10000 = 52m3/ha.

26. All inlets to sediment basins and culverts must be protected with an erosion resistant headwall.
27. No direct discharges shall be made to the SSSI or land drainage ditches. All discharges to be via surface water dissipation and overland flow where feasibly possible.

**Sediment Management**

28. Sediment must be removed from behind sediment barriers when it has reached a height of 1/3 of the height of the barrier above the ground, and before barrier removal.
29. Sediment must be removed from behind bio-bags and other gully filters when it has reached a height of 50mm and before BMP removal.
30. Sediment removal in catchpits and basins must be carried out when the sediment retention capacity has been reduced by 50%, and at completion of the project.
31. All internal site roads used by construction traffic are to be cleaned of sediment buildup using a Road sweeper Vehicle twice weekly or more frequently as required during earthworks.

**Emergency Plans and Procedures**

32. For emergency plans and procedures please refer to current construction method statements.

**EROSION AND SEDIMENT CONTROLS DRAWING SHEET INDEX**

DRG NO. 06129(CP)01 – EROSION AND SEDIMENT CONTROL COVER SHEET
DRG NO. 06129(CP)02 – EROSION AND SEDIMENT CONTROL PLAN – EXISTING SITE CONDITIONS
DRG NO. 06129(CP)03 – EROSION AND SEDIMENT CONTROL PLAN – DRAINAGE MASTERPLAN
DRG NO. 06129(CP)04 – EROSION AND SEDIMENT CONTROL PLAN – CONSTRUCTION DETAILS
DRG NO. 06129(CP)05 – EROSION AND SEDIMENT CONTROL PLAN – CONSTRUCTION DETAILS

**DO NOT scale from this drawing**

| Rev. | Revision details | By / Date | Checked / Date |
|---|---|---|---|
| A | CONSTRUCTION TIMETABLE AMMENDED | N.I. / 28.11.06 | R.J.D. / 28.11.06 |

Client
BISHOPLOCH
(GARTLOCH) LTD

Project
GARTLOCH VILLAGE SUDS

Drawing Title
EROSION AND SEDIMENT
CONTROL PLANS –
COVER SHEET

| | | | |
|---|---|---|---|
| Drawn | N.I. | Checked | R.J.D. |
| Date | 28.11.06 | Date | 28.11.06 |
| Scale | NTS | Drg No. | 06129(CP)01 |

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*Table 2. Excerpts of the Gartloch BMP matrix (Courtesy Dougall Baillie Associates on behalf of New City Vision)*

| BMP MATRIX FOR CONSTRUCTION PHASES | | | | | | |
|---|---|---|---|---|---|---|
| | Site Set-Up and Clearing | Mass Earthworks | Utility Installation | Roads Construction | Final Stabilisation | Wet Weather |
| **EROSION PREVENTION** | | | | | | |
| Preserve Natural Vegetation | X | X | X | X | X | X |
| Ground Cover | | | | | X | X |
| Hydraulic Applications | | | | | X | |
| Plastic Sheeting | | | | | | X |
| Matting | | | | | X | X |
| Dust Control | X | X | X | X | X | X |
| Temporary/Permanent Seeding | | X | X | X | X | X |
| Buffer Zone | X | X | X | X | X | X |
| **SEDIMENT CONTROL** | | | | | | |
| Sediment Fence (internal) | X | X | X | X | X | X |
| Sediment Fence (external) | | | X | X | X | X |
| Straw Bales | | | X | X | X | X |
| Filter Berms | X | X | X | X | | |
| Inlet Protection | X | X | X | X | X | X |
| Dewatering | | | X | X | | |
| Sediment Trap | X | X | X | X | | |

The predominant soil type for the site was fine clay; a soil type that can be difficult to remove from suspension when in water.

To overcome this flocculants were used to maximise the settlement of suspended solids and ensure that runoff discharging to the Bishop Loch was of suitable quality. The temporary settlement basins were designed to achieve a 30 minute retention time for a 10 year storm event using anionic flocculants (as shown in Box 1 below).

The flocculant used was 'Floc Block'; small (180mm x 180mm x 60 mm) solid blocks of slow release anionic flocculant.

The blocks work by being placed at a point source outfall, and flow slowly dissolves the block releasing small amounts of flocculant which binds stone, soil and clay fines, promoting rapid settlement. The flocculant removes a large proportion of suspended solids from the site runoff, minimising the environmental impact on the receiving water.

*Box 1 Volume per hectare calculation for temporary basins*

| | |
|---|---|
| Predominant soil type | - Sandy Clay |
| Typical settling time 1.om | - Greater than 7 days. Flocculant acceleration required |
| Factor of safety | - Design to achieve 30 minute retention for 10 year event |
| SPR HOST | - 40% |
| 10 year 30 minute rainfall | - 13mm |
| **Volume to be retained per hectare of contributing area = 0.013 x 0.40 x 10000 = 52m3/ha** | |

*Figure 6. Temporary sediment basin with oil boom under construction (Courtesy Dougall Baillie Associates on behalf of New City Vision)*

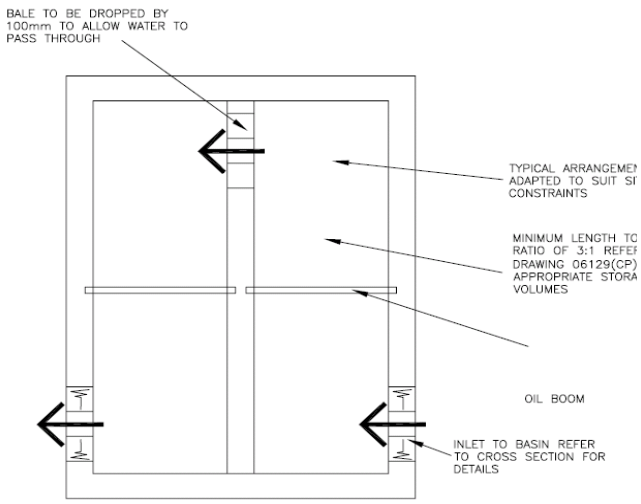


*Figure 7. Plan of temporary sediment basin with oil boom (Courtesy Dougall Baillie Associates on behalf of New City Vision)*

Surface water runoff from the site was managed using a network of cut-off trenches to intercept overland flow and convey it to the flocculant enhanced settlement basins. Where site levels were steep checkdams were necessary to decrease the risk of channel erosion and to increase hydraulic residence time and promoting settlement of suspended sediments.

The in-channel checkdams were initially fabricated from straw bales wrapped in geotextile and anchored into the channel using timber stakes (Figures 10 & 11).

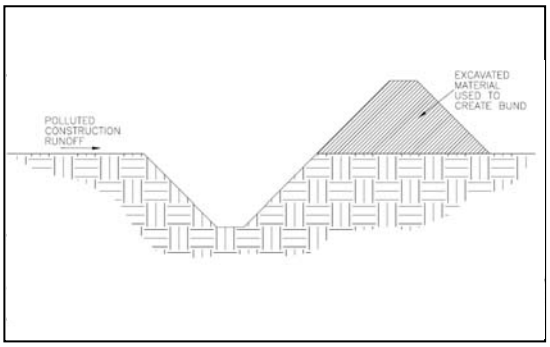


*Figure 8. Typical cross section of temporary drainage channel (Courtesy Dougall Baillie Associates on behalf of New City Vision)*

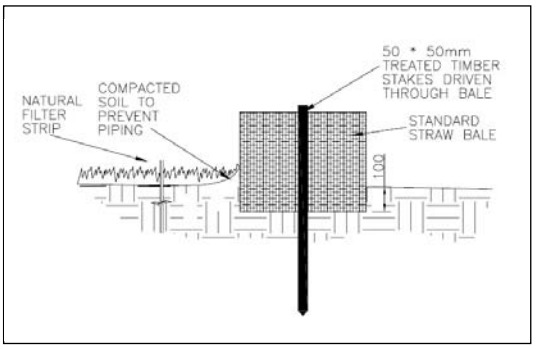


*Figure 9. Typical cross section of in-channel straw bale sediment checkdam (Courtesy Dougall Baillie Associates on behalf of New City Vision)*

The geotextile wrapped straw bales had to be replaced regularly when the bales began to break down. To reduce the level of maintenance to maintain an alternative checkdam design was introduced; timber fabricated with a v-notch weir control.

*Figure 10. Cut-off trench with checkdam fabricated with membrane-wrapped straw bale anchored into the channel base (Courtesy Dougall Baillie Associates on behalf of New City Vision).*

*Figure 11. Low maintenance simple wooden checkdam with v-notch weir; to reduce the maintenance burden of replacing straw bale checkdams (Image courtesy of Greenbelt Group Ltd)*

*Figure 12. Culvert construction to allow site traffic to cross the temporary works (Courtesy Dougall Baillie Associates on behalf of New City Vision).*

Vehicular crossing points for site traffic over the temporary channels were provided by means of reinforced culvert sections over the trenches. These sections were identified using geotextile wrapped straw bales and traffic cones. Regular Inspections of the culvert crossings and channel conditions were carried out to ensure the temporary works were in good order.

As a further preventative measure silt fences were used both on the perimeter of the development and internally, at key points, to remove silt in overland flow. Vegetated buffer zones were used maintained to provide additional protection for the watercourses with a minimum diameter of 10 metres around the SSSI & 5 metres diameter around tributaries.

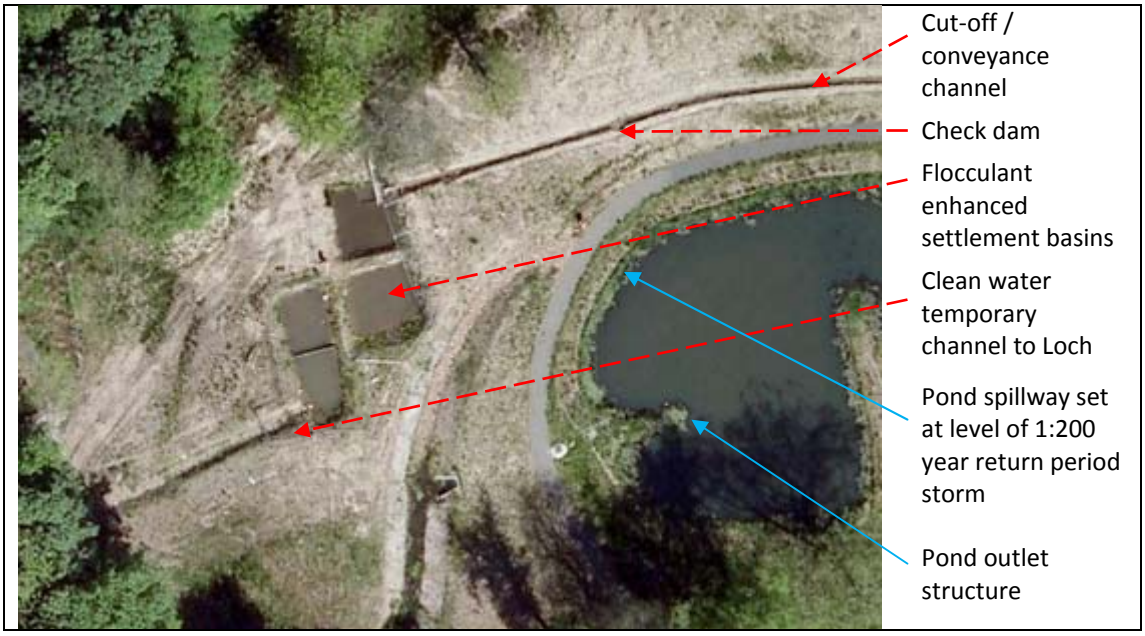


*Figure 13. Temporary works protecting the Loch and Pond A from silt laden construction runoff and other pollutants (Image: ©2010 Google - Imagery ©2010 Infoterra Ltd & Bluesky, The GeoInformation Group, TerraMetrics, Map data ©2010 Tele Atlas).*

## 7. Monitoring and managing the temporary works

As part of the CAR license regular water quality monitoring was to be undertaken during the construction phase on the following basis:

- Once per week on active areas
- Once every two weeks on inactive areas
- Within 24 hours of storm event exceeding 12mm
- Daily when storm water runoff is occurring

The Water Management Team of Dougall Baillie Associates undertook a three tier monitoring process:

1. Visual assessment of the condition and operation of the temporary works,
2. Visual assessment of water quality, and
3. Water quality sampling at key areas of the temporary works.

The visual inspections were critical to ensure the correct operation of the temporary works, particularly at the beginning of the construction phase. The inspections identified shortfalls in operation of the temporary works and what action was required to remedy.

All inspections were documented and included a 'snapshot' of site conditions including the extent of construction activity, exposed surface/erosion risk and weather. All temporary works were inspected and condition and operation recorded and photographs taken to illustrate actual conditions.
Water quality sampling was carried out to monitor turbidity and pH of runoff at discharge points of the temporary works discharging to the loch. Monitoring data was compared to baseline water quality data taken from the Gartloch Pool located upstream of the construction site (with locations identified using national grid references).

The temporary works were actively inspected and maintained by a dedicated maintenance team, with additional input from the DBA monitoring assessment, to ensure that they were effective.

Examples of operational issues identified and rectified as a result of regular inspection include:

*General areas:*

- Heavy sediment build up behind check dams & basins
- Silty runoff bypassing temporary works
- Failure of temporary culverts (to facilitate vehicular crossing over diversion ditch)
- Coagulant not replaced in settling basins
- Water quality sampling identifying high level of turbidity and requirement for additional silt fencing

*Temporary channels:*

The temporary channels provided adequate means to convey construction runoff to the settlement basins. Ongoing management of these basins and channels to ensure their effectiveness included:

- Re-diversion of temporary channels located near stockpiled materials; slippage of stockpiled materials into the channel reduced water quality and placed additional burden on the sediment basins.
- Infilling of 'redundant' channels and creation of new channels to suit construction needs, e.g. for new haul roads
- Dredging channels
- Stabilising channel banks to minimise additional sediment contribution
- Checkdams levels too high; damming water in the channel
- Implementing additional checkdams to minimise erosion

*Figure 14. Bale check dam higher than channel. (Image courtesy of Dougall Baillie Associates on behalf of New City Vision).*

*Temporary sediment basins:*

Maintenance / modification included:

- Replacing membrane wrapped straw bales (used for checkdams and central berms of the sediment basins) with more durable structures fabricated from metal, wood or formed clay.
- Reforming banks following slippage
- Adjusting levels of oil booms for performance
- Clearing blockages at inlet areas
- Introducing metal skips as forebay structures to reduce the need to dredge larger areas / reduce risk of damage to basin during remedial works

*Figure 15. Initial temporary settlement basin with oil boom. Note the straw bales wrapped in membranes to maximise flow path; bales degraded quickly and their replacement was labour intensive.*
*(Image courtesy of Dougall Baillie Associates on behalf of New City Vision).*

*Figure 16. Later style sediment basin adjacent to Pond A. Note the use of the metal skip in the foreground of the picture (acting as a forebay promoting sediment settlement which could be easily removed without dredging the entire structure) and the replacement of the straw bales with clay bunds (Image courtesy of Greenbelt Group Ltd).*

*Flocculant use:*

The Floc-Blocks used within the channels and basins were successful in promoting settlement of the fine clays however there were several operational issues to overcome to maintain their effectiveness:

- Accumulation of washed through debris (construction material, leaf litter, etc) around the blocks resulted in polluted flows not achieving sufficient contact with the coagulant; this was overcome by increasing the monitoring of the blocks.

- In some locations, especially in the conveyance ditches, Floc Blocks had fallen from their position and were lying on the ditch inverts where contact with polluted water is limited[7].
- At the temporary basin inlets Floc Blocks are 'stacked' reducing the fall from the inlet invert to the Floc Block itself which reduces mixing and limits self cleansing [4].


*Figures 17 and 18. Use of 'Floc Blocks'; flocculant blocks used to enhance settlement of silt within the temporary works (Images courtesy of Dougall Baillie Associates on behalf of New City Vision).*

## 8. Conclusions and recommendations

Silt laden construction runoff can have a detrimental effect on the water environment and this may result in substantial fines from the environmental regulator. Adequate means to manage runoff during the construction phase must be identified at the planning stage of any project and implemented prior to mobilisation.

Using erosion and sediment controls to manage runoff provides the added benefit of protecting SUDS infrastructure, reducing risk of additional work and cost to remediate prior to handover.

Once in place, it is essential that the temporary works are regularly inspected to review their effectiveness, highlight any shortfalls in operation and to revise the design and operation of structures accordingly. Local conditions may favour the use of certain techniques, or materials, and these are often best identified by operatives working on the site.

[7] Dougall Baillie Associates. Sediment and erosion control plans: Monitoring walkover survey. Report 15. 27/09/07.