SAC Consulting

CSGN STUDY

Project Proposals
Linlithgow Loch

A report prepared for
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1 Executive Summary

The aim of this report is to identify a number of potential projects that could lead to an improvement of the water quality of Linlithgow Loch and the habitat networks within its catchment.

This report provides:

- costed projects for six of the farms within the catchment with suggestions for funding sources.
- potential projects for work around the edge of the loch with the aim of reducing the amount of nutrients flowing into the loch.
- a review of the woodland around the loch with suggested projects to reduce nutrient levels.
- recommendations for projects relating to the amenity sector
- a template for an awareness campaign
- an action plan to enable the process to progress

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2 Background

Concern about deterioration in water quality at Linlithgow Loch is shared by regulatory bodies and stakeholders alike. This is believed to be associated with eutrophication. It has been assumed that phosphorus pollution is the main cause of elevated algal biomass at this site and that this nutrient enters the loch from a variety of sources in the surrounding catchment. Nitrogen is also considered to be seasonally important.

SAC have been commissioned to examine potential projects for work within the loch catchment with the aim of reducing the level of phosphorous and/or nitrogen entering the loch.

3 Project Brief

The project brief agreed with the consultants is described below:

Project completion date: 31 March 2011.

To include:

1 Desktop evaluation, Identification of potential projects and liaison with stakeholders and landowners

2 Site surveys to ascertain effectiveness of project ideas

3 Action plan and costed proposals will be combined

The following staff within SAC will work on this,

Chris McDonald – Agricultural consultant
Malcolm Clapperton – Amenity consultant
Carole Christian – Environmental consultant
Eric Hayward - Environmental consultant
Derek Robeson – Conservation consultant
Jennifer Greaves – Woodland consultant

4 Desktop Evaluation

A Desktop evaluation was carried out by SAC consultants based on previous reports and knowledge of the loch and farm environment.

Potential project ideas for further investigation were discussed as follows.

General awareness raising
Awareness of Urban Bird feeding Low P
Awareness Farming including Planet (nutrient management programme)
Awareness Farming soil erosion
Awareness Septic tanks
Awareness amenity
Feasibility of treatment systems at river inlets
Fencing off watercourses for stock access and providing troughs etc.
Manure storage on farms
Reducing soil erosion through arable margins including gate realignment
Habitat planting opportunities Feasibility of managing existing woodland to reduce nutrients
Opportunities for New Woodland planting and linking habitats
Loch outlet
Vennel CSO and Springfield CSO Opportunities for treatment

In addition, comments received from a number of stakeholders including Historic Scotland, West Lothian Council, Scottish Natural Heritage and local landowners via telephone conversations or email are as follows:

Historic Scotland

Andy Smart

Historic Scotland Countryside Ranger

1) Raising awareness among visitors, residents and businesses of the potential consequences of their activities through interpretative interventions including on site representation and leaflets.
2) Riparian buffer zones - intercepting pollution as it enters the loch in an attempt to filter pollutants.
3) Repeating the Yellow Fish campaign in other catchment areas of the town.
4) Funding & installation of a vending machine at Town Bay dispensing bird food; for use by the general public. Objective: to encourage responsible feeding of the loch's bird population.
5) No.4 above could be supported by a publicity campaign: in the local press and on site.
6) Installing a pond dipping platform at the loch edge to be used in educational sessions to assist the education of children & adults in loch water quality.
7) Review and enhancement of the overall plant life in the loch.

West Lothian Council

Comments from Graeme Hedger West Lothian Council:

1. Focus on creating habitat networks
2. Buffer strips
3. SUDS on M9
4. Treat / reduce contaminants
5. Bells burn and sediment
6. Road run off Springfield
7. Check if Canadian pondweed is a problem
8. Consider creating a Linlithgow loch trust to stimulate community interest

Scottish Natural heritage

1. Buffer Zones
2. SRDP applications with local farmers
3. Linking existing habitats

Local Farmers

Local farmers were visited within the catchment and project ideas discussed – this is described further on in this report.

5 Site Visits

The following site surveys / visits were carried out :

- Visits to six farms identified as important within the catchment and where possible a second visit to discuss the project plans with the farmers. The visits were carried out mostly by both Chris McDonald and Derek Robeson.
- Site survey of loch water outlets with a view to potential treatment sites
- Woodland surveys around the loch
- Specific watercourses including examination of pipe sizes
- Amenity sector.

6 Summary of Project Details

Following consultations and site visits a series of projects have been drawn up and are described individually in the Appendices.

The projects are summarised as follows:

6.1 Farm Projects

The main recommendations are summarised by site as follows.

Site 1
Project Recommendation 1- Place a metal grate in the ditch (5m from culvert) to catch trash coming down ditch. Clean out periodically to prevent overspill into field. Keep plough line at least 2m away from the top of the bank on each side of the ditch. Create a grass 'buffer strip'. Do not apply fertiliser or pesticides on the grass margin.

Project Recommendation 2- Create 4m grass margins under LMO either side of the ditch and a 6m stepped swale grass margin down the east side of the field to take the overflow water to the drain under the motorway. When the ditch overflows in high flows then soil erosion will be very much less likely to occur.

Site 2
Recommendation 1- Ensure that field margins are compliant with GAEC

Project Recommendation 2- Ensure land management is compliant with GBRs

Project Recommendation 3- Create 6m grass margins under either LMO/RP along the lowermost field boundaries in each arable field.

Project recommendation 4- Sow out lowermost field corners to permanent pasture to catch silt and fertiliser run-off (no grant aid)

Project recommendation 5- Deculvert the main drain through the farm to create a surface watercourse and fence off or buffer with fence grass strips. This will take the drain away from the steading area. Extend the watercourse to the underground drain beneath motorway. (Beware that 4 underground pipelines run across site. Any ground work near the pipes will require appropriate consent). Review effect on motorway drainage prior to undertaking this work.

Project recommendation 6- Create a series of silt traps, retention ponds and reed beds down the channel. Create an off-stream wildlife pond. Plant with amenity trees.

Site 3
Project Recommendation 1- Ensure that land management operations are compliant with both GAEC and GBR requirements

Project recommendation 2- Create a small silt trap and pond/reedbed on line of existing watercourse. This will trap all the silt and nutrients coming down the burn. The nutrients (N and P) will break down naturally in the vegetated ponds area. Resite field gate.

Site 4
Project Recommendation 1- Ensure that land management operations are compliant with GAEC and GBR requirements.

Project Recommendation 2- Create 6m grass margins under LMO around field boundaries (of parts) of the 4 fields within the catchment.

Site 5
Project Recommendation 1- Ensure that land management operations are compliant with GAEC and GBR requirements.

Project Recommendation 2- When field is cropped, create a 3m (or 6m) grass margin under LMO along the east side of the neighbouring ditch.

The farmer at site 5 agreed he would put in place grass margin at his own cost when the field was in crop. This would be done in 2011.

Site 6
Project Recommendation 1- Ensure that all land management operations are compliant with GAEC and GBR requirements

Project Recommendation 2- Combination of land management options for 3 field sites

6.2 Projects relating to watercourse inlets and outlet around the loch

The main detail is shown in Appendix 1

Site 7 - Inlet at east end of Loch
Option 1 Create three pools with intervening reed filters.

Option 2 Create a meandering channel which overflows during high flows. Plant with mixed aquatic plants

Site 8 - North Inlet – motorway discharge
The limited area and the high banking would only allow one small wetland

Site 9 - Bells Burn inlet on south side of the Loch
There would be sufficient room for a three cell wetland

Site 10 - Loch Outlet
Rebuild the bar screen such that the majority of the weed is caught in one part leaving most of the screen open and not clogged.

6.3 Woodland solutions around the loch

This project considers the effect that woodland management has on reducing the level of phosphorous and nitrogen in the loch environment.

The proposed measures are shown in detail in Appendix 2.

6.4 Amenity Sector

A full report is shown in Appendix 3. The main recommendations are:

1. Promote reduced fertiliser and pesticide applications through bespoke maintenance regimes for each amenity area.
2. Ensure frequency and height of cut is compliant with industry standards for efficiency and effectiveness e.g. IOG/BIGGA/SAPCA
3. Ensure quantity and frequency of fertiliser inputs is effective through regular soil testing.

4. Ensure any irrigation and/or drainage schemes for all amenity areas are functioning effectively.

6.5 Awareness Raising

Awareness raising of the issues affecting the loch is key to achieving an improvement in water quality. Target audiences vary depending upon the issue but it is recommended that any strategy should have a set of goals and objectives that combine to form a coordinated awareness campaign. This way the target audience's understand the entire issues involved and feel part of a joint process all with the aim of improving the water quality in Linlithgow Loch.

It is suggested that the awareness campaign is based on the following model

1. Set goals and objectives
2. Define target audiences
3. Provide key messages
4. Review research to back up key messages
5. Develop strategies
6. Measure results
7. Budget costs

The key areas are described in Appendix 4.

6.6 Other issues

6.6.1 Canal

It is not clear how much impact the overflow water from the canal places on the nutrient loading in the loch.

This report recommends analysis and review of water quality data from the canal. Assess volumes of canal overflow water using ultrasonic depth calculator fixed at the site. Capture 10 rainfall events annually to measure water quality.
Estimated cost £5,000 plus VAT.

6.6.2 CSO

The remaining CSO is still putting a risk of sewage entering the loch. A project should explore the opportunity for extending this further to meet the outfall of the loch.

6.6.3 M9 and road network

Surface water from the M9 appears to drain into the Loch on the North side at the same point as land drainage. It is not clear how much of an issue this is except that clearly salt and grit is used in the road network and some of this will end up in the loch. It has been suggested that sodium levels in the loch are rising which may indicate that the source is the road network.

Further research is recommended including

1. Monitoring salt levels in the loch
2. Analyse the salt and grit used in the road systems and assess variability
3. Estimate quantities entering the loch

7. Action Plan

This plan summarises the main recommendations from this report with suggested funding sources and estimates of costs where relevant.
The cost estimates are a guide only and have not been costed based on quotations from contractors.
Potential funding sources identified include
CSGN
Historic Scotland
Land fill tax credits (Polmont)
Land managers options
Lottery funding
Scottish Government whole farm review scheme
Sepa Restoration Fund
SNH
SRDP rural priorities scheme
WLC

Some of the above sources may fund a complete package of measures for the loch e.g. Lottery funding. These are not repeated each time in the table.

ACTION PLAN

Target	*Action*	*Funding sources*	*Est. Cost or time*
Farmers in the catchment	Undertake 6 farm conservation audits and ensure that land management operations are compliant with both GAEC and GBR requirements	SNH Scottish Government (WFR scheme) CSGN Landfill Tax Credit Scheme funds	£5,400
Site 1	Place a metal grate in the ditch (5m from culvert) to catch any plants or other material coming down ditch.	SRDP funding SEPA restoration fund SNH	£500
Site 1	Create 4m grass margins under LMO either side of the ditch and a 6m stepped swale grass margin Costs are typically associated with loss of crop income e.g. typical gross margin of wheat @ 10t/ha. @ £125/t grain price is £983/ha. SAC farm man handbook 2010/11. Note Grain prices have risen since this was published.	SRDP LMO funding CSGN	Variable Loss of crop income
Site 2	Create 6m grass margins under either LMO/RP along the lowermost field boundaries in each arable field.	SRDP LMO funding CSGN	Variable Loss of crop income
Site 2	Sow out lowermost field corners to permanent pasture to catch silt and fertiliser run-off	SEPA restoration fund Landfill Tax CCGN	£500

Site 2	Deculvert the main drain through the farm to create a surface watercourse and fenced off or buffer with grass strips. This will take the drain away from the steading area. Extend the watercourse to the underground drain beneath motorway. (Beware that 4 underground pipelines run across site. Any ground work near the pipes will require appropriate consent). Review effect on motorway prior to undertaking this work.	SRDP SEPA restoration fund CSGN	Will need approval from pipeline companies
Site 2	Create a series of silt traps, retention ponds and reed beds down the channel. Create an off-stream wildlife pond. Plant with amenity trees. Est. cost similar to site 7.1	SRDP CSGN SEPA restoration fund	£7000
Site 3	Create a small silt trap and pond/reed bed on line of existing watercourse. This will trap all the silt and nutrients coming down the burn. The nutrients (N and P) will break down naturally in the vegetated ponds area. Resite field gate	SRDP CSGN SEPA restoration fund	£2,000
Site 4	Create 6m grass margins under LMO around field boundaries (of parts) of the 4 fields within the catchment.	SRDP LMO funding CSGN	Variable Loss of crop income
Site 5	When field is cropped, create a 3m (or 6m) grass margin under LMO along the east side of the neighbouring ditch.	Note – farmer agreed to do this without funding	Variable Loss of crop income
Site 6	Create buffer zones between burn and field. Three options have been suggested.	SRDP LMO funding CSGN	Variable Loss of crop income

Site 7	Option 1 Create three pools with intervening reed filters. Option 2 Create a meandering channel which overflows during high flows. Plant with mixed aquatic plants	SEPA WLC SRDP Historic Scotland CSGN	£6,863 £5953
Site 8	North Inlet – motorway discharge The limited area and the high banking would only allow one small wetland	SEPA WLC SRDP Historic Scotland CSGN	£6,634
Site 9	Bells Burn inlet on south side of the Loch There would be sufficient room for a three cell wetland	SEPA WLC SRDP Historic Scotland CSGN	£10,014
Site 10	Loch Outlet Rebuild the bar screen such that the majority of the weed is caught in one part leaving most of the screen open and not clogged.	SEPA WLC SRDP Historic Scotland CSGN	£15 - £20k
Woodland surrounding loch	Undertake detailed tree survey	Forestry commission SNH CSGN Historic Scotland SRDP	£8,000

Woodland surrounding loch	Woodland management to reduce nitrogen and phosphorous in soil tree surgery	Forestry commission SNH CSGN Historic Scotland SRDP	Cost dependant on woodland report
Amenity grassland	Appraisal of Existing Maintenance Schedules at golf courses and cricket clubs and with council staff - soil analysis and use of specialist advice in nutrient management.	CSGN SRDP	£14,750
Awareness raising campaign	Agree awareness raising strategy with LLCMG and appoint coordinators with responsibility for the different strategies	All LLCMG	N/A
Awareness raising	Extend the Yellow fish campaign across other areas within the catchment	SNH SEPA restoration fund Historic Scotland	Schools and Scout network
Awareness raising	Assess numbers of drains in the area leading into the loch and Insert permanent drain markers on drains leading into the loch	SEPA restoration fund WLC	Cost £5 / marker plus fitting
Awareness raising birds	Research the type of feed used, quantities and effects on wildlife Encourage children / community groups to monitor bird feeding	SNH SEPA restoration fund	Seek help from local groups and schools
Canal	Water sampling of top horizon at key periods (10 times) of the year, and assess canal overflow using ultrasonic depth calculator.	SEPA restoration fund British Waterways	£5,000
Motorway and road network	Monitor salt levels in the loch at different times of the year 12 analyses at 4 times of the year from 3 different parts of the loch. Measure Conductivity and sodium	SEPA restoration fund SNH	£900

Motorway and road network	Review salt and grit usage and estimate quantities entering the loch Analyse materials used and variability of material used. Say 6 analysis and desktop study	SEPA restoration fund SNH	£2,000
Properties with Septic tanks	Campaign of door to door visits of all septic tank householders	WLC, SEPA, Lottery, CSGN	Approx 5 days of time
CEH report	Implement recommendations from CEH report "An assessment of water quality and management requirements at Linlithgow Loch including 1. Improve monitoring of external nutrient loading 2. Annual synthesis of external nutrient load 3. Conduct cost-benefit analysis on management options available 4. Initiate annual macrophyte surveys to map non native and desirable species 5. Opportunities to test the use of emerging techniques 6. Better understanding on the impacts of fishery management on aquatic food web structure and function in relation to phytoplankton levels		

8 Appendices

1 Treatment of watercourses entering loch and outfall

2 Woodland Solutions

3 Amenity Sector

4 Awareness Campaign

APPENDIX 1

Options for treatment of watercourses entering loch and outfall

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Date:
March 2011

1 Introduction

This sub report examines the opportunities for work around the edge of the loch to reduce the amount of nutrients flowing into the loch.

It also suggests work at the outfall of the loch.

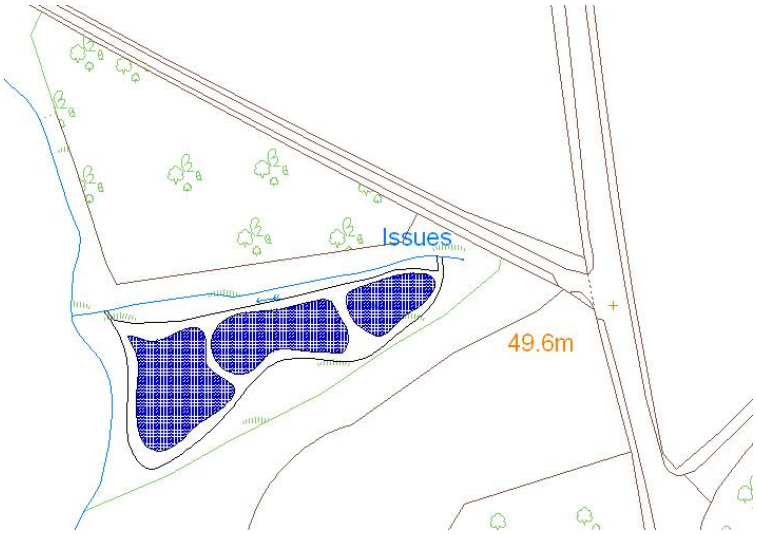
Any work would require prior consent from Historic Scotland.

2 Inlet at east end of Loch

The area of land to the south of the watercourse, between the watercourse and the footpath, would be suitable for a wetland. There is about 1050m^2

The soil is waterlogged to approximately 200mm below ground level and there is a firm stony base at approximately 700mm below ground level.

Option 1



Create three pools with intervening reed filters.

Option 2

Create a meandering channel which overflows during high flows. Plant with mixed aquatic plants.

3 North Inlet – motorway discharge

There is an area of about 580m^2 east of the watercourse and north of the footpath. There are mature trees on the east and north periphery.

The limited area and the high banking would only allow one small wetland.

The soil does not have a high clay content. But as the watertable is close to ground level, it will contain water.

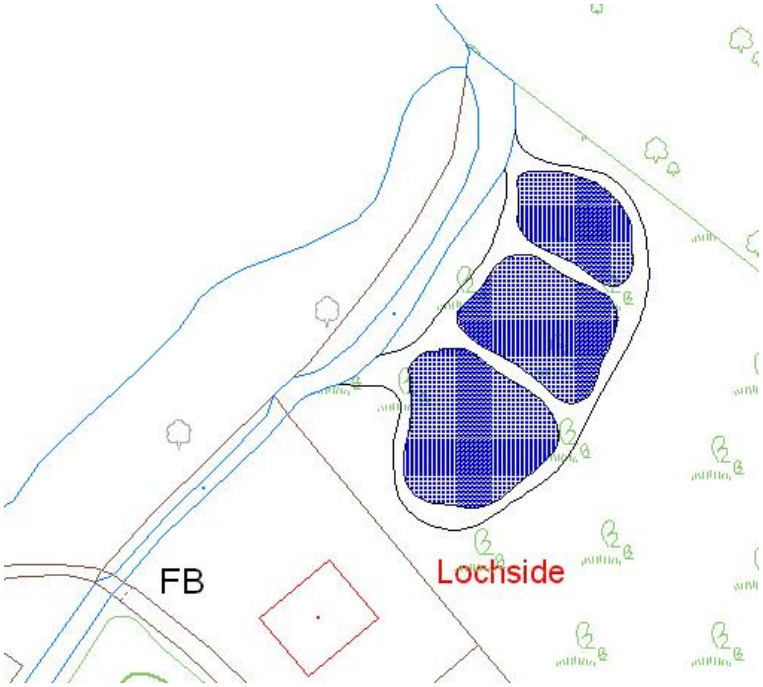
4 Bells Burn inlet on south side of the Loch

This watercourse has the highest flow rate of the three inlets and would require a large wetland if a reasonable quantity of sediment is to settle out. There is insufficient land on the north side of the watercourse,

There is an area of scrub ground and fallen trees on the south side of the watercourse,

This land might be in private ownership.

If available, there would be sufficient room for a three cell wetland.



5 Linlithgow Loch outlet

The outlet flow from Linlithgow Loch negotiates,

1. A bar screen, supported by concrete pillars.

2. A vegetated channel.

3. A valve housing and overflow weir.

Of the three, the bar screen appears to be the structure which is restricting discharge from the Loch. Some attempt is made to clear the screen and there are heaps of weed on the banking. The grade of weed looks fairly consistent, with only a few larger sticks.

It is assumed that the purpose of the bar screen is to prevent fowling in the valve housing and that the screen cannot be made redundant. The only option therefore is to improve the function of the bar screen.

A possible option would be to rebuild the bar screen such that the majority of the weed is caught in one part leaving most of the screen open and not clogged. As there is little fall along the vegetated channel, the bar screen could be rebuilt in an L-shape, with the long arm of the L parallel to the bank and the short arm perpendicular to the bank. Most of the weed would catch in the short arm which is perpendicular to the direction of flow. The long arm of the L-shape would collect less weed, being parallel with the direction of flow, reducing the risk of blockages.

6 Project costs

Estimate of costs are shown in the sub- Appendix 2.1

Work at the outfall is roughly estimated to cost in the region of £15,000 - £20,000 but this estimate should be confirmed.

7 Motorway Flow inlet

Estimated calculated flow rate for a 1 in 50 year return period storm for the catchment of the north (motorway) inlet, plus 1.3km of motorway. Using the Inst. of Hydrology equation and the Flood Studies Report UK growth curves, got a flow rate of 711 litres/sec.

Using the ADAS booklet 345, “The design of field drainage pipe systems”, Chart 10, “Restricted and open inlet un-corrugated pipes – eg concrete pipes”, I worked out the following,

For 700 litres/sec, are shown in the table below,

% Gradient	Internal Pipe Diameter
1	600mm
2	525mm
5	450mm
7	450mm

SUB APPENDIX 2.1 Cost Estimates

The following costs are estimates only

Inlet		East inlet - option 1(3 cell)	East inlet - option 2 (meander channel)	North inlet (motorway)	Bells Burn inlet	
excavation volume	cub m	275	219	365	584	
excavation cost	£	1375	1095	1825	2920	
number of plants		3320	2620	944	1624	
planting costs	£	2988	2358	849.6	1461.6	
excess soil volume	cub m	0	0	365	0	
excess soil cost	£	0	0	1460	0	
set up/CDM	£	500	500	500	500	
Others	£	2000	2000	2000	2000	
scrub clearance area	sq m	0	0	0	1566	
scrub clearance cost	£	0	0	0	3132	
TOTAL	£	6863	5953	6634.6	10013.6	TOTAL 29464.2

SUB APPENDIX 2.2 Examples of work at Loch Leven

This shows photographs of work undertaken at Wester Gospetry, in the Loch Leven catchment. The bund shown demonstrates a method for retaining sediment from field run-off. This has relevance to some of the soil erosion issues experienced in Linlithgow Loch catchment.

Picture 5031

5031 is the distribution trench in the grass barrier strip. This was a sort of slow release mechanism which allowed the water trapped in the bund to trickle down to the burn.

Picture 5042

5042 is the bund looking east.

Picture 5059

5059 is the bund under construction looking west.

Picture 5062

5062 is the construction of the outfall pipe within the bund.

APPENDIX 2

Linlithgow Loch Green Network Study Project

Managing existing woodlands
to reduce nutrient runoff and increase nutrient uptake.

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1 Introduction

Linlithgow loch is surrounded by a variety of land uses, trees being one of the most prominent. As well as providing a habitat for wildlife, shelter and shade and enhancing the landscape the trees around the Loch also play a role in reducing run off into the loch and feeder burns, as well as taking up nutrients as they grow.

This impact on the nutrient run off and uptake can be understood, and therefore managed, to reduce the nitrification of the loch, and the associated environmental impacts this has.

2 Nutrients uptake in trees and woodlands

Nitrogen and phosphorus are essential components to trees and woodlands and the management of trees can play a role in reducing the amount of N or P within the soils through the uptake by the trees and thus at a potential risk of leaching out in to the watercourses or loch. In addition trees and tree roots can act as a mechanical barrier to soil erosion and can reduce surface run off, perculation and the limited amount of horizontal capillary action.

This sequestering of nutrients within woodlands is influenced by many factors and some of these are discussed below. Before management regimes are put in place these influences must be understood.

The initial study into the external nutrient loading in Linlithgow Loch highlighted the role phosphorous and nitrogen play in the eutrophication of the Loch and the discussion below has focused on these nutrients.

95% of plant biomass is composed of carbon, oxygen and hydrogen. The remaining 5% is composed of essential elements such as nitrogen (N) , phosphorus (P), sulphur (S) , potassium (K) , calcium (Ca) and others.

As well as the existing nutrients within the soil, N and P can be made available to plants through atmoshpheric deposition. Atmospheric N is unavailable to trees except those that are capable of nitrogen fixation. So the primary sources of N are ammonium and nitrate ions dissolved in rainfall (and subsequently the soil) and biological N fixation by microorganisms. The only form of phosphorus available to trees is as phosphate.

Once in the soil the nutrients can either be transported to roots for uptake, precipitation as an insoluble compound or leaching from the soil. Therefore the more tree roots that are available to take up the nutrients, the less nutrients will be leached out into the loch. Nitrate has a high mobility and this allows rapid uptake both by diffusion (movement of nutrients within the soil from areas of high concentration to areas of low concentration) and mass flow (when nutrient arrive with the convective flow of water). Phosphorus is relatively immobile and will generally be available to roots through diffusion.

Roots can exploit solids to a distance of around 0.1 to 15mm from their roots, so logically a way of increasing uptake in the soil is to increase the amount of roots seeking nutrients. The amount of roots a tree has is related to soil conditions and the size of the tree canopy. ‘Too few roots leads to lack of water in the canopy, where as too many roots is a waste of resources that could be put towards canopy growth’ (Peter Thomas).

However, whilst the uptake of nutrients is an important part of woodland and tree growth, on an annual basis nutrient recycling within ecosystem forms the major source of nutrients for plant use. This is mainly due to the breakdown of organic matter, including leaves and root death, by microbes.

Once the tree has taken up the nutrients, they can either be incorporated into the 'biomass' of the tree, recycled into the soil via litter fall, leaching from leaves or roots or recycling from leaves to use the following year. The percentage of each of these can vary between nutrient and between tree species, however a general guide is that concentrations in leaves is much higher than in stems, although this is per kg, with the stem being much denser than the leaves. In addition, there are differences throughout the lifecycle of a woodland: small trees tend to have much less stem biomass relative to leaf biomass, the nutrient content of foliage generally decreases with age, and litter quality reaching the forest floor also changes, with a higher proportion of woody biomass reaching the floor under older stands. In addition the type of forest influences the amount of nitrogen and phosphorus, a study of 32 stands showed that 60kg/ha of nitrogen was returned to the soil in a temperate deciduous forest, and 36kg/ha in a temperate coniferous woodland. In addition 83% of nitrogen return was by litter fall and 85% phosphorus.

Deciduous woodlands also require more nitrogen in stem wood then coniferous forests. 'annual requirement for nitrogen by the temperate deciduous forest is more then twice than that of the temperate coniferous forest' However, it must be remembered that recycling and translocation in deciduous forests is also higher. Therefore, conifers species tend to 'meet all their annual nutrient requirements through the uptake process, whilst deciduous species are meeting only two thirds from uptake, the rest coming from translocation'. However, conifers require less nitrogen per unit of biomass than deciduous, and this is thought to be due to the retention of needles. In addition, northern species of conifers are more efficient at using nitrogen per unit of production than more southerly conifers, suggesting that the northern trees have evolved to be more efficient at using nitrogen. However, phosphorus shows an opposite trend where the rate of uptake and recycling is higher in conifer forests than deciduous.

Therefore removing stems, leaves and branches will result in a much higher nutrient removal per unit biomass from the site than leaving them.

Other factors to consider when looking at nutrient removal from a woodland is that removal of canopy layer will increase soil temperatures and therefore increase decomposition rates in the soil, soil moisture will also increase, again increasing organic breakdown. Nutrient losses will also increase in the tree felling and removal increases soil disturbance, thus increasing soil erosion and leaching.

Nitrogen fixing trees such as alder will increase nitrogen fixation and should be removed.

3 Role of trees in reducing overland flow of nutrient bound in sediments.

Phosphorus is usually attached to soil particles and can be absorbed by the roots of the vegetation, nitrogen tends to be dissolved in overland and subsurface flow.

The roots of woody vegetation can stabilise soils and banks, reducing soil erosion and subsequent nutrient mobilisation (especially important when looking at phosphorous).

Forest buffer strips

Previous research has concluded

- Deciduous trees have greater nutrient uptake demands than conifers.
- Young developing trees in a managed woodland strip take up more nutrients at that life stage than mature trees[1]
- Winter retention of nitrate is critical as 80% of the nitrate leached from agricultural soils is concentrated during this season.[2] This is due to bare fields, lower evapotranspiration rates and low uptake from dormant plants
- Nitrate retention in winter is due to the soil microbiological community and a higher surface biomass will increase microbiological activity.
- Compared to a mature woodland, vigorously growing tree and shrubs that are periodically cut as they approach maturity will require more nutrients for growth[3].
- Different tree species may have different uptake rates as well as different retention rates.
- In general, trees that have evolved in nutrient rich environments will require high levels of nutrients to grow, and will therefore uptake and retain more nutrients than species that have evolved in nutrient poor environments.
- Specis such as Fagus (beech) , tilia (Lime) , Populus (poplar) Acer (Maple / sycamore) Quercus (Oak) require higher amounts of nutrients then other species and therefore will be best suited as acting as a buffer strip.

Key elements of nutrient up take and run off to consider when managing existing trees

- Fast growing, younger trees take up more nutrients (including coppiced trees)
- Branches / stems and if possible leaves need to be removed from site
- Conifers / broadleaves play different roles so retaining a mix of both is important.
- Reduce soil disturbance by coppicing or leaving stumps in the ground when felling.

4 Survey of age class distribution and woodland types.

In order to get an idea of what the tree cover is currently, and how this can be managed, each woodland or block of trees within 500m of the loch, and over 0.1ha, was visited and categorised into one of the following:

Age Class

- Young
- Young – semi-mature
- Semi-mature
- Semi-mature – mature

[1] Ducnuigeen, Williard and Steiner (1997) Nutrient Requirements for Riparian Vegetated Buffer Strips. ICPRB report Number 97

[2] Haycock and Pinay Haycock, N.E., and G. Pinay. 1993. Groundwater nitrate dynamics in grass and poplar vegetated riparian buffer strips during the winter. J. Environ. Qual. 22:273-278.

[3] Welsh D.J. 1991. Riparian Forest Buffers: Function and Design for Protection and Enhancement of Water Resources. USDA Forest Service, Northeastern Area S&PF, ForestResources Management, Radnor, PA. 20p.

- Mature

Species type

- Mixed conifer
- Mixed broadleaves
- Mixed conifer and mixed broadleaves.

Map A shows the results of the age class distribution, and map B show the results of the species type.

5 Management proposals and estimated costs.

The management should aim for the majority of the trees to be in the young to semi mature or semi-mature to mature age brackets. In addition, the mix of conifers and broadleaves should be maintained, with a slight increase in the number of conifers.

A thorough tree survey should be under taken, with each tree mapped, aged and the species recorded. This could be in conjunction with the council's/ Historic Scotland's current tree safety surveys. Once this has been done, each tree should be considered for coppicing, and this work should be undertaken on a rolling programme over 10 – 15 years.

For tree species unsuitable for coppicing, each tree should be looked at individually, with consideration for landscape value, habitat network connectivity value visitor safety and life expectancy. If it is deemed that felling and replanting will not adversely affect the above considerations, this should be undertaken sensitively.

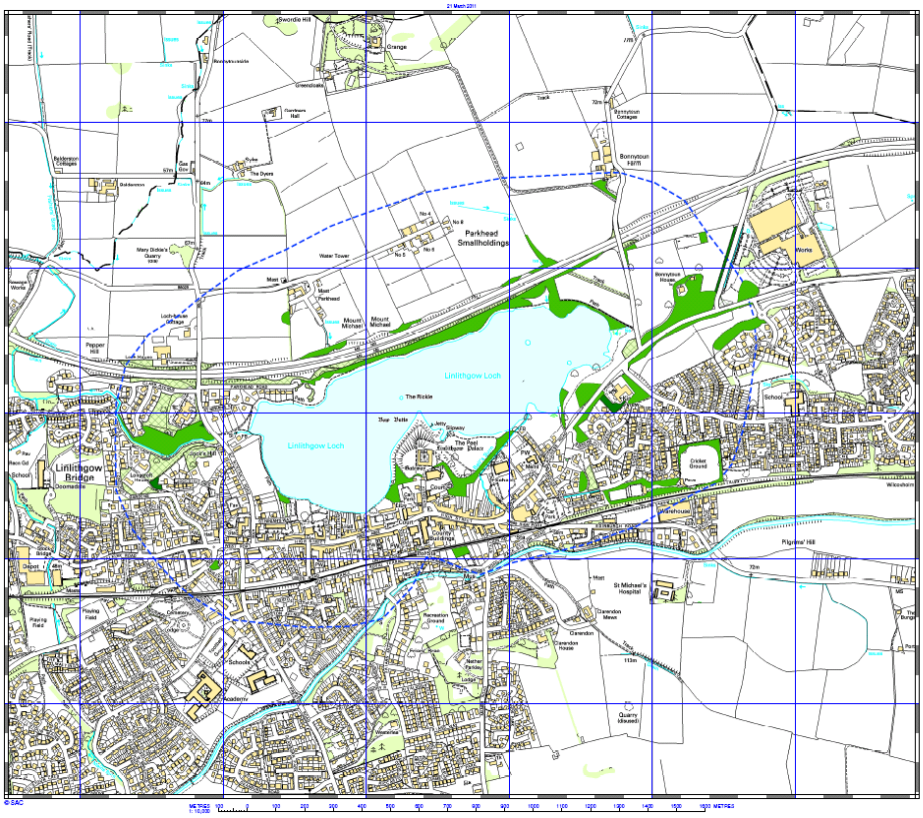
For both coppicing and felling, the branches and stems and if possible, leaves, should be removed from site.

Any management changes should be agreed with Historic Scotland and Scottish Natural Heritage, as the site is an SSSI.

Costs

To undertake a detailed tree survey around the Loch, would cost in the region of **£5,000 – £8,000** depending on the quotes from contactors.

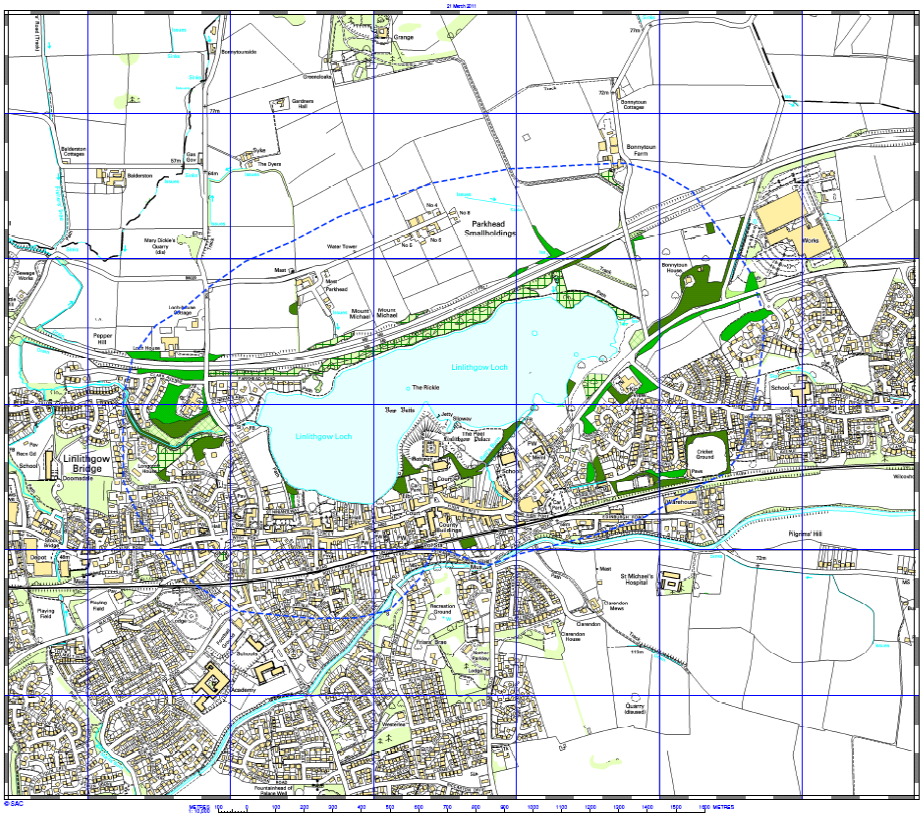
The actual tree work required will depend on the results of the survey, however an average day rate for a two man tree surgery team plus equipment is **£450 -£500** per day.



Species distribution.

- Mixed Broadleaves
- Conifer
- Mixed conifer / Mixed broadleaves
- Boundary

SAC



Age - class distribution.

- Young
- Young - Semi Mature
- Semi - Mature
- Semi - Mature - Mature
- Mature
- Boundary

SAC

APPENDIX 3

Amenity Sector

Report prepared by Malcolm Clapperton, SAC consultant

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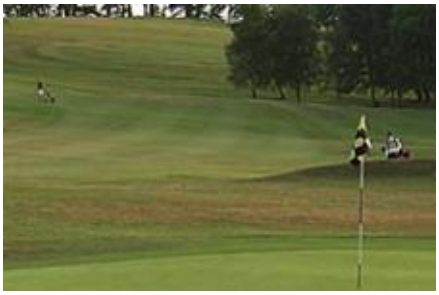
CSGN-Linlithgow Loch Amenity Grassland Areas

For Linlithgow Loch's amenity grassland, the day-to-day management of turfgrass can be the single largest resource consumption area. Inputs include embodied energy in products such as maintenance machinery, fertilizers and pesticides, to the treatment of water and the use of non-renewable fuels.

Identifying reductions in the resource requirements of turfgrass can unlock significant economic and environmental gains for all managed amenity grassland areas within the Linlithgow Loch Catchment.

An appraisal of the current resource inputs to the following amenity areas will allow an assessment of potential impact on biodiversity within the catchment:

1. Golf Courses
    a. Linlithgow Golf Club
    b. West Lothian Golf Club
    c. Kingsfield Golf Centre



2. Sports Pitches
    a. Linlithgow Academy
    b. Linlithgow Leisure Centre
    c. Cricket Club

3. General Amenity Parkland
    a. Linlithgow Palace

The proposal would be to review all maintenance schedules in place for the above facilities as appropriate. An assessment of the effectiveness and efficiency of mowing regime, fertiliser applications, pesticide applications and watering systems would be carried out to identify any potential negative effects on biodiversity.

Costs (Indicative at this stage)

Appraisal of Existing Maintenance Schedules (including recommendations for improvement) £ 12,000.00
Soil Testing £ 2,750.00
Total £14,750.00

Timescales

Initial soil testing and appraisal of maintenance schedule over Spring/Summer/Autumn 2011 in order to assess inputs necessary to maintain healthy consistent surfaces and identify efficiency gains and reductions wherever possible.

Project Outcomes:

1. Promote reduced fertiliser and pesticide applications through bespoke maintenance regimes for each amenity area.
2. Ensure frequency and height of cut is compliant with industry standards for efficiency and effectiveness eg IOG/BIGGA/SAPCA
3. Ensure quantity and frequency of fertiliser inputs is effective through regular soil testing.
4. Ensure any irrigation and/or drainage schemes for all amenity areas are functioning effectively.

APPENDIX 4

Awareness Raising

1 Background

Awareness raising of the issues affecting the loch is key to achieving an improvement in water quality. Target audiences vary depending upon the issues but it is recommended that any strategy should have a set of goals and objectives that combine to form a single awareness campaign. This way the target audiences understand the entire issues involved and feel part of a joint process all with the aim of improving the water quality in Linlithgow Loch.

The following approach is suggested as a way of developing an awareness raising campaign. The Linlithgow Loch catchment management group should comment on the goals and provide clear objectives.

2 Goals

Suggested goals include increase awareness of:

- the value of the loch to the community, its history and ecology
- the loch environment and nutrient loading using data from CEH report
- soil erosion (for farmers and land managers)
- septic tank locations and the responsibilities for householders and other property owners
- the water drainage network leading into the loch
- the effect of fertiliser and grass cutting in the amenity sector
- the effect of feeding birds in the loch
- the successful Yellow fish campaign, extending this across other areas of the catchment

3 Objectives

Objectives should be measurable for example “increase awareness of all septic tank holders by 2012”. The objectives should be set by the LLCMG

4 Target Audiences

Examples will include:

- All recreational users of the loch eg Angling club
- Householders in the catchment particularly those that have drains nearby leading into the loch
- Farmers in the catchment
- Other Landowners
- Tourists or visitors to the loch
- Septic tank owners
- Statutory organisations responsible for the loch eg members of the LLCMG

5 Key Messages

Key messages should be agreed. It is important that the target audiences can see some benefits for them - "What's in it for me"

These messages might include:

- The value and "pride" of the loch to the community eg "Lets keep Linlithgow Loch beautiful" as described on the yellow fish campaign leaflet
- The recreational, scenic and historical value of the loch
- The importance of the loch as an SSSI due to its high wildfowl population and uniqueness in the area
- The benefits to water quality of lowering the levels of Nitrogen and Phosphorous – regular updates to the public on the water quality of the loch

6 Research

To be credible, the awareness campaign must be backed up by factual statements. Some of this has been provided with some of the research already done however it is not complete. Once the key messages are agreed an assessment of the research should be carried out to ensure the messages are credible.

Market research to assess the general public's knowledge of the issues and success of previous campaigns thus providing a baseline for measuring the success of the campaign. Focus groups may be cost effective way of doing this.

7 Strategies

Septic Tanks

There are a limited number of un-sewered domestic properties in the catchment, estimated to be 50. These were described in a previous report by SAC It is proposed that a campaign of door-to-door visits be made at a time when householders are likely to be at home. At the visit, advice would be given about emptying and maintenance requirements and maybe even help given householders find their septic tank and to examine the effluent with them.

This would be supported by the distribution of The Septic Tank Guide, as produced by the Dee Catchment Partnership. It is suggested that, to improve rates of registration, SEPA have a fee amnesty for the registration of septic tanks in the catchment for the duration of this project.

Estimated cost: 50 visits at 20 minutes per visit = approximately 3 days of time. plus 1 day preparation and 1 day reporting.

Potential funding sources through WLC, SEPA, Lottery, CSGN

Septic Tank Guide available here : http://www.theriverdee.org/userfiles/file/Guidance/SepticTanksFINAL.pdf

Farming

One-to-one on-farm meetings would be the most effective way to reach the farmers and land managers. Each farmer would receive structured information on the following topics:

- Soil Erosion – causes and effects
- Good Agricultural and Environmental Condition (GAEC) and General Binding Rules (GBRs)
- PLANET Scotland, nutrient budgeting and soil analysis
- Farm walk giving tailored information on compliance and on potential measures on-farm
- Information about financial support for measures including SRDP and LMO

At least six whole farm conversion audits would be carried out offering land management advice tailored to SRDP options and also promoting GAEC and GBRs. Examples of farm conservation audits can be made available.

It is anticipated that each farm would be able to make an SRDP application for funding for environmental and biodiversity/habitat measures and it is recommended that the one-to-one farm visits should be integrated with the conservation audit to make a full assessment of each farms' conservation audit. The overall aim would be to try to achieve a plan of work that is cohesive on the individual farms and collaborative across the catchment.

Each farm visit would be supported by a folder containing information about the topics above and a set of drawings indicating the options recommended for the farm. The farmer would be able to take forward any proposed work through their regular farm advisor.

Estimated cost for producing six whole farm conservation audits £5400 plus VAT.

Amenity Sector

The main awareness raising issues for the amenity sector have been discussed in Appendix 4

General Public

Yellow Fish Campaign

Extend the Yellow Fish project throughout the urban catchment and including road gullies in the rural part of the catchment. This project was piloted in the Springfield Estate. School children and scouts, under the supervision of the Linlithgow Ranger, marked drains with a stencilled yellow fish. There were also school assemblies, leaflets and children's items such as pencils and rulers. There was also press coverage in the Linlithgow Gazette. It is recommended that this format be used for the campaign – in particular getting children's involvement could be very useful.

http://www.historic-scotland.gov.uk/cragandpeelwinter2011.pdf

Permanent Drain Markers

Permanent "drain markers" reminding the public that water that goes down the drains ends up in the loch. Eg highlighting "only for rain water" See website http://www.pollution-prevention.net/page2.htm

Press Articles and media

Regular local news releases
Either the Linlithgow Gazette or the West Lothian Bulletin could be used to increase householder awareness of the projects that are being taken forward and of the issues themselves.

Target national media sources to engender a sense of urgency and importance.

Websites and podcasts on specific topics have been used by SAC as a way of knowledge transfer

Continue the involvement of local schools and community groups

Feeding birds
Feeding the birds around the loch is a regular and clearly enjoyable pastime for many of the children and others in the community. It is difficult to assess whether this is relevant to the nutrient status of the loch without carrying out further research.

The phosphorous content of different foods used to feed the birds can vary considerably. For example the phosphorous content in wholemeal bread is much higher than white bread since a lot of the phosphorous is concentrated in the bran. The USDA food composition tables suggest white bread has a Phosphorous content of 1g/kg (fresh weight) whilst wholemeal bread has a phosphorous content approximately double this value. Typical phosphorous contents of wheat are 3.5g/kg in the dry matter whilst wheat bran is 13.6g/kg in the dry matter.

Typical Nitrogen contents of bread (based on Nitrogen = crude protein / 6.25) are in the order of 5g/kg fresh weight. A typical nitrogen content of wheat is 19.8g/kg DM or 2% in the dry matter. The differences between bread and wheat are mainly due to the values quoted in fresh weight and dry weight.

Research should be carried out to ascertain the following:

- Types of feeds used
- Quantities of foods used
- Levels of nitrogen and phosphorous coming from this source
- Seasonality

Members of the public along the loch shore would be surveyed at four timings in the year.

This may be a project that volunteers could undertake eg Scouts, School children, but would need some professional analysis and involvement.

Statutory and other Businesses
The knowledge transfer process of the research and other work carried out needs to continue amongst the statutory and voluntary organisations.

The Linlithgow loch catchment management group is a useful forum to do this. Regular progress updates such as that planned by CEH should be encouraged. All stakeholders need to be aware and updated of the progress and commitments from the different sectors.

The costs of continuing this are mainly time and commitment of the organisations involved.

8 Measuring Results

The success of the campaign should be measurable by firstly setting baseline data and recording for example:

- Pre-campaign surveys
- Post-campaign surveys
- Number of website hits
- Number of press articles
- Changes in practices
- Improvements in water quality