Cyfoeth Naturiol Cymru
Natural Resources Wales

Application for an environmental permit:
Part LPD1 – Application for a deployment

Use this form for deployments for the landspreading of waste where the operator holds a permit for any of the following standard rules:

- SR2010No4 Mobile plant for landspreading (land treatment resulting in agricultural or ecological benefit);
- SR2010No5 Use of mobile plant for land reclamation, restoration or improvement of land;
- SR2010No6 Mobile plant for landspreading of sewage sludge; or a
- Bespoke mobile plant permit for landspreading or land reclamation.

Please check that this is the latest version of the form available from our website.

Please read through this form and the guidance notes that come with it. All relevant guidance documents can be found on our website.

Where you see the term 'document reference' on the form, give the document references and send the documents with the application form when you've completed it.

Contents

1 About the permit

1a Discussions before your application

If you have had discussions with us before your application, give us the case reference or details on a separate sheet.

Case or document reference

1b Permit number

Permit number this application relates to FB3606GC

1c What type of permit do you want to deploy under? (Please tick)

SR2010No4 Mobile plant for landspreading (land treatment resulting in agricultural or ecological benefit) ☒

SR2010No5 Use of mobile plant for land reclamation, restoration or improvement of land ☐

SR2010No6 Mobile plant for landspreading of sewage sludge ☐

Bespoke mobile plant permit for landspreading or reclamation, restoration or improvement of land ☐

2 About you

Please give us details of the permit holder. For companies, the details must match Companies House.

Organisation name (if relevant) Agrispread Ltd

Title Mr

First name R & R

Last name Piggott

Address 22 Coniston Drive

	Frodsham
	Frodsham
	Cheshire
Postcode	WA6 7LR
Telephone - mobile	
Telephone - office	01978 661866
Email address	agrispreadltd@gmail.com

If you are applying as an organisation of individuals, every partner needs to give us their details, including their title. If necessary, continue on a separate sheet and tell us the reference you have given the sheet.

Document reference	

3 Contact details

Who can we talk to about your application? This can be someone acting as a consultant or 'agent' for you.

Title	Mr	
First name	Richard	
Last name	Street	
Telephone - mobile		
Telephone - office	01978 661866	
Email address	agrispreadltd@gmail.com	

4 About the deployment

4a Multiple deployments for one area of land

You may spread more than 10 waste streams on the same area of land, provided you submit additional fully completed deployment forms listing the additional wastes. Your benefit statement must take into account the total benefit to the land of all wastes to be spread.

Is this deployment one of a batch (multiple deployments) for the same area of land?

No ☒ *Go to section 4b*

Yes ☐ How many deployments are in the batch?

4b Nominated competent person

4b1 Give us details of the nominated competent person. This is the person who will be responsible for compliance with the permit for this deployment. See the guidance notes on LPD1 for further details.

Title	Mr	
First name	Richard	
Last name	Street	
Telephone - mobile		

Telephone - office	01978 661866
Email address	agrispreadltd@gmail.com

4b2 What evidence are you using to show the nominated competent person has suitable technical skills and knowledge to manage the activity?

An approved technical scheme ☒ *Go to section 4b3*

Documented in-house training ☐ You must provide evidence – see below.

You must provide evidence to show the documented in-house training meets the requirements set out in technical guidance. See the guidance notes on LPD1 for further details and give us the document reference.

Document reference _____ *Go to section 4c*

4b3 Which approved scheme are you using to show you have the suitable technical skills and knowledge to manage your facility?

CIWM / WAMITAB ☒

ESA / EU ☐

4b4 Tick to confirm you've included all original *and* continuing competence evidence. ☒

4c Which risk band does the activity fall within?

Please complete Table 1 below to indicate which risk band your activity falls within. This is a combination of waste types and proximity to sensitive receptors.

Once you have selected the risk band your activity falls within, the form guidance tells you what additional information you need to send with the application.

The risk banding affects the fee you need to send with your deployment application. See section 6.

Table 1 – risk band

Permit type	**Lower risk location** - Not in an SPZ 2, and/or - Over 500 meters from: • European site, and/or • Ramsar, and/or • SSSI	**High risk location** - In a Source Protection Zone 2, and/or - 500 meters or less from: • European site, and/or • Ramsar, and/or • SSSI **You *must* submit a site specific risk assessment.**
SR2010No4 List A wastes (Lower risk)	Low risk deployment ☐	Medium risk (2) deployment ☒
SR2010No4 List B wastes (Higher risk)	Medium risk (1) deployment ☐	High risk deployment ☐
SR2010No5 (Any waste listed)	Medium risk (1) deployment ☐	High risk deployment ☐
SR2010No6 (Any waste listed)	Medium risk (1) deployment ☐	High risk deployment ☐
Bespoke mobile plant permit	Low risk deployment ☐	Medium risk deployment ☐ / High risk deployment ☐

4d Additional information on sensitive receptors

Is the deployment within an SPZ 2 and/or 500m of a European site, Ramsar or SSSI, or being made under a bespoke permit?

No ☐

Yes ☒ You must submit a site specific risk assessment (see question 4e).

4e Site specific risk assessment

Your site specific risk assessment must show how you intend to prevent any harm to any SPZ 2, European site, Ramsar or SSSI. For more information on risk-assessment please see the accompanying guidance to LPD1 and Technical Guidance Note 'TGN 8.01'.

Please tick a box below to indicate which type of risk-assessment you have submitted.

I have attached a site-specific risk-assessment as the deployment is within and SPZ 2 and/or 500m of a European site, Ramsar or SSSI. I have also addressed risks to other receptors in the risk assessment ☒

I am not within an SPZ 2 and/or 500 m of a European site, Ramsar or SSSI but have addressed risks to other receptors in my benefit statement. ☐

I am deploying under a bespoke permit and have attached a site-specific risk assessment (regardless of location). ☐

4f About the waste

Please list all the individual waste streams you want to spread/use under this deployment, in Table 2 below. We've included an example to help you.

Please note: You can only spread/use 10 waste types per deployment.

Table 2 – waste types

	List of Waste code (6 digit)	**Waste description**	**Physical form**	**Waste producer**	**Total amount being spread/used** (tonnes)
e.g.	03 03 05	De-inked paper	Sludge	Smith's Newsprint	500
1	03 03 11	Liquid from on-site effluent plant	Liquid	**Ahlstrom Chirnside**	1094.6
2					
3					
4					
5					
6					
7					
8					
9					
10					
				Total tonnage	1094.6

4g About the land you want to treat

4g1 Please give details of the main address of the land to be treated.

Address	Land at Sealand Manor
	Fox's Drive
	Sealand
Postcode	CH5 2SF
National grid reference (12 digit)	SJ 34306 59808

4g2 What type of land do you want to treat?

Agricultural land ☒ Please give your County/ Parish/ Holding number 56/010/00020

Non-agricultural land ☐

4h The parcels of land you want to treat

Please list all the individual areas (parcels) of land you want to include this deployment, in Table 3 below.

Please note: the total area to be treated must not be more than 50 hectares.

Table 3 – parcels of land

	Field name/ number/ reference	**Grid reference - centre of field** (12 digit)	**Waste types to be spread/used** (List of Waste code) Separate using commas.	**Size** (hectares)
1	**100 Acre Field**	**SJ 33143 68355**	**03 03 11**	42.1
2				
3				
4				
5				
6				
7				
8				
9				
10				
			Total hectares	42.1

4i Is the permit holder the owner or occupier of the land you want to spread on/treat?

Yes *Go to section 4k*

No ☒ You must give us details of the land owner or occupier, below.

Organisation name (if relevant)		
Title	Mr	
First name	James	
Last name	Darlington	

Address	Honkley Hall
	Burton
	Rossett
	Wrexham
Postcode	LL12 0AP
Telephone - mobile	07716058098
Telephone - office	
Email address	

If there is more than one owner or occupant for the area covered by this deployment, you must give us details of each. Please continue on a separate sheet and tell us the reference you have given the sheet.

Document reference	

4j Do you have the consent of the owner or occupier to carry out the activity?

Yes ☒ *Go to section 4k*

No ☐ You must tell us why you think you can carry out the activity without the consent of the occupier. Please give an explanation in the box, below. Continue on a separate sheet if needed.

Explanation

4k Previous land treatment

Has any of the land listed in Table 3 been treated with other wastes, sewage sludge, slurries or manures etc. in the last 12 months?

No ☐ *Go to section 4l*

Yes ☒ You must give us details in Table 4 below *and* account for them in your benefit statement.

Table 4 – previous land treatment

	Field name/ number/ reference	**Describe the waste spread** (in last 12 months)	**Person/ company who spread the waste**	**Quantity spread per hectare** (in tonnes)	**Deployment/ other reference** (if known)
e.g.	East field	Digested sewage sludge cake	Eastern Waters	20	PAN 000000
1	100 Acre Field	FYM	Farmer	5	
2					
3					

4					
5					
6					
7					
8					
9					
10					

4l Waste storage

Are you proposing to store waste in connection with this deployment?

No X *Go to section 5*

Yes You must give us details in Table 5 below.

Table 5 – waste storage details

	Grid reference (12 digit)	**Waste type being stored** (6 digit List of Waste code)	**Storage method**	**Quantity stored at any one time** (in tonnes)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

5 Payment

5a Tick an option below to show how you will pay for the application.

Electronic transfer (for example, BACS)	☒	*Go to section 5b*
Cheque	☐	*Go to section 5c*
Postal order	☐	*Go to section 5d*
Credit or debit card	☐	*Go to section 5e*

5b Paying by electronic transfer

If you choose to pay by electronic transfer use the following information to make your payment.

Company name: Natural Resources Wales

Company address:	Income Dept., PO BOX 663, Cardiff, CF24 0TP
Bank:	RBS
Address:	National Westminster Bank Plc, 2 ½ Devonshire Square, London, EC2M 4BA
Sort code:	60-70-80
Account number:	10014438

Reference number

You can use any reference number but we prefer the number to be 'EPDEP' followed by the first five letters of your organisation name followed by a four-digit number.

For example, for a company named Joe Bloggs Ltd, the reference number might be EPDEPJOEBL0001. (Remember you can use any four-digit number at the end.)

The reference number you will provide will appear on our bank statements so we can check your payment. We may need to contact your bank to make sure the reference number is quoted correctly.

You should also email your payment details and payment reference number to banking.team@naturalresourceswales.gov.uk / banking.team@cyfoethnaturiolcymru.gov.uk or fax it to 0300 065 3001 and enter it in the space provided below.

BACS reference	
Amount paid	779

Making payments from outside the UK

These details have changed. If you are making your payment from outside the United Kingdom (which must be received in sterling), our IBAN number is GB70 NWBK6070 8010 0144 38 and our SWIFT/BIC number is NWBKGB2L.

If you do not quote your payment reference number, there may be a delay in processing your payment and application.

5c Paying by cheque or postal order

You should make cheques or postal orders payable to Natural Resources Wales and they should be marked 'A/c Payee'. We will not accept post-dated cheques (cheques with a future date written on them).

Cheque/ postal order number	
Amount paid	

5d Paying by credit or debit card

If you are paying by credit or debit card, please fill in the separate form CC1.

You can download this from our Website or you can ask for one of our customer service providers to send one by post. We will destroy your card details once we have processed your payment. We can accept payments by Visa, MasterCard or Maestro UK card only.

6 Supporting documents

You must provide all relevant documents to support your application. The information we need depends on the type of deployment application you're making. If you don't provide us with all the information we need, we won't be able to assess your proposal and the application may be rejected.

Better quality deployments result in shorter processing times. If we don't need to come back to you for more information, we'll be able to give you a decision quicker.

6a What supporting evidence do you need to send?

Are you applying to spread/use waste under a SR2010 No4 standard rule set permit?

Yes	☒	Complete the checklist in Table 6 *and* Table 7	*Go to section 6b*
No	☐	Complete the checklist in Table 7 only.	*Go to section 6c*

6b Checklist for deployments under SR2010 No4 only

Complete the checklist in Table 6, below. Tick to confirm you've completed the action.

Table 6	
Do the grid references (for fields and storage areas) match the map locations?	☒
Are the grid references in the correct format i.e. AB 12345 67890?	☒
Have details of previous land treatment been provided?	☒
Have you included a location map?	☒
Does the map include all the relevant features as set out in the guidance?	☒
Have you included a waste analysis?	☒
Is the waste analysis for each waste less than 12 months old?	☒
Does the waste analysis include pH, Nitrogen (N), Phosphorus (P), Potassium (K), % dry matter and Potentially Toxic Elements (PTE's)?	☒
Have you included a soil analysis?	☒
Is the soil analysis less for each field than 4 years old?	☒
Does the soil analysis provide the soil pH, Potassium (K), Phosphorus (P), Magnesium (Mg) and PTEs if they are high in the waste?	☒
Have the soil indices for P, K and Mg for each field been provided?	☒
Have you included a Certificate of Agricultural Benefit?	☒
Has the proposed cropping regime been stated?	☒
Has the waste application rate been stated?	☒
Has the timing of application been stated and is it appropriate for the cropping regime?	☒
Has the intended method of waste application been stated?	☒
Have the total nutrients supplied by the waste been stated and have they been provided in oxide format?	☒
Has the nutrient requirement for the proposed crop been provided?	☒
Has the soil nitrogen supply (SNS) for each field been provided?	☒
If the land has been treated with other wastes, sewage sludge, slurries manures etc. in the last 12 months, has relevant information been provided?	☒
If more than one waste stream is to be applied to the land; has the benefit for each individual waste stream been demonstrated?	☐
Have you included a site specific risk assessment? (where relevant)	☒
Does the Site Specific Risk Assessment; consider all potential receptors, identify all risks from the activity, and include information on all measures you'll use to minimise or mitigate the impact and why they're suitable.	☒

6c Checklist for all types of deployment application.

Complete the checklist in Table 7, below. Tick to confirm you've completed the action.

Table 7		
Item	**Complete**	**Your document reference/ description**
Location map (required for all deployments)	☒	Appendix A – Site Map

Benefit statement (required for all deployments)	☒	Appendix E – Benefit Statement
Waste analysis (required for all deployments)	☒	Appendix C – Waste Analysis
Receiving soil analysis (required for all deployments)	☒	Appendix B – Soil Analysis
Site-specific risk assessment (in accordance with 4e)	☒	Site Specific Risk Assessment
Any other additional information	N/A	
	N/A	
	N/A	
	N/A	

7 The data Protection Act 1998

We, the Natural Resources Body for Wales (hereafter "Natural Resources Wales"), will process the information you provide so that we can:

- deal with your application;
- make sure you keep to the conditions of the licence, permit or registration;
- process renewals; and
- keep the public registers up to date.

We may also process or release the information to:

- offer you documents or services relating to environmental matters;
- consult the public, public organisations and other organisations (for example, the Health and Safety Executive, local authorities, the emergency services, the Department for Environment, Food and Rural Affairs) on environmental issues;
- carry out research and development work on environmental issues;
- provide information from the public register to anyone who asks;
- prevent anyone from breaking environmental law, investigate cases where environmental law may have been broken, and take any action that is needed;
- assess whether customers are satisfied with our service, and to improve our service; and
- respond to requests for information under the Freedom of Information Act 2000 and the Environmental Information Regulations 2004 (if the Data Protection Act allows).

We may pass the information on to our agents or representatives to do these things for us.

8 Confidentiality and national security

We will normally put all the information in your application on a public register of environmental information. However, we may not include certain information in the public register if this is in the interests of national security, or because the information is confidential.

You can ask for information to be made confidential by ticking the box below and enclosing a letter with your application giving your reasons. If we agree with your request, we will tell you and not include the information in the public register. If we do not agree with your request, we will let you know how to appeal against our decision, or you can withdraw your application.

Please treat the information in my application as confidential. ☐

You can tell the Secretary of State that you believe including information on a public register would not be in the interests of national security. You must enclose a letter with your application telling us that you have told the Welsh Ministers and you must still include the information in your application. We will not include the information in the public register unless the Welsh Ministers decides that it should be included.

Only tick the box below if you are certain that you wish to claim confidentiality or national security for your application. This may delay your application.

I attach a letter stating that I have written to the Welsh Ministers explaining why my information should not be included on the public register for national security reasons ☐

9 Declaration

You must read this section before making the declaration and sending your form to us.

A relevant person should make the declaration. You must be a relevant person or have the authority of a relevant person to sign this application on their behalf.

Relevant people means each applicant, and in the case of a company, a director, manager, company secretary or any similar officer or employee listed on current appointments in Companies House. In the case of a Limited Liability Partnership (LLP), it includes any partner. If the permit holder is an organisation of individuals, each individual (or individual trustee) must complete the declaration.

To simplify and speed up the application process we recommend that the declaration is filled in by an officer of a company or one of the partners in a Limited Liability Partnership (LLP).

If you wish a manager, employee or consultant etc. to sign the declaration on behalf of a relevant person, we will need written confirmation from a relevant person; that is, an officer of the company, a partner in the LLP or the individual, confirming that the person has the authority to fill in the declaration.

If you are joint permit holders you should each fill in your own declaration. We have provided a separate sheet for this.

Where the operator is the subject of any insolvency procedure, the declaration must be filled in by the official receiver/appointed insolvency practitioner.

9a Are you signing the form on *behalf of* a relevant person?

If you are *not* a relevant person, but want to sign the application on their behalf, you must include confirmation that you can do this.

I have included written confirmation from a relevant person to confirm I can sign on their behalf. ☐

9b Does your deployment application relate to a standard facility permit?

If your deployment application is being made in relation to a standard facility permit (SRP), you also need to confirm that you are able to meet all relevant criteria of the standard rule set/sets under which you are applying.

I confirm that my activity/activities will fully meet the rules of the permit deployment I have applied for. ☒

9c Sign to confirm you understand the declaration.

If you knowingly or recklessly make a statement which is false or misleading to help you get an environmental permit (for yourself or another person), you are committing an offence under the Environmental Permitting (England and Wales) Regulations 2016.

I declare that the information in this application is true to the best of my knowledge and belief. I understand that this application may be refused or approval withdrawn if I give false or incomplete information.

I understand that if I knowingly or recklessly make a false or misleading statement:

- **I may be prosecuted; and**
- **if convicted, I may have to pay a fine and/or go to prison.**

By signing below, you are confirming that you understand and agree with the declaration above.

Title	Mr	
First name	Richard	
Last name	Street	
On behalf of (if relevant)		
Today's date (DD/MM/YYYY)	28/01/2019	

Certificate No. OCC67391

Operator Competence Certificate

Title:

Mobile Plant for land spreading (land treatment resulting in benefit) (4MTMPL6)

This Certificate is awarded to

Richard George Street

Awarded: 21/12/2016

Authorised

WAMITAB Chief Executive Officer

CIWM Chief Executive Officer

The Chartered Institution of Wastes Management

This certificate is jointly awarded by WAMITAB and the Chartered Institution of Wastes Management (CIWM) and provides evidence to meet the Operator Competence requirements of the Environmental Permitting (EP) Regulations, which came into force on 6 April 2008.

00123142

Continuing Competence Certificate

This certificate confirms that

Richard George Street

Has met the relevant requirements of the Continuing Competence scheme for the following award(s) which will remain current for two years from 23/01/2019

LS Land Spreading

Expiry Date: 23/01/2021

Verification date: 21/01/2019

Authorised:

WAMITAB Chief Executive Officer

Learner ID: 22940

Certificate No.: 5138263

Date of Issue: 23/01/2019

CIWM Executive Director

The Chartered Institution of Wastes Management

00127091

Agrispread Ltd
22 Coniston Drive
Frodsham
Cheshire
WA6 7LR

Natural Resources Wales
29 Newport Road
Ty Cambria
Cardiff
CF24 0TP

5th August 2017

To whom it may concern

Re: Deployment Applications declarations

I write to confirm that Richard Street of Trade Effluent Services Ltd is authorised to complete deployment applications and sign declarations on behalf of Agrispread Ltd.

Yours sincerely,

Robert Netzband-Piggott
Company Secretary

Agricultural Benefit Statement

Report Index

1. Permit Details and Appropriate Technical Expertise

The following benefit statement has been written by Richard Street on behalf of Agrispread Ltd. (permit no. FB3606GC).

Relevant Qualifications & Experience include:

- FACTs Qualified – Basis registration no. R/FE/5689
- 9 Years' experience of waste to land recycling operations
- Land spreading of non-farm wastes course (3 day course – May 2010)
- BSc. (Hons) Environmental Management (University of Central Lancashire)

2. Land Details

The following benefit statement proposes to spread Ahlstrom Black Liquor to land. The land details are listed in Table 1, and the site map can be found in Figure 1.

Table 1: Farm and Land Details

Farm Name	Yew Tree Farm
Farm Address and Postcode	Honkley Hall, Stringers lane, Burton Rossett, Nr, Wrexham
Farm NGR	SJ 34306 59808
Land Address and Nearest Postcode	Land at Sealand Manor, Fox's Drive, Sealand, CH5 2SF
Total Area to be Spread (hectares)	42.1

The waste will be spread directly to fields as there is no suitable storage at the land. Details of the operation are discussed in Section 4.

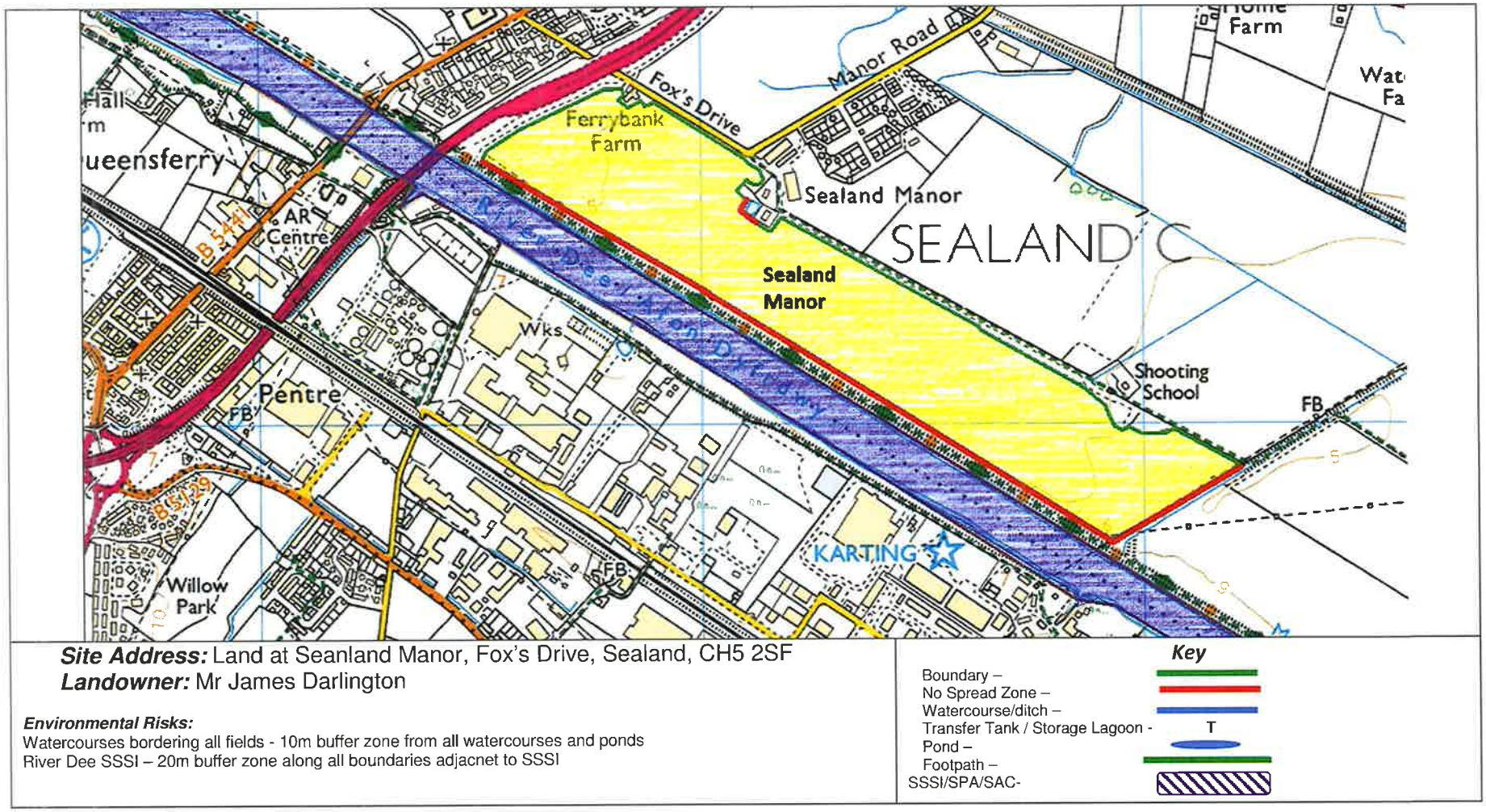

Figure 1: Site map including the fields to spread, receptors, storage (T), and spreading control measures

3. Waste Details

The waste details of Ahlstrom Black Liquor are displayed in Table 2.

Table 2: Waste Details

Waste Producer	Ahlstrom Chirnside Limited
Address of Waste Producer	Mt Sion Works, Mount Sion Rd, Radcliffe, Manchester, M26 3SB
EWC Code	03 03 11
Waste Description	Produced as a by-product of cellulose fibre extraction (sludge from on-site ETP other than 03 03 10)

Ahlstrom Black Liquor contains moderate levels of sulphur and potash, and trace levels of magnesium, phosphate and nitrogen. The waste has been analysed by NRM laboratories in September 2018 for nitrogen, phosphorous, potash, PTE's and other analysis such as FOGs and water soluble sulphur, and the waste analysis, and a waste evaluation, is attached in Appendix D. The ahlstorm waste contains very low concentrations of PTEs at an application rate of 26t/ha

4. Operational Details

The Ahlstrom will be delivered to the site by road tanker and off-loaded. The black liquor will be surface applied by umbilical supplied tractor mounted spreader bar or splash plate to reduce the risk of compaction across fields caused by the travelling weight, and due to the low application rate. In order to reduce the risk of crop scorch, applications of the liquor may be split, especially if spreading occurs during the summer months.

It is intended to spread Ahlstrom to arable fields before seedbed preparation. For this application, the waste is expected to be applied to April 2019 however, this may change due to farmer requirements and weather conditions.

5. Fields and Crop Requirement

Ahlstrom will be applied to all fields and so the crop requirements for all fields, as well as the field sizes and grid references, are displayed in Table 3. Fertiliser requirements are based on figures from the RB209 (9th edition). The magnesium recommendation for all fields is 0 kg/ha.

Table 3: Field Details and Crop Requirements (* denotes crop offtake)

Field	Size	Grid Reference	Current Crop	Next Crop	Expected Yield	Nitrogen	Phosphate	Potash
	ha				t/ha	kg/ha	kg/ha	kg/ha
100 Acre Field	42.1	SJ 33143 68355	Maize	Maize	40	100	55	145
Total	**42.1**							

The soil nitrogen supply (SNS) for the field is 1,

6. NVZ Compliance

The site falls inside an NVZ designated area, which is illustrated in Figure 2. The waste does not apply for the closed periods as Ahlstrom contains trace levels of avai nitrogen. The application rate of Ahlstrom will comply with crop requirement as no more than crop offtake of all nutrients will be applied to fields. In order to aid the landowner or farmer with their recording requirements, a post-notification of nutrients applied will be provided after spreading.

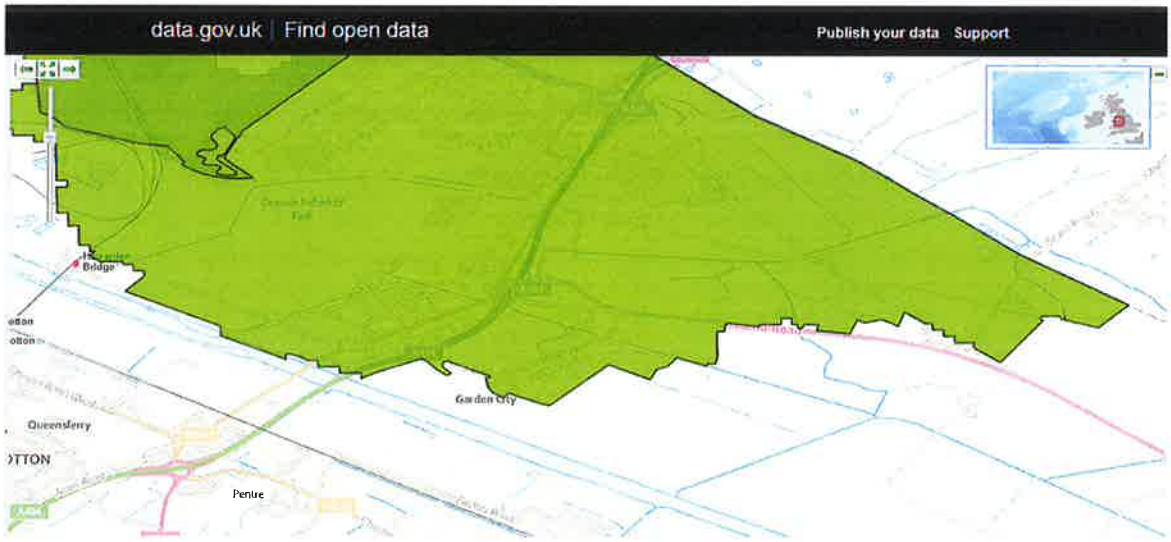

Figure 2: NVZ map for the land to be spread produced from the 'Review of the Designated Areas and Action Programme under the Nitrates Directive in Wales' mapping service on the Welsh Government website (http://lle.gov.wales/apps/nvz/).

Application rates are limited to a maximum of 250 kg total N/ha, and any other organic waste or manure applications have been accounted for. Previous nutrients applied to the fields within the last 12 months are listed in Table 4. The nutrients in Table 4 are total applied, and the availability of each can be taken from the standard figures in the RB209 (9th edition, section 2).

Table 4: Previous Nutrients Applied

Field	Waste Applied	Month Applied	Application Rate	Nitrogen	Phosphate	Potash
			t/ha	kg/ha	kg/ha	kg/ha
100 Acre Field	FYM	March 2018	5	13	6	16

7. Benefits of The Operation

The Ahlstrom will be used to provide plant nutrients that will replace a percentage of the fertiliser that the farmer would normally apply to their crop. The waste will primarily be used as an alternative to potash fertiliser. The liquor will also provide benefit through the addition of organic matter and trace elements. A full waste assessment is attached in Appendix D, and a summary of Ahlstrom can be found in Table 5.

Table 5: Summary of Ahlstrom Nutrients and Application Rate

Waste	Application Rate	Nitrogen		Phosphate		Potash	
	t/ha	(total)	(available) 35%	(total)	(available) 50%	(total)	(available) 90%
Ahlstrom	26	10	3.5	0.1	0.05	100	90

Nitrogen

The waste analysis shows that the ammoniacal and nitrate nitrogen in the waste is relatively low; indicating that only a small proportion of nitrogen will be available immediately. The remaining total nitrogen applied will become available to the crop through mineralisation throughout following seasons. The rate of nitrogen release will be affected by several factors including climate, timing and method of application, and soil type.

Phosphorus

Ahlstrom contains trace levels of phosphorus, and at the proposed application rate of 26t/ha will apply trace amounts of phosphate (<1kg/ha). The landowner/farmer should look to reduce the P index, for fields with P indexes of 3/4, over the coming seasons.

Potash

The waste applied will not meet the crop requirements for potash for all fields but it will allow the landowner/farmer to considerably reduce the amount of chemical fertiliser required to meet the crop need. The application of Ahlstrom at 26 t/ha will provide nutrients at or below crop requirement or offtake, and will not result in an increase in soil nutrient reserves.

Organic Matter

The Ahlstrom waste will also provide a small increase in soil organic matter. This can help to improve soil structure and water, and nutrient holding capacity.

Soils

Additionally, full soil analysis of the proposed fields to be spread has been attached in Appendix C, and a summary table has been included in Table 6.

Table 6: Summary of soil pH and major nutrients for the fields to be spread

Field	Soil pH	Phosphate		Potash		Magnesium	
		mg/l	Index	mg/l	Index	mg/l	Index
100 acre field	7.1	15.6	2	197	2+	85.8	2

The soils were sampled in September 2018 in accordance with the sampling procedures described in the RB209 (9th Edition). Analysis was carried out by NRM laboratories for pH, major plant nutrients,

Soils were found to be medium loam categorised in accordance with RB209 (9th edition) as mineral soils for crop recommendations.

Soil pH is 7.1 and generally slightly above the target value, although it shouldn't affect crop performance. Soil P index' is 2 and the soils are at target index of 2. Soil K levels are at index 2+ around the target index level of 2-. The magnesium index for all fields was satisfactory. PTE concentrations for all fields is low and within the typical range of uncontaminated soil.

8. Potential Negative Impacts

There are no known, or expected, elevated levels of PTEs within the Ahlstrom waste. However, the waste does contains high levels of sodium and sulphur, and justification in this regard is explained in this section. Additionally, a report by '*4Recycling*' prepared for '*Northern Disposal Services*' on the '*Assessment of suitable application rates for the recycling of Ahlstrom Black Liquor to agricultural soils*' has been appended in Appendix E, which further details the sulphur and sodium content.

Sulphur

The sulphur will be less likely to leach as it will be bound to the organic matter in the soil as the soil type is medium loam. This is because the majority of the sulphur present is in the form of lignosulphates, which are organically bound to the soil. These are stable compounds that promote soil aggregation and thus have been used as soil conditioners.

The levels of sulphur will be monitored over the coming seasons to ensure that a continued build-up of sulphur will not have a detrimental impact on the environment, and total sulphur and conductivity will be analysed after spreading.. The fields are relatively flat with drainage and at 26t/ha, a total of 816kg of sulphur will have been applied per field.

Sodium

The Ahlstrom analysis has an elevated conductivity caused by the presence of soluble salts, in particular sodium. If applied in very dry soil conditions, particularly on light textured soils, this might lead to a risk of temporary scorch, in particular grass, and might affect germination of small seeded crops. Therefore, care will be taken to ensure that Ahlstrom is applied to short, cut or grazed grass and to soils that aren't too dry or light textured.

This will be mitigated by the soil types at this farm which are of medium loams and the high rainfall in this area (<700mm/yr). Previous detailed plant growth trials using this waste have shown that electrical conductivity of the soil will return to normal after a period of 10-12 weeks of application and that conductivity or soil structural instability is unlikely to be an issue when applying this waste at 26t/ha.

Site Hazards

Hazards have been identified on the site plan in Figure 1 and relevant control measures and buffer zones have been identified. Operations are to be carried out in accordance with the company generic risk assessment for landspreading, which will reduce the impacts of the operation on the receiving soil.

Odour and Noise Control

The waste has the potential to cause odour it is unlikely to cause nuisance odour issues. The operation will be carried out in accordance within normal agricultural hours to minimise the risk of odour and noise complaints.

9. Sensitive Receptors

There are a number of properties within 500m of the fields proposed to be spread. Odour and noise will be controlled, as detailed in section 8, in order to minimise the disruption caused to residents.

There are no footpaths or tracks crossing the fields to be spread, and no boreholes, wells or springs have been identified within the spreading area.

The site is within a flood prone area and the land is outside a ground water protection zone (Figure 3). The waste will be spread in appropriate conditions with weather and field conditions continuously examined.

The site is within 500m of a statutory designated environmentally sensitive area as defined by Magic Maps (magic.gov.uk). Please find attached a site specific risk assessment

10. Contingency Planning

To cover machinery breakdown, replacement machinery is available or can be hired from suppliers and mobile mechanics are available to attend sites. All machinery is regularly serviced.

There is sufficient trained staff to maintain sickness and holiday cover.

Spreading operations will not be carried out when there are adverse weather conditions that are likely to interfere with the operation. These conditions include; heavy rain, or during periods of heavy snow or frozen ground as defined in the Code of Good Agricultural Practice (COGAP).

Site Specific Risk Assessment – To be read in conjunction with landspreading Generic Risk Assessment

Farm Name: Sealand Manor
Address: Fox's Lane, Sealand

Site Specific Risk Assessment for: Mobile Plant for Landspreading – SR2010No4 – Sealand Manor

Risk Assessment Carried out by: R G Street Date: 28/01/2019

Receptor What is the risk? What do I wish to protect?	***Source*** The agent or process with potential to cause harm	***Harm*** The harmful consequences if things go wrong	***Pathway*** How the receptor might come into contact with the source	***Probability of exposure*** How likely is contact?	***Consequence*** Severity of the consequences if this occurs	***Magnitude of risk*** The overall magnitude of the risk	***Justification for magnitude*** Basis of my judgement	***Risk management*** How I can best manage the risk to reduce the magnitude	***Residual risk*** Magnitude of the risk after management
River Dee SSSI	Concentrations of nutrients in the waste	Contamination of ground water: Chronic effects: Contamination of groundwater requiring treatment of water	Surface run off, Leaching.	Moderate	Moderate	Moderate	Waste is spread in accordance with COGAP. Wastes that are to be surface applied have low application rates.	Waste spread in accordance with COGAP Operations carried out using best available techniques Spreading to be carried out during appropriate conditions Regular checks of watercourses in the area surrounding spreading operation 20m Buzzer zone on boundaries adjacent to SSSI	Low

ANALYTICAL REPORT

Report Number	**26901-18**	**V572**	**FLAG LEAF**	**Client**	**JF AND FN DARLINGTON**
Date Received	**12-SEP-2018**		**HONKLEY HALL**		
Date Reported	**19-SEP-2018**		**STRINGERS LANE**		
Project	**SOIL**		**BURTON ROSSETT**		
Reference	**JF AND FN DARLINGTON**		**NR WREXHAM**		
Order Number			**LL1 20AP**		

Laboratory Reference		**SOIL403720**
Sample Reference		**100 ACRE SHOOT**
Determinand	**Unit**	**SOIL**
pH water [1:2.5]		7.1
Available Phosphorus (Index)	mg/l	15.6 (2)
Available Potassium (Index)	mg/l	197 (2+)
Available Magnesium (Index)	mg/l	85.8 (2)
Textural Class		Clay Loam
Sand 2.00-0.063mm	% w/w	43
Silt 0.063-0.002mm	% w/w	38
Clay <0.002mm	% w/w	19
Available Copper EDTA	mg/l	4.1
Available Zinc EDTA	mg/l	5.0
Available Sodium	mg/l	9.5
Available Calcium	mg/l	1420
Available Sulphate	mg/l	57.1
Organic Matter LOI	% w/w	2.5
Hot Water Soluble Boron	mg/l	1.8
Available Manganese	mg/l	14.3
Available Iron	mg/l	64.2
CO2 Soil Respiration	mg/kg	148
Colour Index		4.89

Notes

Analysis Notes

The sample submitted was of adequate size to complete all analysis requested.
The results as reported relate only to the item(s) submitted for testing.
The results are presented on a dry matter basis unless otherwise stipulated.

ANALYTICAL NOTES

Report Number	**26901-18**	**V572**	**FLAG LEAF**	**Client JF AND FN DARLINGTON**
Date Received	**12-SEP-2018**		**HONKLEY HALL**	
Date Reported	**19-SEP-2018**		**STRINGERS LANE**	
Project	**SOIL**		**BURTON ROSSETT**	
Reference	**JF AND FN DARLINGTON**		**NR WREXHAM**	
Order Number			**LL1 20AP**	

Notes	
Reported by	*Joe Cherrie* Natural Resource Management, a trading division of Cawood Scientific Ltd. Coopers Bridge, Braziers Lane, Bracknell, Berkshire, RG42 6NS Tel: 01344 886338 Fax: 01344 890972 email: enquiries@nrm.uk.com

MR ROB PIGGOTT
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WREXHAM LL13 9YE

F990

Please quote above code for all enquiries

AHLSTROM

LIQUID WASTE

LIQUID WASTE

Sample Reference :

AHLSTROM

Sample Matrix : LIQUID WASTE

Laboratory References	
Report Number	27935
Sample Number	73778

Date Received	19-SEP-2018
Date Reported	26-SEP-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept under refrigeration for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Oven Dry Solids	13.0	%
Conductivity 1:6	11110	uS/cm
Total Nitrogen	<0.04	% w/w
Nitrate Nitrogen	<10	mg/kg
Ammonium Nitrogen	<50	mg/kg
Total Phosphorus (P)	<5	mg/kg
Total Potassium (K)	3200	mg/kg
Total Magnesium (Mg)	<10	mg/kg
Total Copper (Cu)	<0.2	mg/kg
Total Zinc (Zn)	0.69	mg/kg

Released by *Darren Whitbread* Date *26/09/18*

NRM Coopers Bridge, Braziers Lane, Bracknell, Berkshire RG42 6NS
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Report Number	27935
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Date Received	19-SEP-2018
Date Reported	26-SEP-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept under refrigeration for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Total Sulphur (S)	12553	mg/kg
Total Calcium (Ca)	15.9	mg/kg
Total Lead (Pb)	<0.5	mg/kg
Total Cadmium (Cd)	<0.01	mg/kg
Total Mercury (Hg)	<0.05	mg/kg
Total Nickel (Ni)	<0.2	mg/kg
Total Chromium (Cr)	<0.2	mg/kg
Total Sodium (Na)	23904	mg/kg
pH 1:6 [Fresh]	9.31	
Organic Matter LOI	4.44	% w/w

Released by Darren Whitbread Date 26/09/18

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AHLSTROM

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Sample Reference :

AHLSTROM

Sample Matrix : LIQUID WASTE

Laboratory References	
Report Number	27935
Sample Number	73778

Date Received	19-SEP-2018
Date Reported	26-SEP-2018

The sample submitted was of adequate size to complete all analysis requested.

The sample will be kept under refrigeration for at least 3 weeks.

ANALYTICAL RESULTS *on 'as received' basis.*

Determinand	Value	Units
Water Soluble Magnesium	1.74	mg/kg
Water Soluble Phosphorus	1.70	mg/kg
Water Soluble Potassium	2913	mg/kg

Released by *Darren Whitbread* Date *26/09/18*

NRM Coopers Bridge, Braziers Lane, Bracknell, Berkshire RG42 6NS
Tel: +44 (0) 1344 886338 **Fax:** +44 (0) 1344 890972 **Email:** enquiries@nrm.uk.com **www**.nrm.uk.com

Waste Producer Ahlstrom Black Liquor
EWC code 03 03 11
Waste description Black liquor from long fibre pulp
Laboratory NRM Laboratories Ltd **Sample Ref:** 73778

Ahlstrom Black Liquor was sampled in accordance with the standard sampling procedures in October 2017 and was analysis by NRM laboratories Ltd.

	Units	Result	Nutrients applied at 26t/ha
pH	-	9.31	-
Electrical conductivity	µS/cm	11400	-

The waste has low dry matter content and will apply 13% solids to the receiving soil. This will help improve soil structure and aid nutrient and water holding capacity.

The black liquor has a pH of 9.31 and no detrimental effects are anticipated from its application to most soils at the proposed spreading rate of 26t/ha.

A detailed report carried out in 2008 regarding the suitability of land application of the black liquor found no disbenefit from the application of black liquor and this is attached in Appendix E.

1. Major Plant Nutrients

	Unit	Result	Nutrients applied at 26t/ha
Nitrogen	kg/t	0	10
Phosphate	kg/t	0	0
Potash	kg/t	4	100
Magnesium	kg/t	0	0
Sulphur	kg/t	31.38	815.95

The liquor from the effluent treatment plant at Ahlstrom contains high levels of potash and sulphur with small quantities of phosphate, nitrogen and magnesium. Potash availability should be high and will be available for the next crop. Phosphate levels are low and less than 1kg/ha will be applied to the soil and following crop.

2. Potentially Toxic Elements (PTEs)

The waste was analysed for a range of PTEs as described in the Sludge (Use in Agriculture) Regulations. The analysis shows that the waste contains only trace elements of the majority of PTEs additions, and they fall well within the maximum permitted annual application limit. The table below shows the waste contribution of PTEs in kg/ha at the proposed application rate.

Application rate (t/ha)	Copper	Zinc	Lead	Cadmium	Mercury	Nickel	Chromium
26	0.01	0.02	0.01	0.0	0.0	0.01	0.01

3. Sodium

The total addition of sodium in any one application of the Ahlstrom Black liquor waste is 621.50kg/ha, which is higher than that recommended in agency guidance. However, the sodium will not all be immediately available as the extraction process makes use of the less available forms of sodium, which is likely to be bound within the lignin in the waste.

The loamy topsoil at the farm is at a lower risk of structural instability following addition of sodium than if they were a lighter texture. Structural instability is usually a feature associated with the addition of many tonnes of

sodium deposited within topsoil from seawater inundation, saline intrusion or from capillary rise and evaporation of saline water leading to salt in the upper layers. In extreme cases this can lead to de-flocculation of clay particles and structural instability, changes in soil-plant osmotic processes, induced drought stress and in extreme cases sodium toxicity. The sodium content has remained fairly stable since 2005 and with more than 9 years experience of spreading the black liquor; we are yet to see evidence of damage to the soil structure following an application of black liquor.

Bioassays carried out in 2000 applied black liquor at an application rate of 50t/ha and over 800kg/ha of total sodium was added to the soil. No detrimental effect to the soil structure was noted and after 12 weeks the elevated conductivity of the soil was 2165uS/cm, within the normal range for agricultural soils in the UK and within the limit for topsoil detailed in the BS3882. I would therefore conclude from this that the waste will not lead to unacceptable high longer term EC and sodium issues after application.

In addition, sodium is an essential element for grass herbage growth. Sodium fertilizers will not normally give extra grass yield but they will increase the Na content of grass which will improve the palatability of herbage and can reduce the chance of grass staggers. Sodium is also associated with a greater % of live herbage, higher D values and sugar content of grass. Research from Bangor University indicates that these effects increase milk output and % butterfat and may also have a small benefit on somatic cell count. Grass palatability and milk output increase at herbage sodium levels up to 0.5% in the dry matter.

4. Conductivity

While an application of Ahlstrom will temporarily elevate conductivity within the soils this does not automatically mean that it will cause crop scorch or lead structural damage after a receipt of the waste. It is largely dependent on soils type, weather and soil conditions. Many Chemical (Liquid & solid) fertiliser has an elevated conductivity far in excess of that measured in the Ahlstrom waste which will could lead to similar issues.

The conductivity within the waste is measured as the total of all of the salts it contains including chlorides, sulphates and other soluble oxides/compounds. The effects of conductivity are more pounced on soils that are lighter textured and also when soils are dry as the salts applied can increase the strength of the soil water solution and lead to induced drought stress. The fields are loamy textured and are in a heavy rainfall area so are low risk of induced drought stress.

5. Potential disbenefits

- The black liquor pH is 9.31 and no adverse effects are anticipated from its application to agricultural land.
- The level of PTEs applied are well within regulatory recommendations and will have no impact on the receiving soils or crops.
- Compaction of soils will be minimised by the use of an umbilical cord system and tractor mounted spreader.
- The black liquor does not have an offensive odour and is unlikely to cause a nuisance during normal spreading operations.
- Additions of sodium and conductivity which are discussed above.

6. Conclusion

The black liquor from the treatment plant at Ahlstrom provides agricultural benefit through the addition of major plant nutrients and will be used to reduce the requirement for chemical fertiliser. The liquor will supply additional benefit through the addition of organic matter to the receiving soil. Application rates will be reviewed to ensure soil and crop requirements are not exceeded following regular analysis of the waste.

The additions of sodium at the above applications rates fall within those that are recommended within previous assessments.

There should be no significant impacts on soil structural stability.

I would expect the electrical conductivity of the topsoil to initially rise after application but that it will return to normal within a matter of a few weeks, a feature no different to the effects of any fertiliser application.

The material has been recycled to land for a number of years and experience has shown that it can be applied without cause harm to the environment. There should be no disbenefit from the application when applied in accordance with the management plan and relevant current regulations.

COMMERCIAL IN CONFIDENCE

Assessment of suitable application rates for the recycling of Ahlstrom black liquor to agricultural soils

Prepared for:

Geoff Dickinson
Northern Disposal Services

COLIN RUDD BSc, (Soil Science)
ANDY WHORTON BSc, MSc (Soil Science)

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1. BACKGROUND

The Ahlstrom black liquor is produced as a by-product of cellulose fibre extraction from Abaca (Musa textilis). The cellulose is extracted with caustic soda and sodium sulphite at high temperature, high pH and high pressure. The lignin in the plant material is dissolved leaving behind the cellulose fibres. The lignin combines with the sulphite to form water-soluble sodium lignosulphonate which makes up the bulk of the liquor together with any surplus sulphite and sulphate. The remaining sulphite would be converted to either the lignosulphonate or sulphate.

Ahlstrom recycle the liquor to agricultural land and the Environment Agency have recently questioned technical aspects of this activity and responded with the following comments:-

> ***"With regards to your comments on sulphur, I am aware of the issue with regards to the reduction in atmospheric deposition and therefore the requirement for sulphates to be added through "fertilisers" and the mineralization of organic sulphur. In most typical agricultural soils (i.e. neutral soils) the sulphate behaves like nitrate, i.e. it is not bound and is easily leached.***
>
> ***RB209 (much as with the recommendations for nitrogen) provides guidance on the optimum sulphur addition to meet a particular crops need. Application rates above those recommended will present a risk of the excess leaching from the soil. If this excess sulphur enter surface waters it may affect the water's pH and be reduced to potentially toxic sulphides by the same anaerobic bacteria that will reduce nitrates to ammonia. Because the potential for excess sulphur to leach from a soil is similar to that for nitrogen the current advice provided on avoiding nitrate leaching is likely to be equally applicable, e.g. minimise leaching by following recommended rates and timings for fertilisers (see the Defra Code of Good Agricultural Practice for the Protection of Water).***
>
> ***I have calculated that you are applying 557 kg/ha of sulphur trioxide (which is what RB209 quotes) when spreading at 26 tonnes per hectare. The level recommended for silage is 25-40kg/ha when sulphur deficiency is noted prior to each cut."***

4Recycling's technical specialists have been asked to provide a detailed technical evaluation of the actual facts and chemistry of the interactions which occur when Ahlstrom black liquor is spread onto agricultural land.

2. INSTRUCTIONS

In response to the queries posed above by the Environment Agency, this report provides an analysis of the validity of the EA claims and provides researched technical details showing:

- The actual risk of leaching and water pollution and a review of literature to back up these facts.
- Data relating to the "polluting" potential of surface applied sulphate and sulphide, including the chemical reactions which compounds of this type undergo when mixed with organic and mineral matter in soil.
- Rate of leaching of S compounds added to soil compared with nitrate, Na and K.
- Characterisation of the S compounds in the black liquor, from current analysis or new analysis to show the speciation of S compounds.
- Whether or not current application rates are indeed safe and sustainable.

3. LITERATURE SEARCH

A literature search with specific reference to the application of Alhstrom type liquors, "Kraft black liquor" and sodium lignosulphonates to agricultural land yielded few experimental papers or reports of direct relevance.

One reference by Canmig Xiao (PhD thesis, Washington State University 2005) was more concerned with the fate of sodium from these liquors when applied to land and was proposing the substitution of sodium hydroxide with potassium hydroxide. His thesis did not study or consider the fate of the sulphur component of the liquor.

Discussions with Soil Scientists, both within the university community and external consultancies, provided little information on the Ahlstrom type liquors, or the soil chemistry of sodium sulphonates, and only a small amount of information on sulphate leaching that could be verified by experimental data.

It was striking how little information could be obtained on S leaching in soil or any EU or UK policy initiatives to restrict the movement of any S compounds from land to surface or ground waters. No comparison or linkage with nitrate leaching was evident.

Consequently, the report has been based on existing data from various reports commissioned by Alhstrom, analytical data from operational activities or appraised from current literature.

4. ANALYSIS OF THE AHLSTROM BLACK LIQUOR

Below is a summary of the most recent chemical analysis of the black liquor over the past 3 years.

		23.07.07	25.07.06	23.11.05	Mean
Dry matter	%	9.41	8.89	10.6	**9.63**
pH		8.6	8.94	7.93	**8.49**
Conductivity (1:6 ratio)	µS/cm	7720	6550	7480	**7250**
Total Nitrogen	% w/w	0.016	0.03	0.035	**0.027**
Nitrate Nitrogen	mg/kg	<0.1	<0.1		**0.00**
Ammonium Nitrogen	mg/kg	<0.1	13.4		**6.70**
Total					
Phosphorus (P)	mg/kg	42.4	8.33	15.1	**21.9**
Potassium (K)	mg/kg	2298	3165	2315	**2593**
Magnesium (Mg)	mg/kg	0.102	7.51	<0.01	**2.54**
Sulphur (S)	mg/kg	8573	3393	7738	**6568**
Sodium (Na)	mg/kg	16578		16411	**16495**
Calcium (Ca)	mg/kg	4.49	7.94		**6.22**
Water soluble					
Phosphorus (P)	mg/kg	40.6	6.8		**23.7**
Potassium (K)	mg/kg	2179	3065		**2622**
Magnesium (Mg)	mg/kg	0.8	6.9		**3.85**
Sulphur (S)	mg/kg	8426	3303		**5865**
Calcium	mg/kg	4.32	4.57		**4.45**
Total					
Copper	mg/kg	0.077	0.352	0.683	**0.37**
Zinc	mg/kg	0.016	0.759	7.51	**2.76**
Lead (Pb)	mg/kg	<0.01	0.027	0.207	**0.08**
Cadmium (Cd)	mg/kg	<0.01	<0.01	<0.01	**0.00**
Mercury (Hg)	mg/kg	<0.05	<0.05	<0.05	**0.00**
Nickel (Ni)	mg/kg	0.017	0.16	0.34	**0.17**
Chromium (Cr)	mg/kg	0.132	0.131	0.056	**0.11**
Lime Equivalent as CaO	% w/w	0.7	0.5		**0.6**

The analysis of the liquor shows it to contain significant quantities of potassium, sulphur, and sodium. The analysis also shows the liquor to be relatively consistent for dry matter, pH, electrical conductivity, sodium and calcium. The sulphur and sodium are derived from the extraction reagents, with the remaining nutrients derived from the dissolved plant matter.

The mean water soluble concentrations are higher than the mean total concentrations for some of the elements. This is due to the few sample numbers analysed and the variability of extraction techniques within the analytical methods.

Approximately 90% of the sulphur and calcium are soluble in water. However, this does not necessarily mean that these elements will be immediately available for plant uptake or leaching due to the fact that they are closely bound to the lignin.

The potentially toxic elements are all very low and will have an insignificant impact on the environment and/or plant uptake.

5. RATES OF APPLICATION AND FERTILISER VALUE

The fertiliser value has been calculated based on the mean values above and at an application rate of:

Application rate 30.0 t/ha

			Nutrient value	Amount applied
TOTALS	**result**	**units**	**(kg/tonne)**	**(kg/ha)**
Nitrogen (N)	0.27	g/kg	0.3	8
Ammonium-N	6.7	mg/kg	0.01	0
Phosphorus (P)	21.9	mg/kg	0.02	1
Phosphate (P2O5)			0.05	1
Potassium (K)	2593	mg/kg	2.59	78
Potash (K2O)			3.11	93
Magnesium (Mg)	2.54	mg/kg	0.00	0
Magnesium (MgO)			0.00	0
Sulphur (S)	6568	mg/kg	6.6	197
Sulphur (SO_3)			16.4	493
Sodium (Na)	16495	mg/kg	16.5	495
WATER SOLUBLE				
Phosphorus (P)	23.7	mg/kg	0.02	1
Phosphate (P2O5)			0.05	2
Potassium (K)	2622	mg/kg	2.62	79
Potash (K2O)			3.15	94
Magnesium (Mg)	3.85	mg/kg	0.00	0
Magnesium (MgO)			0.01	0
Sulphur (S)	5865	mg/kg	5.9	176
Sulphur (SO_3)			14.7	440

The major constituents of the liquor are sodium, sulphur and potassium. The amount of the nutrient applied from an application of 30 m^3/ ha is 93 kg/ha of potash, 197 kg/ha of S (493 kg/ha SO_3) and 495 kg/ha of sodium.

5.1 Potash

At this rate of application the liquor provides sufficient **potash** to meet most crop demands. Potash fulfils many vital functions in a wide variety of processes in plants, animals and man. It is typically taken-in in greater quantities than required and surpluses are naturally excreted. This process occurs in animals & humans via the kidneys and urine and in plants by the return of potash in senescent tissue at the end of each season - leaves from trees, cereal stubble and roots, etc. Potash is, therefore, naturally recycled widely and in large quantities. Soil reserves are an essential requirement for adequate nutrient supply of potash to plants which commonly contain more potassium than any other nutrient including nitrogen.

5.2 Sulphur

The amount of **sulphur** supplied is greater than crop demand, however, not all of the nutrients will be available for uptake as it is tightly bound to the lignin. This aspect will be discussed later in this report under "plant uptake". Sulphur is an important plant nutrient and needed by plants in similar quantities to phosphorus. Historically, the crop's requirement for sulphur has been met from atmospheric deposition and fertilisers that have contained sulphur as a by-product. However, sulphur deposition from the atmosphere has fallen rapidly in recent years and deposition in 1999 was about 15% of that in 1980. Sulphur deposition will continue to fall in the future.

5.3 Sodium

The amount of **sodium** applied is slightly more than that applied as agricultural salt to sugar beet crops e.g. 375 kg/ha (200 kg/ha Na_2O). The application will have no adverse effect on soil structure even on soils of low structural stability (RB209 Section 4, Pg 96). In addition, sodium is an essential element for grass herbage growth. Sodium fertilisers will not normally give extra grass yield but they will increase the Na content of grass which will improve the palatability of herbage and can reduce the chance of grass staggers. Sodium is also associated with a greater % of live herbage, higher D values and sugar content of grass. Research from Bangor University indicates that these effects increase milk output and % butterfat and may also have a small benefit on somatic cell count. Grass palatability and milk output increase at herbage sodium levels up to 0.5% in the dry matter.

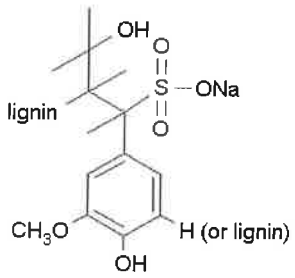
5.4 Potentially Toxic Elements

			Concentration	Amount applied	
TOTALS	result	units	(g/tonne)	(kg/ha)	Limit (kg/ha/yr)
Zinc	2.76	mg/kg	2.76	0.08	15.00
Copper	0.37	mg/kg	0.37	0.01	7.50
Nickel	0.17	mg/kg	0.17	0.01	3.00
Lead	0.08	mg/kg	0.08	0.00	15.00
Cadmium	0.00	mg/kg	0.00	0.00	0.15
Chromium	0.11	mg/kg	0.11	0.00	15.00
Mercury	0.00	mg/kg	0.00	0.00	0.10

The amounts of potentially toxic elements applied are insignificant to the amounts permitted under the "Sludge Use in Agriculture Regulations" (1989).

6. FORMS OF SULPHUR PRESENT IN THE BLACK LIQUOR

It is wrong to assume that because the analysis shows that the majority of sulphur is present in a water soluble form, that it must be present as sulphate or possibly sulphite. The extraction process uses sodium hydroxide and sodium sulphite to digest the plant material with the eventual formation of the complex molecule lignosulphonate. These are stable compounds and have been used as soil conditioners as they promote soil aggregation. The majority of the lignosulphonate will exist in the sodium form due to the amount of sodium sulphite added during the extraction process, but other base metals e.g. potassium and calcium derived from the plant material will also be present. The chemical structure of sodium lignosulphonate is shown below.



Lignosulphonates are stable molecules, with a molecular weight between 10,000-100,000, depending on their degree of the polymerization.

Lignosulphonates are also soluble in water, which is surprising considering their molecular weight. The C-S covalent bond and the S=O bonds will be broken by microbiological activity and not as a result of chemical reaction.

The Environment Agency appears to be concerned about sulphates leaching into surface or ground water resulting in the production of "potentially toxic" sulphides from the application of the Ahlstrom liquor. The release of sulphides from sulphates is a highly specialised process. It is carried out by specific sulphate reducing micro-organisms (Desulphovibrio bacteria) as a result of anaerobic respiration, and will not occur in normal aerated agricultural soils. It can not be reduced by the same micro-organisms as those which reduce nitrate to ammonia as has been implied by the Environment Agency.

Conditions in soil or water need to be intensely anaerobic in order for sulphate reduction to occur. The following table shows the sequence of oxidation-reduction potentials for inorganic reductions that poise a soil as it becomes more anaerobic.

System	Redox potential at 25 °C (mV)	
	pH 5	pH 7
$O_2 + 4H^+ + 4e^- = 2H_2O$	930	820
$NO_3^- + 2H^+ + 2e^- = NO_2 + H_2O$	530	420
$MnO_2 + 4H^+ + 2e^- = Mn^{2+} + 2H_2O$	640	410
$Fe(OH)_3 + 3H^+ + e^- = Fe^{2+} + 3H_2O$	170	-180
$SO_4 2- + 10H^+ + 8e^- = H_2S + 4H_2O$	-70	-220

In normal aerated agricultural soils the redox potential is poised above +400 mV, depending on soil conditions. Soil respiration systems will be based on oxygen, nitrate, manganese and iron depending on the soil conditions. However, for sulphate reduction to occur, the soil must be extremely waterlogged (bog conditions) and sulphate reducing micro organisms to be present. Consequently, sulphate reducing conditions are highly unlikely to occur under normal soil conditions for crop production.

7. SULPHUR IN SOILS

Sulphur occurs in the soil in both inorganic and organic forms, with the organic bound S comprising of over 90% of the sulphur. The majority of the inorganic sulphur will be present as sulphates of varying solubilities.

Soil analysis form fields where the Ahlstrom black liquor is to be applied show total sulphur contents ranging from 0.02% to 0.08 % S. This equates to a total sulphur content ranging from 500 to 2000 kg/ha S, assuming that a hectare of soil in the top 20 cm weighs approximately 2,500 tonnes.

8. INFILTRATION TRIALS

Soil infiltration tests were carried out by Dr R Davies, Soil Environment Services. The infiltration rate was assessed with a double ring infiltrometer on two soil textures using both water and Ahlstrom 410 liquor. The Philips equation was used to calculate infiltration after 1 hour and the average for water was 85 mm/hr and for Ahlstrom liquor 56 mm/hr. This was carried out during relatively dry conditions and therefore could be expected to be half this rate during wetter conditions.

Based on these infiltration data, an application rate of 29.76 tonnes per ha will, therefore, result in percolation of the black liquor to no more than 2.9 mm depth if spread uniformly on the soil when soil conditions were suitable (not during rain or when the soil is at field capacity). If the liquor is applied at moisture contents less than field capacity, the liquor will infiltrate at the above rates but will not pass through the profile due to the relatively small quantities applied and will add very little to the soil moisture content. The soil mass available to absorb the liquor would be expected to retain all of the nutrients and liquor constituents.

This means that the surface soil layer enriched with the black liquor will need to be flushed with a very large quantity of excess winter rainfall (annual rainfall minus evapo-transpiration) to push the material through the soil profile like a piston, assuming the constituents are freely mobile.

9. PLANT GROWTH TRIALS (BIOASSAY)

Plant growth trials utilising the Ahlstrom liquor carried out in 2000 has shown a number of interesting results both in terms of nutrient uptake and the effect on the soil. The black liquor used in the bioassay contained between 3-6 times the quantity of sodium and sulphur respectively as is now contained within the black liquor recycled to land (mean data shown in this report). Although not directly comparable, the data can be used to demonstrate nutrient uptake and residual soil nutrient effects of the application of the black liquor to soil.

9.1 Nutrient uptake

Table 1 shows the effect on nutrient uptake in grass as a result of increasing the rate of application of the Ahlstrom liquor from 0 to 50 m^3/ha. The largest effect was the reduction in the potassium and the increase in sodium concentrations. The Ahlstrom liquor supplied the equivalent of 354 kg/ha of sodium at the 6 m^3/ha application of liquor. Sodium uptake was increased from 0.1 % to 0.31 % at the 6 m^3 rate and up to 1.07% at the 50 m^3 rate. The increase in sodium uptake suppressed the uptake of the other cations. This effect was not observed in the uptake of sulphur, despite an application of 222 kg/ha of sulphur (555 kg/ha SO_3) at the 6 m^3 application rate. The sulphur content only increased from 0.24% to 0.26% at the 25 m^3/ha treatment despite the application of the equivalent of 925 kg/ha of sulphur (2,300 kg/ha SO_3). This demonstrates that the majority of the sulphur can not be present in a plant available form, e.g. sulphate, and is therefore, not likely to be leachable.

Table 1 - Nutrient content of grass (%).

Treatment (m^3/ha)	DM (%)	N (%)	P (%)	K (%)	Mg (%)	Na (%)	S (%)	Cu (mg/kg)
0	14.4	2.90	0.38	4.28	0.14	0.10	0.24	6.87
6	14.8	2.63	0.37	3.96	0.12	0.31	0.22	6.43
12	15.9	2.70	0.34	3.48	0.12	0.54	0.22	6.21
25	16.3	2.48	0.30	3.06	0.11	0.73	0.26	5.65
50	16.9	2.45	0.33	2.56	0.09	1.07	0.27	6.32
SE	0.512	0.134	0.014	0.104	0.007	0.025	0.009	0.350
Sig	5%	NS	5%	0.1%	1%	0.1%	5%	NS

Similar results were observed in oilseed rape (Table 2) and the results presented below. There was a similar reduction in the potassium content, and increase in the sodium content. The differences in the nitrogen, phosphorus and sulphur contents as a result of applying the Ahlstrom liquor were not significant.

Table 2 - Nutrient content of oilseed rape (%)

Treatment (m^3/ha)	DM (%)	N (%)	P (%)	K (%)	Mg (%)	Na (%)	S (%)
0	11.2	2.27	0.39	4.37	0.26	0.08	0.87
6	11.2	2.25	0.38	4.15	0.24	0.34	0.85
12	12.1	2.05	0.36	3.57	0.23	0.47	0.79
25	11.7	2.11	0.36	3.47	0.21	0.75	0.79
50	11.7	2.19	0.40	3.09	0.20	1.12	0.91
SE	0.416	0.061	0.013	0.166	0.008	0.049	0.031
Sig	NS	NS	NS	0.1%	1%	0.1%	NS

The normal application rate of **30 m^3/ha**, is based on the mean fertiliser value of the Ahlstrom liquor in this report and it will apply the equivalent amount of sodium and sulphur as the 6m^3/ha treatments used in the plant growth trials.

9.2 Soil analysis

At the end of the plant growth test carried out in 2000, the soils were analysed and the results presented in Table 3.

Table 3 - Soil analysis - Grass

Treatment (m^3/ha)	pH	Extractable (mg/l)			Ext Na mg/l	Total S mg/kg	Ext SO_4-S mg/kg	Cond µS/cm 20°C	Ext Cu (mg/l)
		P	K	Mg					
0	6.9	36	243	107	19	333	31	2063	5.4
6	6.9	37	224	113	29	349	22	2043	4.9
12	7.0	45	245	136	56	380	57	2100	5.5
25	7.0	40	210	126	133	422	60	2100	5.1
50	7.1	36	234	109	164	446	51	2185	4.9
SE	**0.056**	**3.85**	**27.88**	**4.914**	**31.221**	**24.38**	**17.507**	**31.992**	**0.171**
Sig	**5%**	**NS**	**NS**	**1%**	**5%**	**5%**	**NS**	**NS**	**NS**

The addition of the Ahlstrom black liquor had no significant effect on the available phosphorus, potassium and magnesium content. There was a small significant increase in soil pH which would offset concerns of potential soil acidification resulting from the application of the Ahlstrom liquor.

There was a significant increase in the sodium content but this increase was small at the $6m^3$ /ha rate and would have little impact on the soil. This rate of application would apply the same sodium loading as a 30 m^3/ha application of the current black liquor based on the mean value in this report.

There was a significant increase in the total sulphur content but this increase was not significant at the $6m^3$/ha application rate. There was no significant increase in the plant available sulphate (SO_4-S) even at the $50m^3$/ha rate which supplied 1,650 kg of water soluble–S (4,000 kg SO_3-S). These data further confirms that although the sulphur is in water soluble form, it is not being measured by standard soil tests to identify sulphur that is readily available for plant uptake or leaching.

10. LEACHING OF SULPHATE

The leaching of sulphate was of primary concern by the Environment Agency. These concerns are unproven as the risk of pollution resulting from sulphate leaching is relatively small. This is because the sulphur is present in the form of lignosulphonates which will be organically bound to the soil. The lignosulphonates although soluble in water, are not extracted by standard soil analysis methods that measure the forms of sulphur that are readily leached or available for plant uptake.

The following analysis is based on **all the sulphur being soluble and available for leaching** and was modelled in order to satisfy the Environment Agency that sulphate leaching is unlikely to occur. The amount of S leached is calculated from the current application rate of 30 m^3/ha using nitrate-nitrogen leaching as baseline (assuming S leaching losses are equivalent to nitrate). The amount of nitrate-nitrogen can be calculated using the ADAS Manner programme for a range of soil types and the 3 excess winter rainfall classes described in MAFF bulletin 209. The programme has been set so that all the nitrogen is available for leaching, and that the material is applied to the surface and incorporated within 2 hours of application. The programme calculates that only 6 kg/ha of nitrate-nitrogen is lost through volatilisation, with the remainder available for leaching.

The following excess winter rainfall scenarios have been used to represent the 3 rainfall classes:

Rainfall Class	Excess winter rainfall range	Excess rainfall used in calculation
Low (500-600 mm)	50-150 mm	100 mm
Moderate (600-700 mm)	150-250 mm	200 mm
High (700 + mm)	250 + mm	300 mm

The following table calculates the amount of nitrate-nitrogen leached from an application of 176 kg/ha of available N. This is the same rate of application of water soluble sulphate–S applied in the Ahlstrom liquor applied at 30 m^3/ha. The soil textures are the same for both the topsoil and subsoil.

Amount of NO_3-N leached from an application of 176 kg/ha available N

Excess rainfall	Sandy loam	Silt loam	Clay loam	Clay
100 mm	0	0	0	0
200 mm	71	5	13	31
300 mm	162	76	89	118

The leaching of sulphate–sulphur is generally accepted as approximately 66% that of nitrate-nitrogen. The amount of sulphate-sulphur that is available for leaching can be calculated and presented in the following table. The data has not taken into account:

- any sulphur taken up by the crop which would be in the order of 24 kg/ha S (60 kg/ha SO_3), based on a 2 cut silage system removing 12 kg/ha S (30 kg/ha SO_3 per cut), or
- any sulphur immobilised by the soil.

Amount of SO_4-S (mg/l) leached from an application of 176 kg/ha water soluble S

Excess rainfall	Sandy loam	Silt loam	Clay loam	Clay
100 mm	0	0	0	0
200 mm	47	3.3	8.0	20.4
300 mm	107	50	59	78

The data in the above table is for the <u>worst case scenario</u> where 100 % of the applied sulphur is available for leaching. The following table calculates the concentration of sulphate in the drainage water based on the amount of SO_4-S leached for the 4 different soil textures and three excess winter rainfall classes.

Amount of SO_4-S (mg/l) in drainage water from an application of 176 kg/ha water soluble S

Excess rainfall	Sandy loam	Silt loam	Clay loam	Clay
100 mm	0	0	0	0
200 mm	23.5	1.7	4.0	10.2
300 mm	35.7	16.7	19.7	26.0

The calculations above from MANNER show that small concentrations of SO_4-S **(worst case scenario 35.7 mg/l SO_4-S)** would be present in the drainage waters and would not pose a significant risk to the environment. The majority of soils used for spreading the black liquor will be clay loam or sandy clay loam in texture with leaching rates similar to the clay loam texture e.g. 19.7 mg/l SO_4-S. To put this into context, the World Health Organisation, US Environmental Protection Agency and the The Water Supply (Water Quality) Regulations 2000 all show a figure of 250 mg/l sulphate as a guide upper limit for drinking water. The limit is not set not because this is a potentially harmful limit but because it could affect the taste of the water.

All of the analysis above has assumed that:

- S can leach at the same rate as nitrate which it can not.
- All of the S applied to land in the form of the black liquor is soluble and there is no resistance to leaching when there must be.
- The lignosulphate does not bind with the soils organic matter when it must.
- There is no crop uptake and there must be in practice.

The present environmental legislation does not include any specific limitations to sulphur application or its impact on the environment or provide policy advice or action programmes to control sulphur additions to surface or ground waters. The only indirect reference to sulphur application is stated in the RB 209 "Fertiliser Recommendations" which state that applications should be linked to crop requirement.

The environmental impact of spreading the liquor in a catchment would be very small for 2 reasons:

- firstly due to the huge dilution effect of the addition of the black liquor over a very large area of land
- secondly due to the remote possibility of spreading similar wastes containing a high sulphur content within a catchment.

11. CONCLUSIONS

11.1 A literature search with specific reference to the application of Alhstrom type liquors, "Kraft black liquor" and sodium lignosulphonates to agricultural land yielded few experimental papers or reports of direct relevance. Consequently, the report has been based on existing data from various reports commissioned by Alhstrom, or appraised from current literature.

11.2 The analysis of the liquor shows it to contain significant quantities of potassium, sulphur, and sodium. The total amount of the nutrients applied from an application of 30 m^3/ha is 93 kg/ha of potash, 197 kg/ha of S (493 kg/ha SO_3) and 495 kg/ha of sodium.

11.3 The majority of sulphur present is water soluble in the form of a complex molecule lignosulphonate. These are stable compounds and have been used as soil conditioners to promote soil aggregation.

11.4 The leaching of sulphate was of primary concern by the Environment Agency. These concerns are unproven as the risk of pollution resulting from sulphate leaching is relatively small. This is because the sulphur is present in the form of stable lignosulphonate molecules which will be organically bound to the soil.

11.5 The sulphate leaching was modelled in order to satisfy the Environment Agency's concerns. The model was based on worst case scenario in that all of the sulphur was in a soluble form and available for leaching. The calculations show that based on this precautionary analysis that only small concentrations of SO_4-S could be present in the drainage waters and would not pose a significant risk to the environment.

11.6 Based on the analysis of pollution risk from leaching of sulphur compounds in this report, the current application rate of up to **30 m^3/ha** will have little or no adverse impact on the soil and pose a negligible risk to the environment. The beneficial effects of the application of Ahlstrom black liquor on crop growth have been proven in earlier experimental work, from the provision of Professionally Qualified Advice and from operational experience.