Diageo St. Francis Abbey Brewery Kilkenny

Industrial Emissions Licence Surrender

CRAMP Report

REP/1

Issue 4 | 16 October 2014

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 229808-00

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Contents

Figures

Appendices

1 Background

This is Issue 4 of the Diageo St. Francis Abbey Brewery CRAMP Report.

This report has been updated to take account of recent progress and incorporate the final Appendix E, Detailed Site Assessment (dated 6 August 2014) and Appendix B, Post Closure Monitoring Plan (dated 21 August 2014).

2 Introduction

2.1 Site Description

The St. Francis Abbey Brewery is located on the lands of the former Franciscan Friary in Kilkenny City. The brewery is operated by Diageo Global Supply. Diageo intend to centralise beer production in Ireland at new facilities in St James Gate, Dublin and as a result intends to close the St. Francis Abbey Brewery,

The plant was scheduled to close on 31 December 2013; however, the brewery was required to complete contingency brewing to assist with ramping up of the brewing operations in Dublin. The plant formally ceased production activities on 12 May 2014. Following the cessation operations at the site have been solely confined to decommissioning of plant and utilities equipment. Full decommissioning of the brewery plant was completed in early August 2014. It was necessary that the on-site effluent treatment plant was kept operational during the main decommissioning works in order to treat the resulting wash down waste waters prior to discharge to the sewer.

The St Francis Abbey Brewery site is bordered to the east by the River Nore, to the west by The Ring (road), to the north by Green Street and to the south by John's Bridge (road). The approximately 5.3 hectare site is split into a northern and southern section by the River Breagagh, which flows in an easterly direction and enters the River Nore south of Green's Bridge.

The southern section of the site comprised the main production areas, including the raw materials intake and storage areas, the production buildings and the tanker loading area. The northern section of the site was previously utilised for vehicle parking and keg staging, as well as tanker washing and truck maintenance. This area of site is now disused.

Lands within the 'Orchard Area' located in the northern section of the site are now within the possession and control of Kilkenny County Council in accordance with a Compulsory Purchase Order (CPO) for the construction of the Kilkenny Central Access Scheme. A Technical Amendment has been made to the IE licence in order to amend the licence boundary in this area of the site. Figure 1, Site Location Plan shows the site location, the amended Industrial Emissions licence boundary and the CPO lands.

The site is located within an area of archaeological potential for Kilkenny City and also located within the City Centre and St. Canice's Architectural Conservation Areas (ACAs). There are a number of Protected Structures and National Monuments located on site as follows:

- The protected structure now used as Engineering offices/ a laboratory, heritage centre and the cellar bar.
- St Francis Abbey.
- Evans Tower and Town Wall.
- The site of a St Francis holy well and the site of a tower. These monuments, if still present, are below ground and no longer visible.

This report has been prepared in line with the requirements stated in the EPA *Guidance on assessment and costing environmental liabilitie*s, 2014.

2.2 Activities

The brewing industry on site began in the early 1700's when John Smithwick established a facility on the lands of the former Franciscan Friary.

In 1956, a public share offer was taken up by Arthur Guinness & Son, giving the Dublin Brewery an interest in the company. In 1964, the Smithwick family sold the remaining shareholding to Guinness and in 1965 the brewery was integrated into the Irish Ale Breweries Group, which was controlled jointly by Guinness and by Allied Breweries.

Following a buy-out of Allied Breweries in 1987, the brewery became a full member of the Guinness Group. In 1996, the name of the brewery was changed from E. Smithwick & Sons to St. Francis Abbey Brewery. In 1997, the brewery, along with its sister companies in the Guinness Group, became part of the Diageo Group.

The brewery's output consisted of ale products up to 1986, when the company commenced brewing Budweiser lager beer. The growth in popularity of this brand over the years has resulted in Budweiser accounting for approximately 85% of the output of the Brewery.

In 2010, kegging activities at the site ceased and all product produced at the site was tankered to other breweries within the Diageo Group for packaging. Brewing operations ceased at the site on 12 May 2014.

2.3 Licence/Permit Details

The Environmental Protection Agency (the Agency) issued E. Smithwick & Sons Limited t/a St. Francis Abbey Brewery at Parliament Street, Kilkenny with an Integrated Pollution Prevention and Control licence in January 2000, licence Register Number P0448-01. The Agency made a Section 82A (11) amendment to the licence in December 2013 to bring it into compliance with the Industrial Emissions Directive. The licence is now Industrial Emissions (IE) licence, Register No. P0448-01 from the EPA.

The site also operates a Greenhouse Gas Permit, Permit Number E-GHG027 – 103561 from the EPA. Diageo will apply for the surrender of that permit in January 2015.

2.4 Closure Scenarios

The St Francis Abbey Brewery has now ceased brewing activities. The site is being sold to Kilkenny County Council for future re-development.

Diageo intend to retain the protected structure now used as Engineering offices/ a laboratory, heritage centre and the cellar bar. This building has been renovated into a Diageo Visitor Centre under approved planning permission from Kilkenny Borough Council. The Visitor Centre opened on 31 July 2014.

As part of the sale of the site, a number of redundant buildings on site will be demolished in order to facilitate the future development of the site. These demolition works will be carried out post IE Licence Surrender under approved planning permission from Kilkenny Borough Council. Kilkenny Borough Council Planning Grant of Planning Register Number's 13/43, 13/44 and 13/45 condition these demolition works. Kilkenny County Council will maintain environmental regulation of the site and the works during the demolition works.

Options for advanced demolition of isolated areas of the site, namely the garage to the North of the River Breagagh will be considered by Diageo, to facilitate the requirements of Kilkenny County Council.

The Closure scenario for the site is clean closure. This clean closure comprises the decontamination and decommissioning of all plant and equipment on site, followed by disposal of associated chemicals and surplus raw materials. Equipment on site will not be removed as part of the site closure plan.

There is a hard standing cover in place across the surface of the site. This hard standing will not be impacted by decommissioning activities and will remain in place at IE Licence surrender.

The closure plan will provide for the following:

- Efficient close down and decommissioning of operations.
- Efficient consumption of raw materials/ consumables in the months prior to closure.
- Return of unused raw materials / consumables materials to original suppliers / alternative Diageo sites where practicable.
- Disposal of waste unsuitable for re-use to authorised and approved waste facilities using appropriately licensed contractors.
- Documentation of the close-down and decommissioning activities and disposal of material and wastes.
- Securing of the buildings on site during the post-closure period, prior to handover of the site to Kilkenny County Council.

A team of Diageo personnel has been established and is in place to manage and implement the close-down and decommissioning activities.

2.5 Site Zoning

The relevant local authority planning policies and objectives for this site are set out in the Kilkenny City and Environs Development Plan 2014-2020, which came

into effect on the 13 June 2014. The site is zoned for "Industrial/Warehousing" uses in the current development plan.

The zoning objective of the site has changed to "General Business" use as outlined in Kilkenny City and Environs Development Plan 2014 – 2020.

2.6 The Requirement for Aftercare

Following completion of the closure plan and submission of the Independent Closure Audit to the EPA, the Agency will be in a position to facilitate the surrender of IE Licence Register No. P0448-01. The independent closure audit was undertaken on the site on 10 September 2014. A draft of the Independent Closure Audit report was submitted to the Agency on 26 September 2014.

It is envisaged that the aftercare management plan for the site will consist of security and maintenance of the site, prior to handover of the site to Kilkenny County Council.

Aftercare requirements arising as a result of any required restoration / remediation activities can be added to the Aftercare Management Plan.

A post closure monitoring plan proposal for the River Breagagh is discussed in Section 3.2.

3 Site Evaluation

3.1 Operator Performance

During 2012, the site recorded two non-compliant events in relation to exceedences of quarterly effluent emission limit values for chloride.

In 2013, a non-compliant noise reading was recorded at the site, during the site environmental noise monitoring survey. All non-compliant events have been addressed to the satisfaction of the Agency.

3.2 Incident History

3.2.1 Background

A legacy spillage of PCB oil from a transformer on site occurred in 1980. Approximately 500 litres of PCB oil was released, resulting in contamination of the River Breagagh. In excess of 96% of the spilled material was recovered during the subsequent clean-up operation. In 2001, a further remediation project was undertaken. This included excavation of over 4,000 tonnes of soil from the bed of the River Breagagh and the installation of boreholes to monitor groundwater and soil. An overview of the River Breagagh Remediation project is included in Appendix A. This summary provides information on the works undertaken and control measures put in place.

These remediation works were carried out to the satisfaction of the Agency.

3.2.2 Remediation Project Annual Monitoring

A monitoring programme of the River Breagagh was commenced upon completion of the remediation works. This monitoring programme documents the results of tests on (i) fish tissue, (ii) biological water quality and (iii) riverbed sediment.

The findings of the 2013 monitoring programme for each of these tests is summarised below:

- Fish survey – PCB levels within fresh water fish (trout and salmon) were found to be within the relevant EU Food Safety limits for all samples. A single result for one sample of eels was found to exceed the EU maximum value for sum of non-dioxin like PCBs. The result for sum of dioxin-like PCBs in the same sample was found to be within the EU maximum value.
- Biological Water quality – Biological water quality at the Brewery Yard monitoring location is showing no evidence of contamination. This is consistent with previous monitoring. There is no difference in water quality between upstream river locations and the remediated zone or the river confluence.
- Biota Survey – A biological water quality range of Q3-Q5 was reported at all survey locations in 2013. The results of the invertebrate sampling indicate that the overall water quality in the River Breagagh remains largely unchanged since the last survey in 2012.
- Sediment survey – All results were below the laboratory limit of detection for PCBs which is far below the best practice guideline limit, showing no PCB contamination of the river bed sediment sampled. This is consistent with previous monitoring completed at the site.

The 2013 monitoring was found to be largely consistent with previous years monitoring programmes.

Fish survey samples from the remediated zone within the Breagagh continue to demonstrate higher PCB levels than upstream control samples. Comparison of the fish survey results is not always possible, due to the low sample size, size class differences and absence of information on residency time within the Breagagh, however results obtained through monitoring programmes to date has predominantly indicated a high level of compliance with legislative limits and best practice guidance.

A single eels sample at the Brewery Yard reported a slightly elevated level of PCB compared to a relevant EU legislative limit. The result is within the uncertainty of measurement and within the lower level of confidence; the result would fall within the EU limit.

PCBs have not been detected in the sediment at the Brewery Yard location, or any of the other survey locations. This is the most representative indication that the liner present in the remediated zone is functioning as designed. Results of the biota survey also indicated that there has been no recent contamination event in the area.

3.2.3 Riverbank PCB Soil Contamination

During recent site investigation works undertaken prior to closure of the facility, PCB contamination was detected in soil located on the river bank. Presently, works are being completed to remove this PCB contaminated soil in accordance with the method statement agreed by the Agency and Kilkenny County Council's environment department. This area of contaminated soil is outside the IE license boundary. In accordance with the agreed method statement, the excavated soil is being stored temporarily in an existing building on the Diageo site and soil samples have been taken for environmental testing. Appropriate disposal of the soils will be undertaken as soon as the laboratory test results have been obtained and the soil classified for disposal. The waste contractors have been approved by the Agency.

On completion of the full works, a validation report will be submitted to the Agency for approval.

3.2.4 Post Closure Monitoring

A post closure monitoring plan has been prepared setting out proposed monitoring of the site for a period of 5 years to assess temporal changes in PCB levels. This plan is contained in Appendix B. The Agency has advised Diageo that following licence surrender, environmental requirements, monitoring or other, will be within the environmental enforcement remit of Kilkenny County Council. Diageo will continue to comply with the current monitoring requirements in accordance the IE licence up until the licence is surrendered.

3.3 Environmental pathways and sensitivity

The site enforcement category and location enforcement category are A3 and 16 respectively.

The site is located adjacent to the River Nore which is designated as part of the following Natura 2000 sites:

- River Barrow and River Nore SAC
- River Nore SPA

The potential environmental pathways have been described in the Preliminary Site Assessment and Detailed Site Assessment referenced in Section 6 of this report.

3.4 Site processes and activities

The St. Francis Abbey Brewery produced a range of beers including Budweiser, Budweiser Light, Smithwicks Pale Ale and Smithwicks.

Beer produced on site was previously packaged into kegs, however kegging operations at the site ceased in 2010. More recently all product produced at the site was transferred by road tanker to the Diageo St. James's Gate Brewery for kegging, or to other Diageo sites for packaging.

3.4.1 Production process flow

The main production related operations that took place at the site were:

- Raw material intake and storage (cereal, hops, sugar, yeast and water).
- Brewing processes (milling, brewing, worts production).
- Fermentation/maturation processes (yeast handling, fermentation, maturation, chilling, carbon dioxide recovery).
- Filtration (beer gravity adjustment, filtration, carbon dioxide adjustment).
- Tanker filling for transport to other sites for packaging.

Figure 2 presents a Site Layout, highlighting the location of these production areas.

The process flow schematics for the production of beer at the site are presented in three stages in Appendix C as follows:

1. Raw Material Intake
2. Fermentation Operations to Storage
3. Filtering Operations to Tankering

The production process that took place at the site is broadly described below.

Malted barley and rice from the raw material intake storage silos was milled to crush the grain into grist. The grist was mixed with hot water in the mash vessels in the brewhouse to convert the starches into sugars. It was then filtered in the Lautertun with the solids being retained and the liquid (wort) was drained off and passed onto the kettle where it was boiled and various hops and sugars were added. The solids taken off during the Lautertun process were exported as spent grain and the liquid towards the end of the process which is too weak to continue was sent to the weak worts tanks. Weak worts were disposed off-site.

The wort was then passed through a wort stripper and aeration unit which removed unwanted aromas from the beer and increased the oxygen levels. Once this is complete the wort was cooled and sent to the fermentation vessels (in the fermentation block) where yeast was added and fermentation took place over a period of 5 days. From here, it was transferred to a maturation vessel, woodchips were added and it remained in the vessel for fourteen days. The 'green beer' was passed through a centrifuge, cooled and returned to a further storage/maturation vessel in the maturation/ storage area.

The beer was then chilled, filtered and sent to the bright beer tanks (BBT area) until it was transported off site in tankers.

In addition to the production activities at the site, there are a range of ancillary/service activities that took take place on site. All of the below listed activities have now been decommissioned, except for the effluent treatment plant which is now ready to be decommissioned, subject to the EPA approval:

- Boiler plant (for steam generation)
- Chemicals storage (for cleaning and sterilising)

- Cleaning-in-Place (CIP)
- CO2 recovery and storage
- Compressed air
- Effluent treatment (pH balancing)
- Laboratory activities
- Refrigeration
- Water treatment
- Maintenance and workshop activities
- Site offices and Visitor centre

The staff canteen on site has been closed and decommissioned.

3.5 Surface and Effluent Management

The site comprises a mixture of systems most of which are older and 'combined' (mixture of rainwater, process/ sanitary effluent) with some limited lengths of pipework exclusively for the conveyance of surface water run-off. These systems arose from the expansions of brewing facilities on site when older drainage systems were combined with newer systems.

The main drainage systems at the site include the following, as presented in Figure 3 Site Drainage.

- Process effluent system
- Sanitary drainage system
- Surface water drainage

Process effluent generated at the site, as a result of decommissioning activities has now fully ceased.

All process effluent, which comprised predominantly effluent generated from CIP (clean in place) operations on site was collected in an underground drainage pipework network and collection sump prior to treatment in the effluent pH balancing tank. Following pH balancing, effluent was discharged to the public sewer system located at Market Yard in the south-east section of the site.

Surface water from the site is discharged either to the River Nore, the River Breagagh or via the effluent system to the public sewer system. Rainwater from the brew house building roof and surface water drainage from the yard area used for car parking, and the garage area to the north of the River Breagagh is discharged to the River Breagagh through Class 1 oil interceptors. Rainwater from the roof of the bottling hall/kegging plant, together with overflow from the St. Francis Well discharges into the River Nore. Surface water from production areas onsite is combined with the process effluent and released to the public sewer.

Domestic sanitary effluent from the majority of the buildings on site is also discharged to this sewerage system via the effluent balancing tank. Domestic

effluent from the Mayfair Building is connected to an existing town (public) sewer traversing the northern part of the site.

In the early 2000's, Diageo carried out extensive and comprehensive investigations of the integrity of the drainage networks on site and as a result of a multi-million programme of rationalisation and remediation of the effluent network was completed. These works were carried out in two phases. The result has been a vast improvement in the integrity of the underground drainage network of pipes and manholes, etc.

The drainage network will be left in place and will for the majority of the site continue to discharge surface water to the public sewer, the River Breagagh and River Nore as currently configured.

Works associated with the recent Diageo Visitor Centre building renovations (renovation of the protected structure now used as Engineering offices/ a laboratory, heritage centre and the cellar bar) included drainage modifications in order to connect a new combined drain (storm water / sanitary waste) to the existing local authority combined sewer adjacent to the site. These works have been completed and the Visitor Centre drainage has been isolated from the main body of the site in preparation for future site handover to Kilkenny County Council.

3.6 Emissions and Wastes

The emissions and wastes previously produced on site are described below. The location of emission points are identified in Figure 4 Site Emission Points.

3.6.1 Licensed Emissions to Sewer

The emission point for licensed emissions to sewer from site is SEP001. This is the final effluent discharge release from site to the public sewer.

Process effluent production at the site has now fully ceased as the decommissioning activities at the site have been completed .

Effluent discharge to the public sewer throughout the decommissioning phase comprised routine cleaning and wash down of tanks. The pH balancing tank remained in operation until all decommissioning of plant and equipment was completed in order to ensure compliance with IE Licence conditions. It is now proposed to decommission the pH balancing tanks, with Agency approval.

3.6.2 Licensed Emissions to Surface Water

The emission points for licensed emissions to surface water from site include:

- Emission points SWP001, SWP002, SWP003 and SWP004 - These emission points comprise rainwater runoff from the roof of the Kegging Plant and Bottling Hall. These emission points discharge to the River Nore.
- Emission point SWP005 – This emission point comprises surface water runoff from the brew house and the car park area on site to the south of the River Breagagh. This emission point passes through a Class 1 oil interceptor prior to discharge into the River Breagagh.

- Emission points SWP006 and SWP007 - This emission point comprises surface water runoff from the garage area located to the North of the River Breagagh. Surface water emissions passes through Class 1 oil interceptors at SWP006 and SWP007 prior to discharge into the River Breagagh.

  Surface water emissions from the site will continue into the post closure phase, but will only comprise rainwater runoff from buildings and paved areas on site.

  Surface water from the Diageo Visitor Centre building runoff has been isolated from the main body of the site and has been connected to the existing local authority combined sewer adjacent to the site.

3.6.3 Licensed emissions to atmosphere

The emission points for licensed emissions to atmosphere arise from the two gas boilers on site and from total particulate monitoring in the raw material intake area of the site. These emission points on site comprise of:

NOx and CO emissions

- Emission Point A2-1 – Boiler 1
- Emission Point A2-1 – Boiler 2

Total Particulate Emissions

- Emission Point A2-1 – Malt intake dust intake
- Emission points A2-3 – Malt intake dust cyclone
- Emission point A2-2 – Mill Room dust filtration (Malt milling)
- Emission Point A2-4 – Rice silo dust filtration (Rice milling)

Dust and particulates air emissions have ceased on site as of production completion on 12 May 2014. The two boilers on site were decommissioned throughout May and June 2014.

3.6.4 Disposal of non-hazardous wastes

The following non-hazardous waste streams, as shown in Table 3.1 were produced at the site. Non-hazardous waste produced during the site closure were disposed to approved waste contractors, as illustrated in the table below.

Table 3.1 Non-Hazardous Wastes

Waste Type	EWC	Disposal Method	Destination
Mixed municipal waste	20 03 01	Disposal – D1	Greenstar, Dublin
Mixed packaging	15 01 06	Recovery – R4	Greenstar, Dublin
Glass	20 01 02	Recovery – R5	Greenstar, Dublin
Timber pallets	15 01 03	Recovery – R5	Greenstar, Dublin
Kitchen & canteen waste	20 01 08	Recovery – R10	Greenstar, Dublin
Mixed metals	17 04 07	Recovery – R4	Greenstar, Dublin

Waste Type	EWC	Disposal Method	Destination
Brewers grain	02 07 04	Recovery – R10	KWFS - Feed
Wastewater screenings	02 07 05	Recovery – R3	Molaisin Composting, Waterford
Kieselguhr (filter powder)	02 07 04	Recovery – R3	Ormonde Organics – Waterford
Weak worts	02 07 04	Recovery – R3	KWFS - Feed
Feed beer	02 07 04	Recovery – R3	KWFS - Feed
Surplus Yeast	02 07 04	Recovery – R3	KWFS - Feed
Grain dust	02 07 04	Recovery – R3	KWFS - Feed

3.6.5 Disposal of hazardous wastes

The following hazardous waste streams, as shown in Table 3.2 were produced at the site. Hazardous waste produced during the site closure was disposed of using approved waste contractors, as illustrated in the table below.

Table 3.2 Hazardous Wastes

Waste Type	EWC	Disposal Method	Destination
Waste oils	13 05 07*	Recovery R9	ENVA Ireland Ltd.
Contaminated waste oil materials	15 02 02*	Recovery R9	ENVA Ireland Ltd.,
Oil & ammonia	15 01 10*	Disposal D10	Indaver – AVG, Hamburg
Batteries	16 06 01* 16 06 02* 16 06 04*	Recovery R4	Rilta Environmental
Fluorescent tubes	20 01 21*	Recovery - R4	Irish Lamps Recycling
Laboratory waste	16 05 04* 16 05 06* 14 06 03*	Disposal – D10 Disposal – D15 Disposal – D10	Indaver – AVG, Hamburg
CIP chemicals	06 01 04* 06 02 04*	Disposal – D10 Disposal – D10	Indaver – AVG, Hamburg
Ink cartridges	08 03 13* 08 03 18*	Recovery - R4 Recovery - R4	Hewlett-Packard France and Germany
Lubricants	13 03 10*	Disposal – D10	Indaver – NV, Belgium
WEEE	20 01 35*	Recovery R4	Irish Lamps Recycling

3.7 Bund Integrity

Bunded areas on site are inspected and tested in accordance with the site bund integrity testing programme. The location of bunded structures on site is indicated in Figure 5 Site Bunded Structures.

The last bund integrity testing programme was completed at the site in 2012/ 2013. All bunded structures passed this integrity testing programme in compliance with the requirements of the then IPPC Licence.

Two former bunded areas located in the Garage Area of site, to the North of the River Breagagh, namely Bund Area 9 and Bund Area 10 were decommissioned and partially demolished in 2009/ 2010. These works were carried out to facilitate the removal of diesel storage tanks in this area. Bund Area 9 was not tested during the previous 2003 bund integrity testing programme, while Bund Area 10 failed the integrity testing at this time.

All tanks within bunded structures were decommissioned during the decommissioning works on site. Tanks will be removed from site and the associated bunds will be demolished during the subsequent demolition works contract on site, post IE Licence surrender.

3.8 Inventory of buildings plant and equipment

An inventory of plant and equipment on site has been compiled by Diageo. This has been utilised to develop the master checklist of plant and equipment to be decommissioned. Information on this checklist is provided in Section 4.1.2.

3.9 Inventory of raw materials, products and wastes

Diageo have prepared an inventory of raw materials, products and wastes on site at the time of developing the closure plan. These inventories are provided below. The majority of these raw materials were utilised in the final brews completed on site and operating ancillary utility systems prior to site closure. All residual raw materials was transported to the Diageo licenced facility at St. James' Gate in Dublin for re-use, or if unsuitable for re-use was disposed by an approved waste contractor.

Table 3.3 Raw Materials on Site

Raw Material	Unit	Maximum Capacity
Bud malt	Tonnes	350,000
Ale malt	Tonnes	100,000
Rice	Kilograms	150,000
Barley	Tonnes	50
Roast barley	Tonnes	50
Sugar	Litres	55,000
Hops	Kilograms	80,000
Tetrahop10	Litres	140
Bi-carbonate of soda	Kilograms	230
Granular salt	Tonnes	2.45

Raw Material	Unit	Maximum Capacity
Gypsum	Kilograms	4,200
Orthophosphoric acid food grade	Litres	70
Sulphuric acid	Tonnes	13
Bioglucanase	Kilograms	175
Whirlfloc finnings	Kilograms	100
Sodium hypochlorite (water treatment)	Litres	1,000
Biofine P19 Isinglass Finings	Kilograms	90
Britesorb	Kilograms	3,771
Ammonium sulphate	Kilograms	100
AMG 300	Kilograms	100
Caustic soda liquor	Kilograms	8,850
HAB 2	Kilograms	216
Beechwood mini chips	Kilograms	380

3.10 Maximum storage capacity for raw materials, products and wastes

Wastes were stored within the bunded Material Store/ Waste Store identified in Figure 2. Adequate bunding is in place to ensure that wastes were suitably stored prior to shipment off site. Waste shipments were frequent during the decommissioning phase in order to minimise waste storage requirements.

4 Closure Tasks and Programme

4.1 Brewery Decommissioning

The objectives of the closure plan are to:

- Provide for the efficient close-down and decommissioning of the operations.
- Return unused raw materials and consumable materials to the original suppliers where practicable / alternative Diageo sites where practicable.
- Disposal of waste to authorised and approved waste facilities using appropriately licensed contractors.
- Documentation of the close-down and decommissioning activities and disposal of material and wastes.

The close-down and decommissioning activities were carried out in a manner that minimised the impact on the environment. The achievement of these objectives set and the fulfilment of the criteria for successful closure set out in Section 5 defined the successful completion of the Closure Plan.

The individual stages are:

1. Cessation of brewing operations on site.
2. Plant and equipment decommissioning.
3. Cleaning of bunds, sumps and interceptors.
4. Decommissioning of utilities and site services.
5. Removal of waste off site.
6. Decommissioning of on-site effluent balancing systems.
7. Documentation and Certification of decommissioning.

4.1.1 Cessation of Brewing Operations

The stock of raw materials / consumables stored on site has been wound down in line with the planned closure of the site.

Residual materials and consumables have been transferred to St. James's Gate in Dublin or returned to the supplier where practicable. All other residual materials were collected for disposal off site.

All catering and canteen supplies have been removed from site. Waste materials, including waste oils, have been disposed of or recovered off site in accordance with the IE licence. All cooking equipment containing cooking oils were drained/emptied.

4.1.2 Plant and Equipment Decommissioning

The production plant and equipment have been decontaminated and decommissioned in line with the sequence of production on site. The sequence of decommissioning is provided in Figure 6.

All items of production plant requiring decontamination and decommissioning have been recorded on a master checklist. This checklist will be completed and signed off once all the equipment has been cleaned down. A copy of the checklist is provided in Appendix D.

The checklist contains the following items:

- List of plant and equipment items, and ancillary equipment.
- List of checks to be carried out (e.g. empty/drain, vent, clean, close off, isolate).
- Wastes to be disposed and disposal routes.
- Authorisation signature when specific decommissioning activities have been completed.

The specific steps required for decommissioning of plant and equipment have been listed and scheduled in sequence in the master programme. The production plant and equipment was emptied, cleared, drained, vented and isolated, as required by the checklists.

Cleaning down of production equipment, including tanker loading equipment, is a frequent and routine operation on site specified in the Diageo ISO 9001 management system manual and standard operating procedures. The CIP (Clean in place) process on site was used to clean down production equipment. This did not generate significant additional waste.

Decommissioning activities which have taken place at the facility to date have been recorded on this checklist included in Appendix D.

4.1.3 Cleaning of bunds, sumps and interceptors

A suitably approved and licensed contractor was responsible for cleaning down of all bunds, sumps and interceptors on site. All resulting wastewaters were collected and disposed off-site at an appropriate facility.

The surface water and effluent drains were washed down following all cleaning, dismantling and equipment isolation activities to ensure there are no residues of Diageo operations remaining in the site drainage network.

4.1.4 Utility and Site Services Decommissioning

A similar decommissioning exercise was completed for Utilities Plant and Equipment. This plant and equipment was divided into the following operations and areas:

- Boiler House
- Laboratory
- Medical Department
- Chemicals Storage & Distribution
- Cleaning-in-Place (CIP) System/Centre
- Refrigeration Systems
- CO2 Recovery System
- Compressed Air & Gas Systems
- Diesel Storage
- Effluent Treatment (pH Balancing)
- Water Treatment System
- Electrical Transformers
- Workshop & Maintenance Areas
- Fire Suppression Systems

As with the production plant and equipment, the utilities plant and equipment were emptied, cleared, drained and vented as required by the checklists. A copy of the checklist is provided in Appendix D. All service materials were removed by specialist contractors and taken off site for recovery/reuse or disposal.

All chemicals within the chemical storage areas, storage vessels and bunded areas have been run down as production operations wound down. Surplus chemicals were returned to the suppliers, where practicable. Waste chemicals arising from the wind-down of production activities were sent for recovery/disposal. Chemical holding vessels and distribution pipelines were flushed through and drained.

The CIP systems were drained to the Effluent Neutralisation Plant following final cleaning of the process equipment. Surplus CIP chemicals were disposed of offsite, or sent to St. James Gate for re-use.

Specialist contractors were employed to depressurise the CO2 recovery system and compressed air and gas (N2) systems. These systems were vented to atmosphere in line with best practice. Compressors were drained of oil and the oil was disposed to an approved waste contactor.

The fuelling area for the forklift trucks, consisting of a double skin diesel tank and fuel dispenser, has been decommissioned. Following the cessation of all site vehicle activities, the tank was drained and the lines were cleaned.

The electrical transformers on site were drained of oil and the oil was disposed to an approved waste contractor.

The plant refrigeration systems were drained down and vented by a specialist contractor, in accordance with the site's ISO 9001 standard operating procedures. The refrigerants (ammonia and IMS /water) were disposed off-site in line with IE Licence conditions to an appropriate waste contractor.

The water treatment system will be drained and surplus treatment materials will be transferred to other Diageo sites or disposed of as waste.

The natural gas supply was isolated and the pipelines and burners were vented.

Fire suppression gases were removed from the systems and suitably disposed to an approved waste contractor.

4.1.5 Removal of Waste Off Site

Wastes were removed off site to approved waste contactors in line with the requirements of the site's IE Licence.

High strength/low volume brewing residual waste streams from the final brewing operations were recovered by an approved land spreading/bio filtration at authorised facilities.

Any remaining laboratory chemicals and supplies were returned to the supplier or disposed as waste. The three radiation sources associated with the gas chromatograph in the gas chromatograph laboratory were returned to the supplier in accordance with the site's Radiological Protection Institute of Ireland (RPII) licence.

All materials from the active workshops were disposed. Compressed gases cylinders were returned to the suppliers. Site vehicles, including forklift trucks, currently on lease were also returned to the suppliers.

4.1.6 Decommissioning of the Effluent Balancing Plant

The effluent balancing plant has been maintained throughout the decommissioning process to treat the remaining effluent from decommissioning activities, and surface water from the production areas of the site. Full decommissioning of the brewery plant has been completed, and the effluent balancing plant can now be closed down and decommissioned. The plant will be drained and flushed to the public sewer.

The chemical storage and addition systems at the plant will be drained down and cleaned as described in line with the decommissioning checklists. Residual materials in the plant will be disposed of offsite.

4.1.7 Documentation and Certification of Decommissioning

Decommissioning activities included inspection of each area and records of previous decommissioning activities. Where an unused area was decommissioned previously (namely the Garage, Kegging Plant and Keg Maintenance Area), the area was inspected to confirm its status and associated drainage pipework was cleaned.

Following completion of all decommissioning activities, the decommissioning checklist will be signed off and verified as complete, with all appropriate supporting documentation and wastes disposal certificates filed.

4.2 Demolition

4.2.1 Buildings to be Demolished on Site

As part of the sale of the site to Kilkenny County Council, Diageo will be carrying out demolition of a number of non-protected redundant buildings on site. These selected buildings will be demolished to ground slab level, leaving a concrete hard standing ground slab finish on site.

Demolition works will be carried out in compliance with the conditions of approved planning permissions obtained from Kilkenny Borough Council, as described in Section 2.4. Kilkenny County Council will be responsible for regulatory environmental control for the duration of these works.

4.2.2 Buildings to be Retained on Site

The following buildings will be retained on site for future use by Kilkenny County Council.

- St. Francis Abbey and adjacent Sample Room
- Evan's Tower
- Mayfair building
- Hopstore and Squash buildings
- Brew house building

- Maturation building – with maturation tanks removed.

Diageo will retain the protected structure and associated drainage works currently used as engineering offices, a laboratory, heritage centre and the cellar bar. Diageo have developed this building into a Visitor Centre under approved planning permission from Kilkenny Borough Council.

4.2.3 Asbestos Containing Materials

Refurbishment/demolition (formerly Type 3) asbestos surveys were completed at St. Francis Abbey Brewery in August 2013 and December 2013. A number of buildings at the brewery have asbestos containing materials (ACMs) present.

The asbestos surveys identified the following ACM's within the plant as shown in Table 4.1 below.

Table 4.1 Asbestos Containing Material at St. Francis Abbey Brewery

Asbestos Containing Material	Location
Cement Sheeting	Vicar Street Car Park Building
Cement Sheeting	Transport Garage Roof
Floor Tiles & Adhesive / Sink Pad / Linoleum	Transport Garage Area 1F
Loose Millboard Gasket	Transport Garage Area Boiler House
Galbestos	Keg Hall Roof / Side Sheeting/ Internal Sheeting
Floor Tiles & Adhesive / Linoleum / Cement Board	Keg Hall Offices
Galbestos	Racking Plant Roof / Side Sheeting
Galbestos	Main Store Side Sheeting
Floor Tiles & Adhesive	Main Store Bottling Hall Office
Floor Tiles & Adhesive	Overhead Passage Way
Rope seals	Fermentation Block Roof Lights
Gasket	Oil Storage Area (Flange)
Corrugated asbestos cement roof sheeting	Mayfair building
Floor Tiles & Adhesive	Mayfair building (rear hallway)
Asbestos rope	Mayfair building (safe in the store)
Asbestos fibre gaskets	Brewhouse
Galbestos	Brewhouse (Hot service tanks area)
Asbestos fibre gaskets	Boilerhouse
Rope seals	Boilerhouse (Room off engine room)
Asbestos fibre gaskets	Maturation
Asbestos fibre gaskets	Main Store
Asbestos rope gaskets	Main Store

The decontamination and decommissioning activities to take place as part of the plant closure on site for the purpose of IE Licence Surrender did not interfere with the identified Asbestos Containing Materials.

The licensed removal and disposal of this material will be completed post IE Licence surrender during the demolition works.

The demolition contractor has been appointed and the Demolition Contract documents states that '*Hazardous material such as asbestos, shall be handled only by competent persons and in accordance with the relevant Regulations. The removal of asbestos should be in accordance with BS 5970: 2001 and Section 6.12 and 31.3 and Safety, Health and Welfare at Work (Exposure to Asbestos) Regulations 2006 SI 386 of 2006. The removal of asbestos based material must be carried out by a licensed Asbestos Removal Contractor (licensed by the Health and Safety Authority) under the supervision of the Demolition Contractor. Detailed records of the waste produced, reused and recycled shall be maintained by the contractor. All waste transfer documentation should be retained on site and included in the Health and Safety file'*.

These works will take place under approved planning permission from Kilkenny Borough Council.

4.3 Raw Materials, Products and Waste Disposal / Recovery

All chemicals within the chemical storage areas, storage vessels and bunded areas were returned to suppliers or transferred to the Diageo's St. James Gate site where practicable.

The CIP systems were drained to the effluent balancing plant following final cleaning of the process tanks on site.

All waste materials generated at the site during the close-down and decommissioning phases, other than the high strength/low volume brewing waste streams, were stored in designated areas of the site and bunded and protected against leaks or damage as appropriate.

The waste was disposed of from the site in accordance with the conditions of the licence and National and European Waste legislation.

All waste collected from the site was recorded, including the type, quantity and disposal route, in particular the final destination.

4.4 Programme

The revised Plant and Equipment Decommissioning Programme and the Utilities decommissioning programme is attached in Appendix E.

Full decommissioning of the brewery plant was completed in early August 2014.

5 Criteria for Successful Closure

The successful closure of the facility (in the context of IE licensing compliance) will be achieved following implementation and completion of the Closure Plan, and achievement and demonstration of clean closure.

The Closure Plan has been prepared in the context of the site history, including the past and current activities, and the site's location. Successful closure of the site will have been achieved when it can be demonstrated that the Closure Plan has been fully implemented, as appropriate to the closure scenario. This will require that the following criteria were met:

- All production plant and equipment and utility systems area are safely decontaminated as per Diageo specified ISO 9001, ISO18001 and ISO 14001 standard procedures.
- All wastes have been handled, packaged, stored and disposed in accordance with IE licence requirements.
- Records relating to the disposal / recovery of wastes are retained throughout the closure process.
- Records relating to raw materials transferred off site for reuse are retained throughout the closure process.
- Records relating to check lists used during the decommissioning of the production and utility plant and equipment are retained throughout the closure process.
- All conditions of the IE licence are complied with during the closure process.
- Any restoration and remediation activities that may be required on the site were carried out.

6 Aftercare

In line with EPA "*Guidance on the Management of Contaminated Land and Groundwater at EPA Licensed Sites*" 2013, a Preliminary Site Assessment and Detailed Site Assessment have been completed at the site. These assessments are described below.

6.1 Preliminary Site Assessment

Preliminary Site Assessment, Issue 2 is attached in Appendix F. This report has been updated in line with Agency comments.

6.2 Detailed Site Assessment

The Detailed Site Assessment, Issue 3 report is attached in Appendix G. This report has been updated in line with Agency comments.

A risk based approach has been adopted for the assessment of analytical data collected from the Phase 1, Phase 2, Phase 3 and Phase 4 site investigations completed at the St Francis Abbey Brewery in September 2013, December 2013, March 2014 and June 2014. The results of these intrusive investigations coupled with the results of biannual groundwater monitoring completed at the site have been discussed in the Detailed Site Assessment report.

6.3 Summary and Conclusion

Upon cessation of the activity, closure of the site and application for IE Licence Surrender the SFAB site will continue to be covered in a layer of hard standing. This is the end site status for the purpose of the Closure Restoration and Aftercare Management Plan Report and IE Licence Surrender.

The detailed site assessment has evaluated the site indicating that contaminants of potential concern on site will be removed during the decommissioning works and natural attenuation of the groundwater on site is expected. No source – pathway – receptor pollutant linkage exists as there is no viable pathway to soils, groundwaters or other potential receptors.

Site users will not be directly exposed to soils and no negative impact to the environment, health of site occupants or surrounding site residents will result from the site.

No additional remediation measures are proposed and normal building control and protection measures should apply to the development of this brownfield site.

7 CRAMP Validation

7.1 Environmental monitoring

Following completion of the closure plan and decommissioning activities on site, the following environmental monitoring were completed.

1. Groundwater Monitoring
2. Surface Water Monitoring at licensed emission points.

This monitoring was evaluated in the Independent Closure Audit.

7.2 Independent Closure Audit.

Following the completion of decommissioning activities at the site, a draft Independent Closure Audit was submitted to the Agency on the 26 September

2014. The scope of the independent closure audit as agreed with the Agency was to review:

- The Closure Restoration and Aftercare Management Plan which incorporated:
  - The Waste Inventory/Register listing all wastes arising onsite, including a description of the waste, EWC Codes, tonnages, permit details of hauliers, permit/licence details of final destinations and all relevant documents,
  - Details of all underground structures including tanks, pipelines and sumps and their integrity testing history,
  - Verification that all plant, equipment, tanks, bunds, sumps has been fully emptied, and cleaned, and that contents have been removed appropriately.
  - An assessment of the potential for soil/groundwater contamination. The assessment included a Source/Pathway/Receptor assessment together with a Conceptual Site Model.
  - Consideration of health & safety issues during decommissioning and site security.
- Where there is potential for asbestos to be present, that an appropriately certified independent contractor has been identified and appointed and has reported on the full identification, management and if required safe removal of this asbestos.
- Proposals for any revised sampling, analysis and reporting arrangements, for agreement with the Agency.

The Independent Closure Audit Report documented the findings of the audit. The report was completed in accordance with all relevant Agency guidance and included a declaration as to whether or not the 'condition of the site is not causing or likely to cause environmental pollution and the site of the activity is in a satisfactory state'.

8 IE Licence Surrender

The Licence Surrender Application for the then IPPC Licence Register Number P0448-01 was submitted to the Agency on 16 August 2013. This report forms part of this surrender application.

Figures

A1

Area shown hatched subject of granted TA

CPO for Central Access Scheme

Military

KILKENNY

Legend:
- IE Boundary
- Central Access Scheme CPO

R3	10/10/14	SB	OH	NOS
R2	15/05/14	GMcT	VB	NOS
R1	14/11/13	GMcT	VB	NOS
Report Issue				
Issue	Date	By	Chkd	Appd

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Arup, 50 Ringsend Road
Dublin 4
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www.arup.ie

Client
Diageo

Job Title
CRAMP Report
IE P0448-01

Figure: 1
Site Location Plan

Scale at A1 1:1250 (1:2500 @ A3)
Discipline Consulting
Job No **229808-00**
Drawing Status **Report**
Drawing No **N1001**
Issue **R3**

Do not scale

R3	10/10/14	SB	OH	NOS
R2	15/05/14	GMcT	VB	NOS
R1	14/11/13	GMcT	VB	NOS
Report Issue				
Issue	Date	By	Chkd	Appd

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Client
Diageo

Job Title
CRAMP Report
IE P0448-01

Figure: 2
Site Layout

Scale at A1 1:500 (1:1000 @ A3)
Discipline Consulting
Job No **229808-00**
Drawing Status **Report**
Drawing No **N1002**
Issue **R3**

Do not scale

N

LEGEND:

- Effluent Manhole that has been refurbished or reconstructed
- Foul Manhole that has been refurbished or reconstructed
- Surface Water Manhole that has been refurbished or reconstructed
- Manhole that has been lined
- Newly constructed manhole
- Deleted or Redundant manhole
- New Stainless Steel Sump
- New Stainless Steel Gully
- New Stainless Steel Channel & Sump Box
- New Aco Channel & Sump Collection Box
- Relined Pipe
- New Section of Pipeline
- Redundant or Deleted Pipeline
- New Containment bund
- An Area that has been retiled
- An Area that has been reconcreted
- An Area that has been repaired with resin flooring
- Effluent By Pass Hatchbox 4
- Effluent Line
- Foul Line
- Surface Water Line
- Drains with a backfall
- IE Boundary
- Stationary point

R3	10/10/14	SB	OH	NOS
R2	15/05/14	GMcT	VB	NOS
R1	14/11/13	GMcT	VB	NOS

Report Issue

Issue	Date	By	Chkd	Appd

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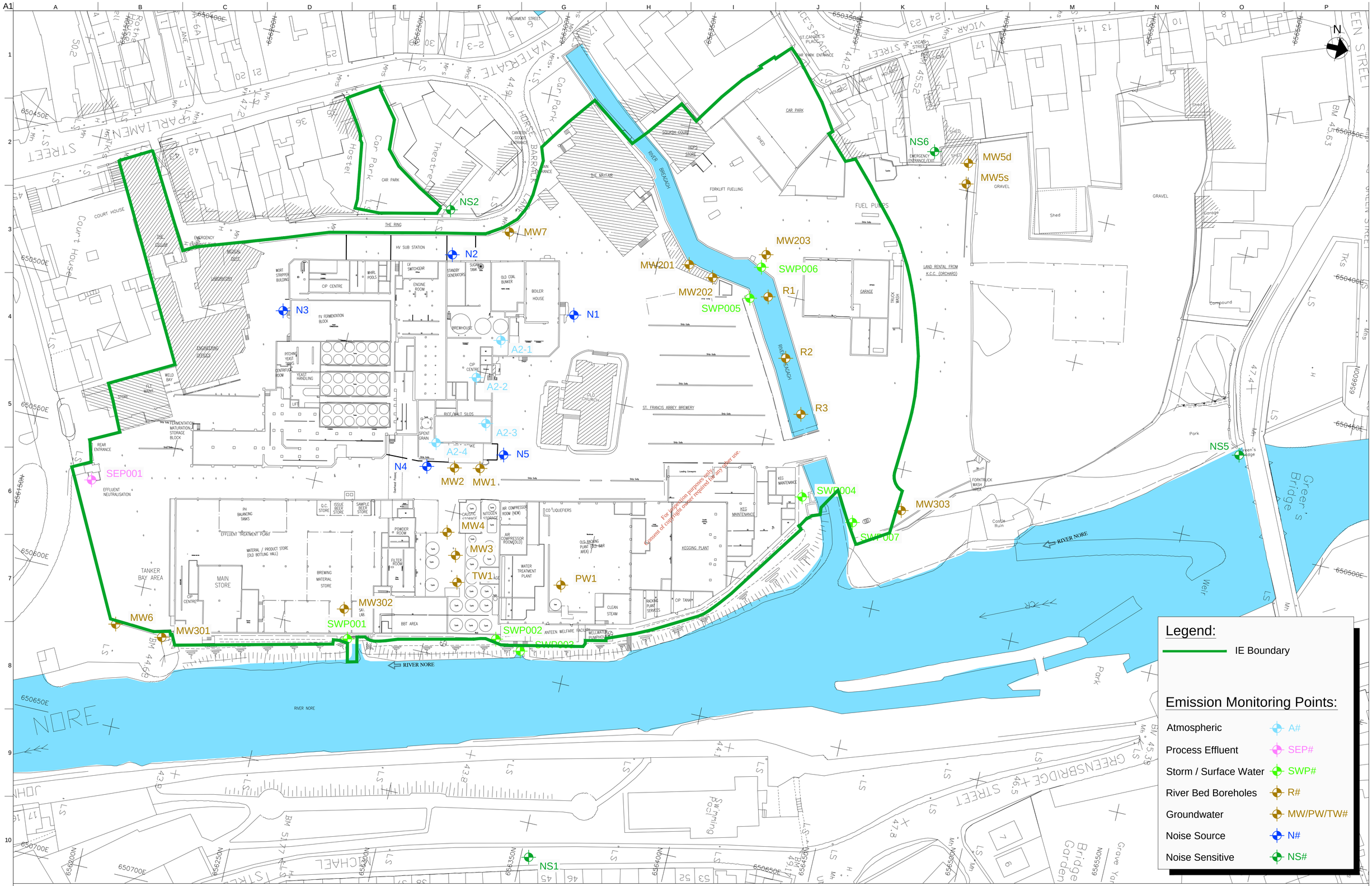
Client
Diageo

Job Title
CRAMP Report
IE P0448-01

Figure: 3
Existing Drainage

Scale at A1 1:500 (1:1000 @ A3)
Discipline Consulting
Job No **229808-00**
Drawing Status **Report**
Drawing No **N1003**
Issue **R3**

Do not scale



Legend:

- IE Boundary

Emission Monitoring Points:

Atmospheric	A#
Process Effluent	SEP#
Storm / Surface Water	SWP#
River Bed Boreholes	R#
Groundwater	MW/PW/TW#
Noise Source	N#
Noise Sensitive	NS#

R3	10/10/14	SB	OH	NOS
R2	15/05/14	GMcT	VB	NOS
R1	14/11/13	GMcT	VB	NOS

Report Issue

Issue	Date	By	Chkd	Appd

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Client
Diageo

Job Title
CRAMP Report
IE P0448-01

Figure: 4
Licenced Emission Monitoring Points

Scale at A1: NTS
Discipline: Consulting
Job No: 229808-00
Drawing Status: Report
Drawing No: N1003
Issue: R3

A1

N

ST.CANICE'S PLACE
CAR PARK ENTRANCE
VICAR STREET
HOUSE
HOUSE
HOUSE
HOUSE
SHED
CAR PARK
SQUASH COURT
HOPS STORE
SHED
CANTEEN GOODS ENTRANCE
MAIN ENTRANCE
THE MAYFAIR
RIVER BREAGAGH
FORKLIFT FUELLING
EMERGENCY ENTRANCE/EXIT
SHED
Shed
GRAVEL
Shed
GRAVEL
FUEL PUMPS
COURT HOUSE
THE CELLAR
EMERGENCY ENTRANCE
MEDICAL DEPT.
LABORATORY
THE RING
HV SUB STATION
WORT STRIPPER BUILDING
CIP CENTRE
LV SWITCHGEAR
STANDBY GENERATORS
SUGAR TANK
OLD COAL BUNKER
BOILER HOUSE
ENGINE ROOM
FV FERMENTATION BLOCK
BREWHOUSE
CIP CENTRE
PITCHING YEAST TANKS
CENTRIFUGE ROOM
YEAST HANDLING
LIFT
ENGINEERING OFFICES
WELD BAY
FLT. MAINT.
STORE
OLD CHURCH
ST. FRANCIS ABBEY BREWERY
MALT SILOS
SPENT GRAIN
MALT INTAKE
GARAGE
TRUCK WASH
LAND RENTAL FROM K.C.C. (ORCHARD)
RIVER BREAGAGH
FERMENTATION MATURATION STORAGE BLOCK
REAR ENTRANCE
EFFLUENT NEUTRALISATION
Overhead Passageway
Loading Conveyors
KEG MAINTENANCE
KEG MAINTENANCE
FORKTRUCK WASH AREA
Park
Castle Ruin
RIVER NORE
O.C. STORE
ISSUE BEER STORE
SAMPLE BEER STORE
PH BALANCING TANKS
EFFLUENT TREATMENT PLANT
MATERIAL / PRODUCT STORE (OLD BOTTLING HALL)
POWDER ROOM
FILTER ROOM
NITOGEN STORAGE
CO2 COMPRESSOR ROOM (NEW)
AIR COMPRESSOR ROOM(OLD)
CO2 LIQUEFIERS
OLD RACKING PLANT (OLD BAR AREA)
KEGGING PLANT
WATER TREATMENT PLANT
TANKER BAY AREA
MAIN STORE
WASTE/CHEMICAL STORAGE AREA
BREWING MATERIAL STORE
CIP CENTRE
SAT. LAB.
BBT AREA
CLEAN STEAM
RACKING PLANT SERVICES
CIP TANK
SPRINKLER PUMPHOUSE
OLD CANTEEN WELFARE FACILITY
WELLWATER PUMPHOUSE
RIVER NORE
RIVER NORE

Legend:
IE Boundary

R4	10/10/14	SB	OH	NOS
R3	15/05/14	GMcT	VB	NOS
R2	14/02/14	GMcT	VB	NOS
R1	14/11/13	GMcT	VB	NOS

Report Issue

Issue	Date	By	Chkd	Appd

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Client: Diageo

Job Title: CRAMP Report
IE P0448-01

Figure: 5
Bunded Structures On Site

Scale at A1: 1:500 (1:1000 @ A3)
Discipline: Consulting
Job No: **229808-00**
Drawing Status: **Report**
Drawing No: **N1005**
Issue: **R4**

Do not scale

A1

Legend:

IE Boundary

1. Raw Materials
2. Brewhouse
3. fermentation
4. Yeast Management
5. Beer Re-processing
6. Maturation & Storage
7. Filtration
8. Bright Beer
9. Tanker Station
10. Lab

R3	10/10/14	SB	OH	NOS
R2	15/05/14	GMcT	VB	NOS
R1	14/11/13	GMcT	VB	NOS

Report Issue

Issue	Date	By	Chkd	Appd

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Client: Diageo

Job Title: CRAMP Report
IE P0448-01

Figure: 6
Decommissioning Sequence

Scale at A1: 1:500 (1:1000 @ A3)
Discipline: Consulting
Job No: **229808-00**
Drawing Status: **Report**
Drawing No: **N1006**
Issue: **R3**

Do not scale

Appendix A

River Breagagh Remediation Project – Project Overview

A1 River Breagagh Remediation Project – Project Overview

Please see River Breagagh Remediation Project – Project Overview overleaf.

P0448-01 River Breagagh Remediation Project

Project Overview

Diageo Kilkenny
PCB Surveys
IE0310690-22-RP-0005, Issue: A

Issue date: 16 May 2014

Document Sign Off

P0448-01 River Breagagh Remediation Project
Project Overview

Diageo Kilkenny
PCB Surveys
IE0310690-22-RP-0005, Issue A

File No: IE0310690.22.150

CURRENT ISSUE					
Issue No: A	Date: 16/05/2014	Reason for issue: For Information			
Sign Off	Originator	Checker	Reviewer	Approver	Customer Approval (if required)
Print Name	Eileen Lee		Tim O'Shea	Eileen Lee	
Signature			**Authorised Electronically**		
Date	15/05/2014		16/05/2014	16/05/2014	

PREVIOUS ISSUES							
Issue No	Date	Originator	Checker	Reviewer	Approver	Customer	Reason for issue

Contents

1 Executive Summary

The River Breagagh Remediation Project, which was carried out in June – September 2001, was completed in compliance with the agreed criteria.

Over 4,000 tonnes of material was excavated and sent off-site for recycling in a registered facility.

Civil and archaeological constraints were imposed on the excavation works by the requirement to preserve the medieval city walls which formed one bank of the River Breagagh.

Residual contamination which could not be removed due to these constraints has been isolated by a barrier. Due to the presence of residual contamination, on-going monitoring has been carried out as outlined below:

- monitoring of the local groundwater
- monitoring of the river water
- fish monitoring within the Breagagh and Nore
- sediment monitoring within the Breagagh and Nore
- biota monitoring with the remediated zone.

2 Glossary of Terms

Chainage:	Unit of measurement (in metres) along the centreline of the river. Chainage 0 represents the confluence of the River Breagagh with the Nore. Chainage 150 represents the upstream extent of the excavation works.
PCB	Polychlorinated Bi-phenyl
ΣPCB7 dry weight	Denotes the sum of the seven marker PCBs dry weight. In a sample containing PCBs, there are often several dozens of different congeners. For practical reasons, all of them are not always measured, but the most important congeners are used as indicators. The PCB congeners used were 28, 52, 101, 118, 153, 138 and 180 as recommended in the Dutch Guidelines on Intervention Values for Soil Remediation (Dutch Ministry of Housing, Spatial Planning and Environment 1994)
OPW Bed Levels	River Breagagh bed levels required to meet Flood Relief Scheme requirements

3 Introduction

3.1 Background

The contamination, which was the subject of the River Breagagh remediation works, originally occurred on 12 June 1980 when an electrical transformer was breached while being moved across the brewery yard at St. Francis Abbey, Kilkenny. The dielectric contents of approximately 500 litres of Arochlor PCB1260, leaked onto the yard, from where it was washed, in error, into a surface water drain which drained into the River Breagagh. At the time of the incident, a clean-up plan was initiated and it was estimated that more than 95% of the PCB-contaminated material was recovered and incinerated in the United Kingdom.

Subsequent to the pollution incident, and unrelated, Kilkenny County Council commissioned the Office of Public Works (OPW) to prepare a plan to modify the River Nore and the River Breagagh to reduce the risk of flooding which had been experienced in parts of the city. The flood management plan was designed to cater for a 100-year flood and would leave the level of the bed of the River Nore lower than the bed of the River Breagagh. This could have led to scouring of the bed of the Breagagh and potential carryover of contaminated material into the River Nore.

It was therefore required that the contaminated area in the Breagagh be remediated and that the excavated riverbed material be disposed of in a controlled manner prior to the implementation of the works for the flood management project.

3.2 River Breagagh Remediation Project

The project was carried out in accordance with the River Breagagh Remediation Plan as outlined in the following documents, which were submitted to the EPA and all appropriate statutory bodies:

- River Breagagh Remediation Plan, 25/8/00 (original submission which included a risk assessment)
- Additional Information for the River Breagagh, 15 December 2000 (revisions and updates to original submission)
- Method Statement for the River Breagagh Remediation Plan, 31 May 2001

The consultees included:

- Kilkenny County Council
- Kilkenny Corporation
- Dúchas, the Heritage Service
- Office of Public Works (OPW)
- Southern Regional Fisheries Board
- Fisheries Research Centre
- South Eastern Health Board

The scope of work involved:

a) Further assessments to establish the full extent of the contamination

b) Removal of contaminated riverbed materials to meet the clean-up criteria of <0.1mg/kg ΣPCB_7 dry weight as far as possible and practical

c) Installation of a membrane to isolate residual contamination which could not be removed due to the condition of the medieval wall

d) Excavation and re-instatement of the riverbed to OPW bed level requirements (for Kilkenny flood management plan).

The on-site works for the River Breagagh Remediation Project started in June 2001 and finished in October 2001. Consultation with interested parties continued throughout the project as appropriate.

4 Methodology for Delineating the Extent of Contamination

4.1 Introduction

As part of the pre-works for the project, a number of surveys were carried out to determine the level of PCB contamination in the River Breagagh. The results from these surveys indicated that:

- The highest levels of contamination were in the upper section of the river, chainage 145 – 90, i.e. just downstream of the source of the spill. Excavation in this area was restricted by the medieval wall and therefore a membrane was proposed to isolate any residual contamination in this area which could not be removed.
- A number of high banks, which had built up in the river over the years, contained high levels of contamination. It was not anticipated that complete excavation of these banks would pose a problem.

- Lower levels of contamination were present from chainage 90 – 65, i.e. on-site bridge, and the levels decreased with distance from the source of the spill. As a precaution it was proposed to extend the membrane from the site of the spillage to the on-site bridge.
- There were low levels of contamination below the on-site bridge. It was anticipated that all contamination could be removed in this area.

Through discussions with the EPA it was agreed that the Dutch standard for soil protection would be the most appropriate standard to adopt for this project. A target remediation level of 0.1mg/kg ΣPCB_7 dry weight was agreed with the EPA. This applied to those areas where it could be safely achieved without the risk of damage to, or collapse of, the medieval wall.

The agreed sampling criteria to be used to define the extent of excavation were as follows:

- <0.1 mg/kg at 0.5m and 1m depths, no further excavation required for decontamination purposes
- >0.1 mg/kg at 0.5m depth, further excavation required
- >0.1 mg/kg at 1.0m depth, re-assay using 1mg/kg as detection level
- >1 mg/kg at 1.0m depth, laboratory confirmation of actual contamination level required.

All depths were relative to the required OPW bed level.

The locations of the samples taken and the analysis results were identified according to the chainage along the River Breagagh. The chainage begins at the confluence with the Nore, chainage 0, and ends at the upstream limit of the works, chainage 150.

Based on the results of previous surveys and excavation limitations, the river was broken into the following sections:

a) between the site of the spillage and the on-site bridge (termed upstream of the on-site bridge), chainage 150 – 65,

b) under the on-site bridge, chainage 65 - 55,

c) downstream of the on-site bridge to the confluence, chainage 55 – 0 and the cofferdam in the Nore

These three sections and the chainages are shown in Figure 1.

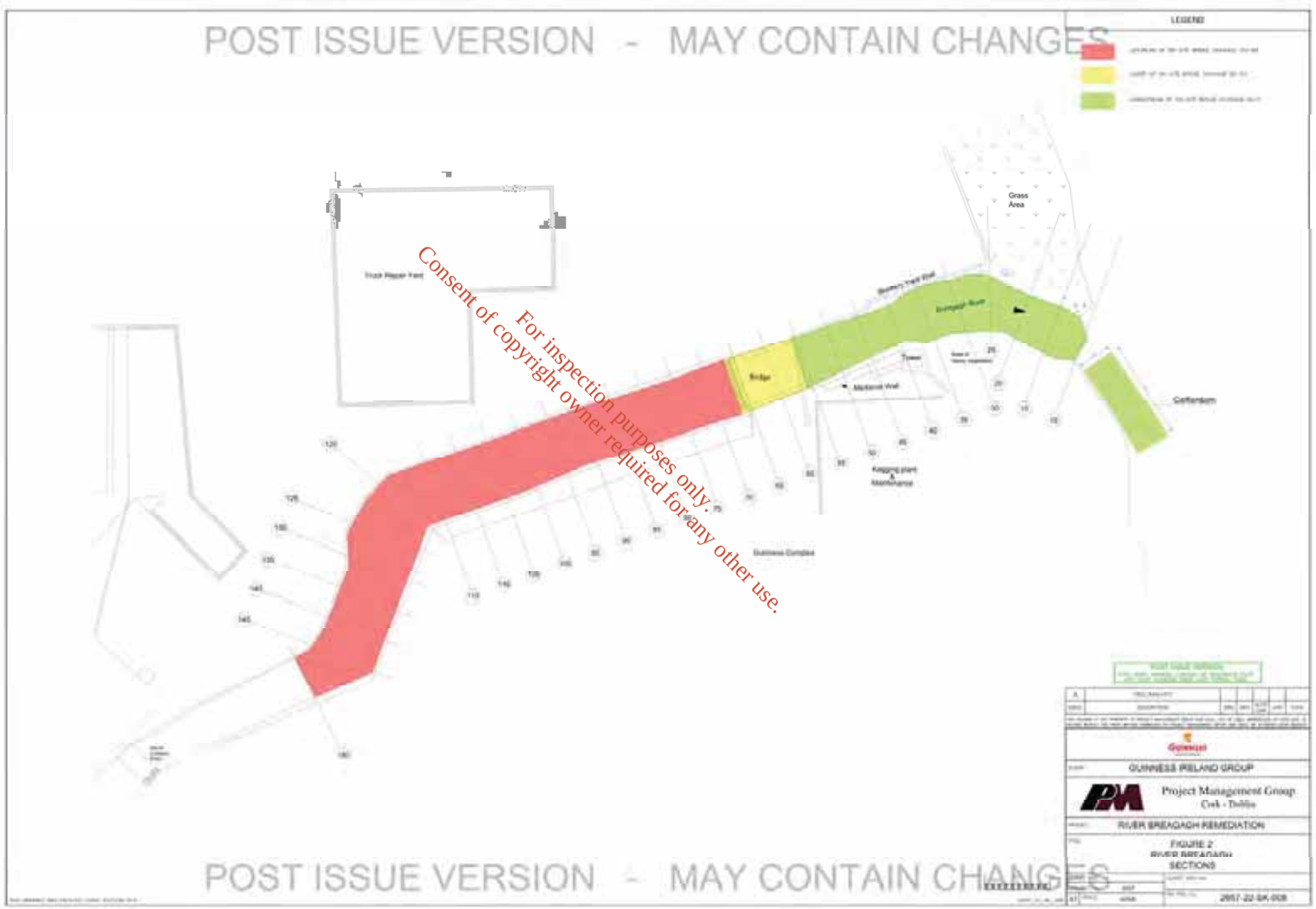


Figure 1: River Breagagh Sections

A typical cross section for the excavation in the area from chainage 150 - 65 is shown in Figure 2. Support was provided for the walls in the form of a concrete beam or backfill as required.

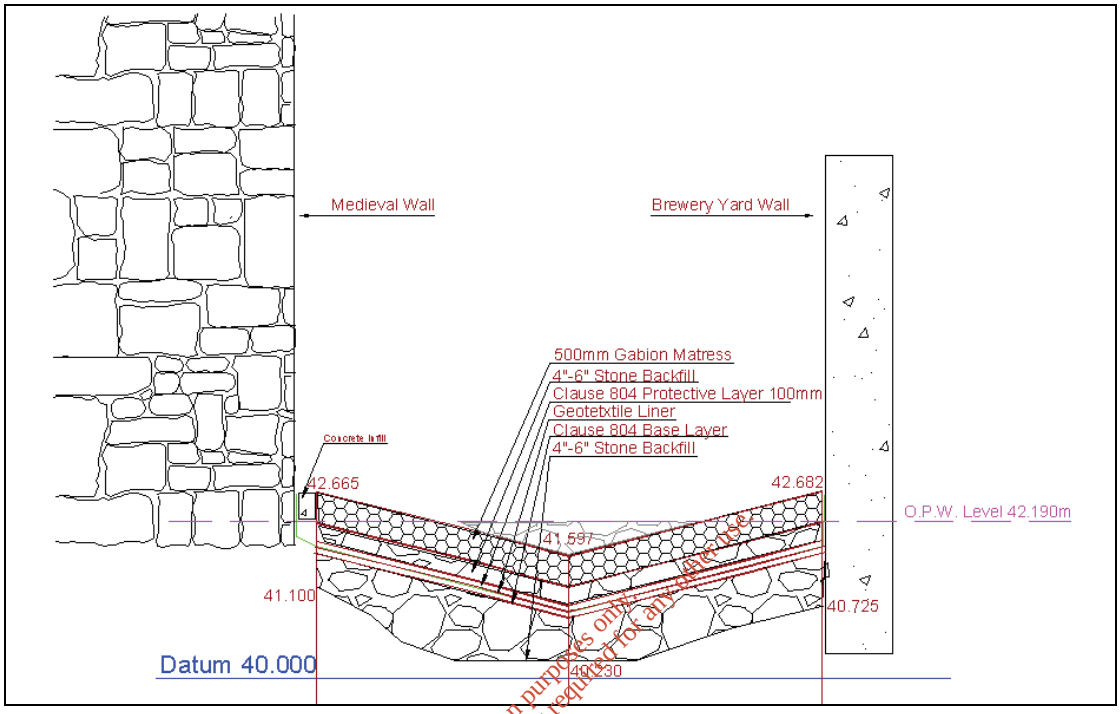


Figure 2: Typical Cross Section for Excavation Upstream of the On-site Bridge, Chainage 150 - 65

A typical cross section for the excavation in the area from chainage 55 - 0 is shown, in Figure 3.

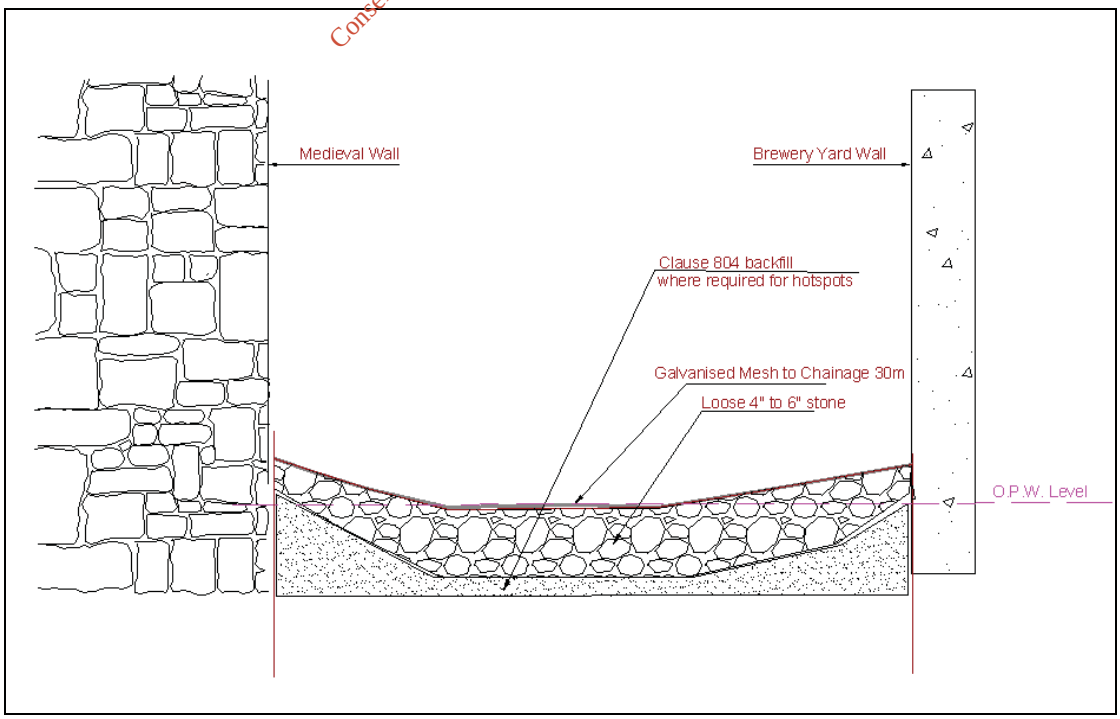


Figure 3: Typical Cross Section for Excavation Downstream of the On-site Bridge, Chainage 55 – 0

It was apparent from all excavations that the riverbed was generally formed of sand and gravel grade material with localised areas which included clasts up to cobble size. Trial pits indicated a highly plastic, organic rich silty clay horizon at shallow depth. The gravels and sands were loose at shallow depth, becoming denser with depth. The gravels /sands excavated very easily even at depth.

5 Validation

5.1 Introduction

The remediation project was successfully completed to the defined criteria as certified by validation results outlined below.

All on-site assay sampling and off-site laboratory analysis were carried out by independent bodies, KT Cullen for on-site assays and Alcontrol Geochem for laboratory analysis.

5.2 Upstream of the On-site Bridge, chainage 150 - 65

Upstream of the Brewery Bridge, sampling was undertaken at the deepest extent of the excavations. At 5m chainage intervals, three samples were taken across the width of the river, i.e. adjacent to the medieval wall, mid-river and adjacent to the north wall. The results are summarised in **Table 1**.

Table 1: Results from Analysis at the Deepest Extent of Excavation – Upstream of On–Site Bridge

Chainage (m)	Old Wall		Centre		North Wall	
	Depth (m) Note 1	(mg/kg)	Depth (m) Note 1	(mg/kg)	Depth (m) Note 1	(mg/kg)
145	2.03	52.170	1.86	15.837	1.6	0.620
140	1.57	56.908	1.96	1.437	1.96	0.438
135	2.11	21.423	1.86	358.876	1.65	0.729
130	0.875	2.394	1.01	0.470	1.20	1.035
125	1.00	14.560	1.00	3.307	1.00	0.141
120	1.00	5.386	1.00	4.412	1.00	8.670
115	1.10	1.357	1.00	0.166	1.15	3.418
110	0.80	0.845	1.43	0.782	1.00	3.141
105	1.00	40.093	2.00	0.326	1.00	0.532
100	0.80	4.700	1.00	0.351	1.00	5.670
95	0.80	2.912	1.00	0.809	1.00	0.670
90	0.80	74.859	1.00	3.700	1.00	0.160
85	0.80	1.207	1.00	0.361	1.00	6.732
80	0.80	0.101	1.00	1.042	1.00	0.098
75	0.80	1.900	1.00	0.749	1.00	0.246
70	0.80	1.058	1.00	0.877	1.00	0.034

Chainage (m)	Old Wall		Centre		North Wall	
	Depth (m) Note 1	(mg/kg)	Depth (m) Note 1	(mg/kg)	Depth (m) Note 1	(mg/kg)
65	1.00	0.253	1.20	0.104	1.00	1.370
60			1.00	0.021		

Notes:

1. Depths are relative to re-instated bed level.

All of the residual contamination which could not be accessed due to the location of the medieval wall has been isolated by the installation of the membrane barrier.

5.3 Under the On-Site Bridge, chainage 65 - 55

The depth of excavation under the bridge was 0.5m. There was no contamination detected at this depth and therefore no validation sampling was required.

5.4 Downstream of the Bridge to the Confluence, chainage 55 - 0

The results of the analyses downstream of the on-site bridge to the confluence are summarised in Table 2. These are a combination of the lab results from the initial survey and confirmatory assays at the furthest extent of excavation. The locations of the boreholes and the extent of dig are shown in Figure 4.

Table 2: Results from Analysis at Final Dig Levels – Downstream of On-Site Bridge

Bore Hole	Depth (m) (Note 1)	Result (mg/kg) (Note 2)	Lab Analysis or Site Assay	Depth of Dig/Comment
1	2	<0.001	Lab Analysis	2m
	3	<0.001	Lab Analysis	
1a	2	<0.1	Site Assay	Extent of dig sample
1b	2	<0.1	Site Assay	Extent of dig sample
2	1	<0.001	Lab Analysis	0.6m
	2	<0.001	Lab Analysis	
	3	<0.001	Lab Analysis	
3	1	<0.001	Lab Analysis	0.6m
	2	<0.001	Lab Analysis	
	3	<0.001	Lab Analysis	
25 Located between BH3 and 4	2	<0.1	Site Assay	2m
4	4	<0.001	Lab Analysis	4m
26 (Located between BH4 and 5	2	<0.1	Site Assay	Extent of dig sample
5	1	0.017	Lab Analysis	1m
	2	<0.001	Lab Analysis	
	3	<0.001	Lab Analysis	
6	1	<0.001	Lab Analysis	0.6m
	2	<0.001	Lab Analysis	
	3	<0.001	Lab Analysis	

Bore Hole	Depth (m) (Note 1)	Result (mg/kg) (Note 2)	Lab Analysis or Site Assay	Depth of Dig/Comment
7	2	<0.001	Lab Analysis	Extent of dig sample
	2.4	<0.001	Lab Analysis	
8	1	<0.001	Lab Analysis	1 – 2m
	2	<0.001	Lab Analysis	
9	2	<0.001	Lab Analysis	2m
10	3.3	<0.1	Site Assay	Extent of dig sample
	4	<0.1	Site Assay	
11	3	<0.001	Lab Analysis	3.3m
12	3	<0.001	Lab Analysis	3.3m
13	3.3	<0.1	Site Assay	Extent of dig sample
	4	<0.1	Site Assay	
13a	3	<0.1	Site Assay	<3.3m
13b	1	<0.1	Site Assay	Confirmatory analysis only,
	2	<0.1	Site Assay	no dig required
	3	<0.1	Site Assay	
14	0.4-0.6	0.034	Lab Analysis	0.6m
24 Located between BH14 and 15	1	<0.1	Site Assay	2m
	2	<1.0	Site Assay	No result at 0.1 mg/kg due to crack in test-tube during field analysis
15	2	<0.1	Site Assay	Extent of dig sample
23 Located to south of BH15	0.5	<0.1	Site Assay	1-2m
22 Located between BH15 and 16	1.6	<0.1	Site Assay	2m
16	0.4-0.6	0.076	Lab Analysis	0.6m
17	1	<0.1	Site Assay	1m
17a	1	<0.1	Site Assay	Extent of dig sample
17b	1	<0.1	Site Assay	Extent of dig sample
18	0.4-0.6	0.01	Lab Analysis	0.6m
19	0.4-0.9	0.046	Lab Analysis	0.6m
20	1	<0.1	Site Assay	Extent of dig sample
21 (Note 3)	2	<0.1	Site Assay (From April 2001 survey)	2m
	3	<0.1	Site Assay (From April 2001 survey)	

Note:

1. All depths are relative to required OPW bed level.
2. All lab analyses results are mg/kg ΣPCB_7 dry weight. All assays results indicate whether or not the PCB concentration exceeds the specific detection level noted.
3. This is same location as one of the boreholes in April 2001 survey

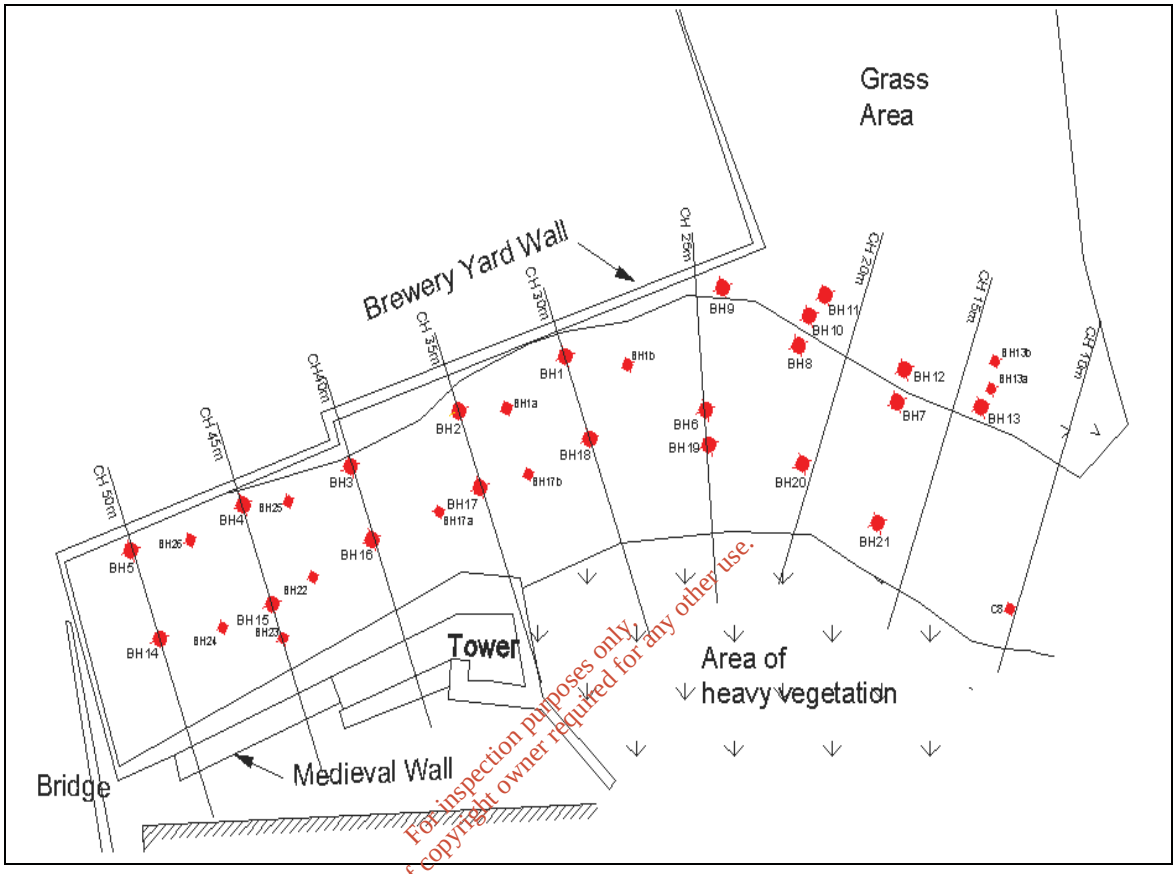


Figure 4: Borehole Locations Downstream of the On-site Bridge, Chainage 55 - 0, Validation Sampling

The results of the analyses at the depth of excavation in the cofferdam are summarised in Table 3. The locations of the boreholes are shown in Figure 5.

Table 3: Results of Assay Sampling at Final Dig Depth in the Cofferdam at the Confluence

Location	A	B	C	D	E	F	G	H
Sample Depth (m)	3	3	3.3	3.3	3.3	3.3	3	3
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Site Test	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

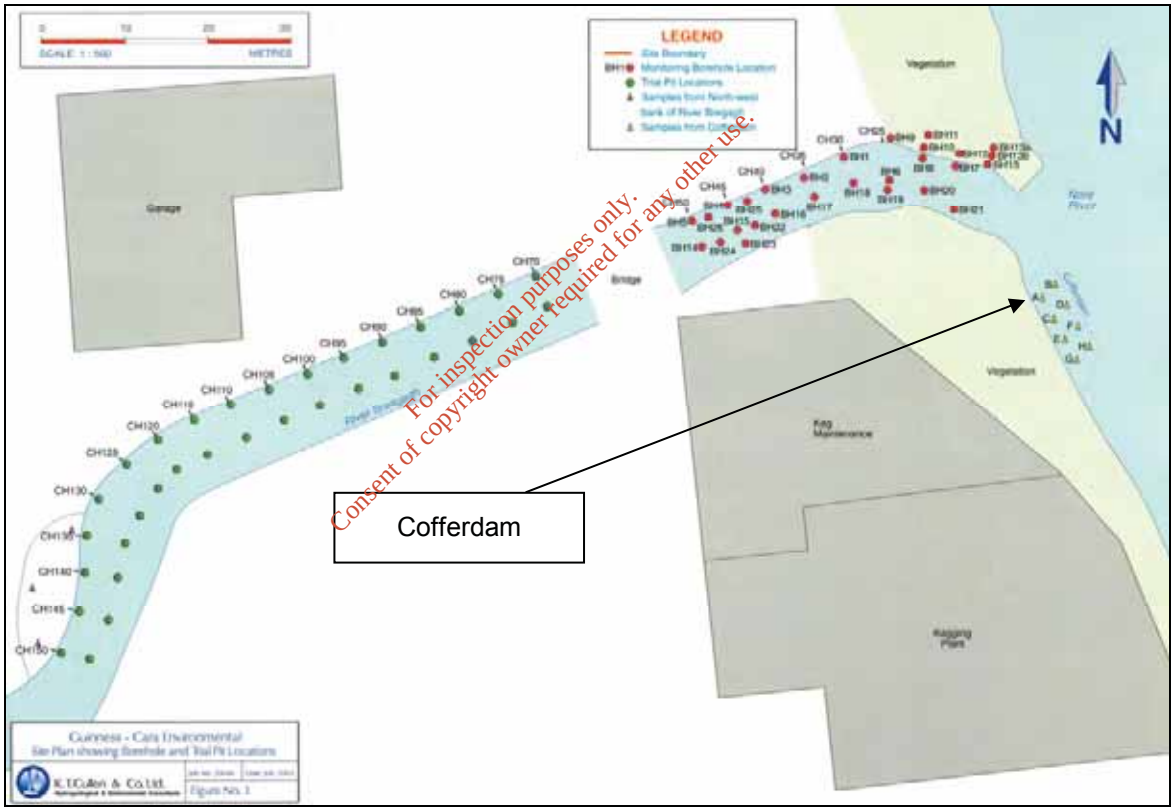


Figure 5: Location of Sampling Points in Cofferdam

6 Liner Installation & Methodology

6.1 General

The lining system was designed to provide a high degree of environmental protection by isolating residual contamination in a secure stratum below a composition of barriers.

The principal components of the system are a geosynthetic clay liner (GCL) which is a self-repairing, impermeable barrier and protective Reno© Mattresses which provide scour resistance in the riverbed. They are supplemented by textiles to enhance the performance of the barrier. The GCL and textiles are guaranteed for twenty years after installation.

A cross section, showing the different layers of the membrane, is presented in Figure 6.

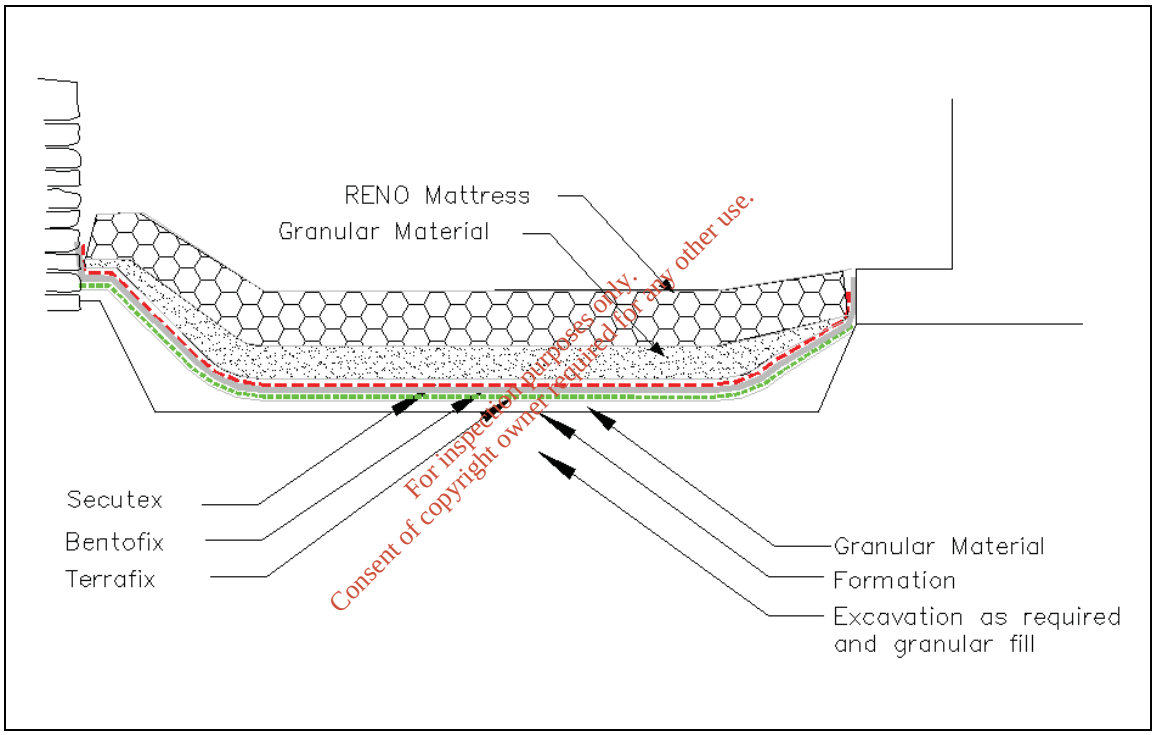


Figure 6: Cross Section Showing The Different Layers Of The Membrane

A brief description of each layer is provided below. Full specifications for the elements of the membrane and the warranty for the materials installed are provided in Attachment 1. Information has been requested from the liner supplier on examples of where this type of liner has been used for similar purposes and how it is performing. This information is not yet available, however, if such information is available, it will be forwarded to the EPA as soon as it is received.

a) Compacted base, Clause 804 gravel

b) Terrafix 813, needle punctured staple fibre filter geotextile. This is a two layered non-woven filter with an opening size of 0.06mm and a water permeability of 1.86 x 10^{-3} m/sec (with Δh = 250mm)

c) Bentofix NSP 4900-3, a sodium bentonite geosynthetic clay liner (GCL). When installed, this material has a water content of ≤15%. It has a water absorption capacity of ≥600%. The permittivity is ≤ 5 x 10^{-9} l/s.

d) Secutex R504, a protective textile liner. This is a non-woven filter with an opening size of 0.12mm and a water permeability co-efficient, k_v, of 5.0 x 10^{-3} m/sec and a co-efficient, k_h, of 9.3 x 10^{-3} m/sec (at a load of 2kN/m^2)

e) Compacted granular material, Clause 804 gravel

f) Reno© mattress, wire mesh gages fabricated from a double-twist, hexagonal mesh of soft annealed, heavily galvanised wire. These wire cages (also known as gabion bags) were filled with 4”-6” stones. These gabion bags were required to provide sufficient weight to hold the membrane in place and to provide protection from river scour. The proposed stone size and river bed finish were discussed in advance with the Southern Regional Fisheries Board, which indicated it’s satisfaction with the proposals.

The combined depth of material placed above the liner was 0.9m to ensure adequate weight was placed on the liner. The calculations to determine the weight required together with the calculations for the membrane puncture resistance are provided in Attachment 2.

The complete barrier system was installed from chainage 150 to chainage 65, as shown in Figure 7.

At chainages 100, 88 and 76, vent panels (measuring 6m x 1m) were installed, as shown in Figure 7, to relieve potential artesian pressures from under the membrane. The vent panels were formed by omitting three sections (6m x 1m) of the bentonite GCL layer and substituting it with a second layer of Terrafix 813.

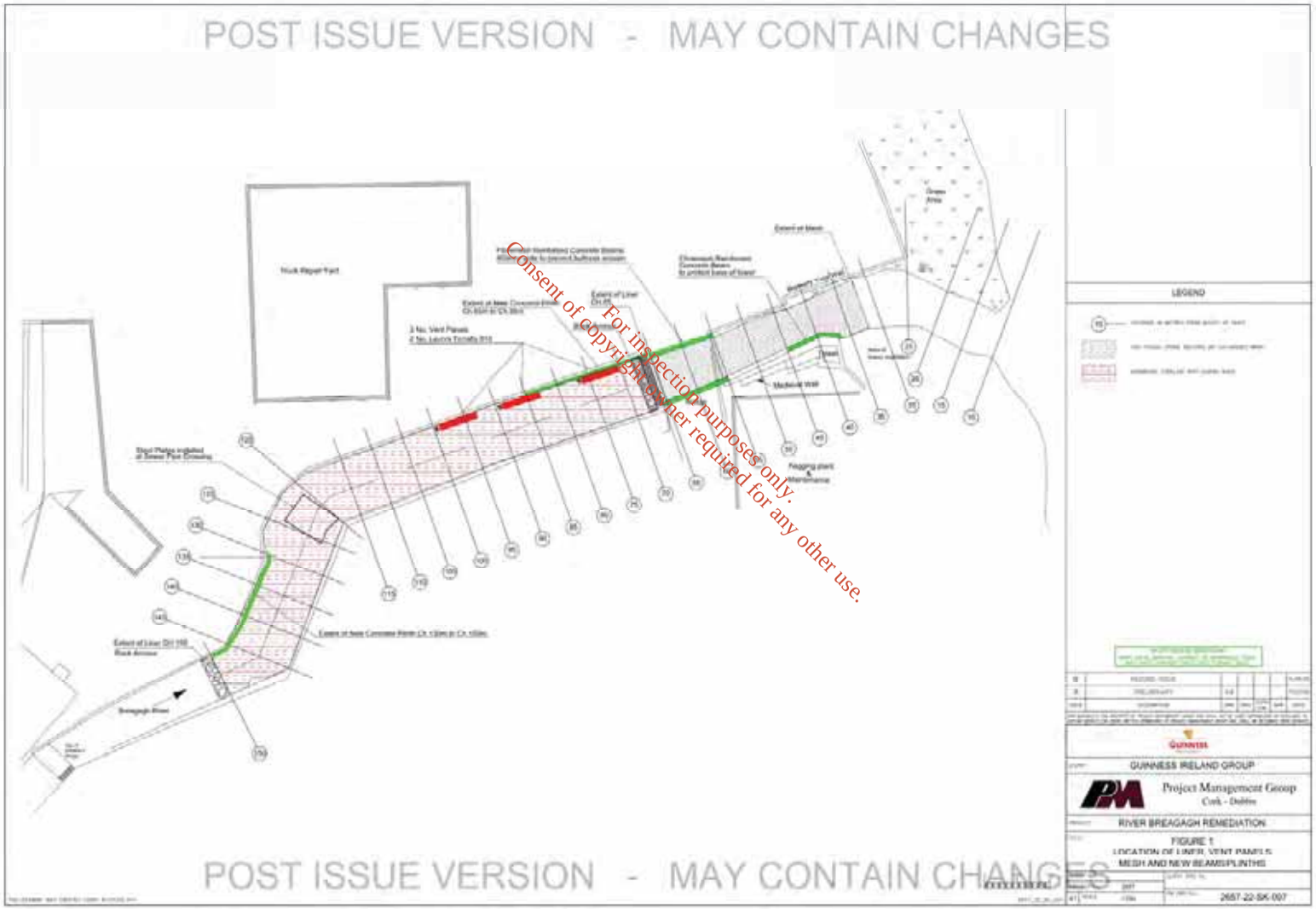


Figure 7: Location of Liner and Vent Panels

6.2 Chainage 150: Start of Liner

At chainage 150, the membrane was stepped down to a depth of 1.4m below OPW bed level. Stepping the liner down was designed to reduce the potential for uplifting or undermining of the liner. The step was formed by an additional dig at chainage 150 to allow the addition of a second Reno mattress (0.5m deep), which was placed on the liner as shown in Figure 8. The over dig was filled with 250mm single sized stone (rock armour).

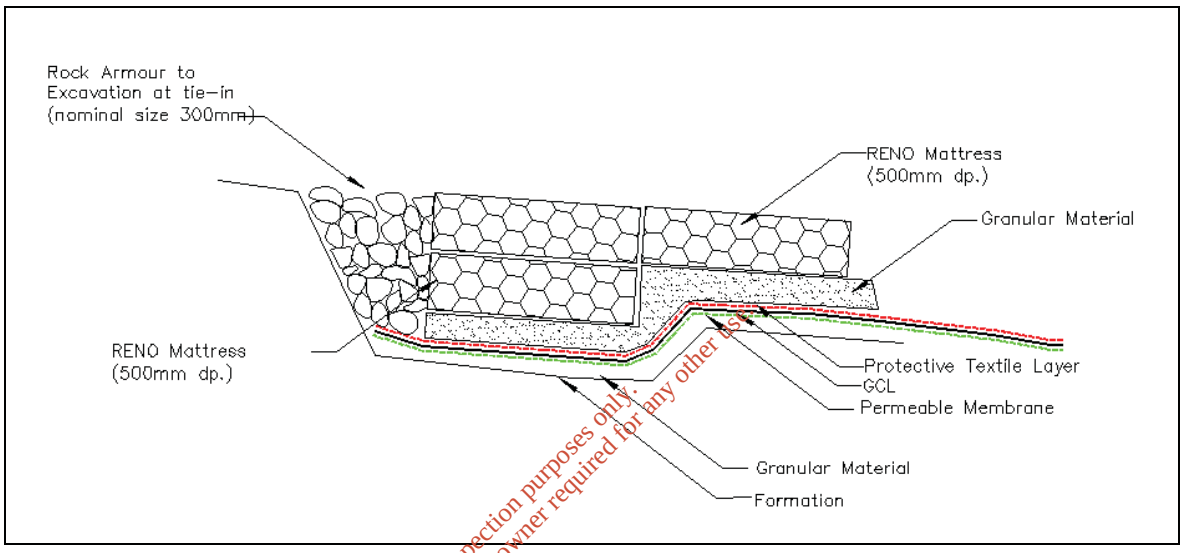


Figure 8: Membrane Tie-in Details at Chainage 150

6.3 Chainage 128: Pipe crossing

At Chainage 128, 3 pipes cross the river. The concrete haunching protecting the pipes at this location restricted the depth of fill material that would be placed on the liner. As the depth of fill was established to prevent buoyancy of the liner a large welded steel plate was used to add weight to hold the membrane in place. Details at pipe crossing are provided in Figure 9. The steel plates used were standard sizes measuring 2.4m x 1.2m (8ft x 4ft) and 20mm thick and were welded into position. Reno mattresses were then placed onto the steel plates.

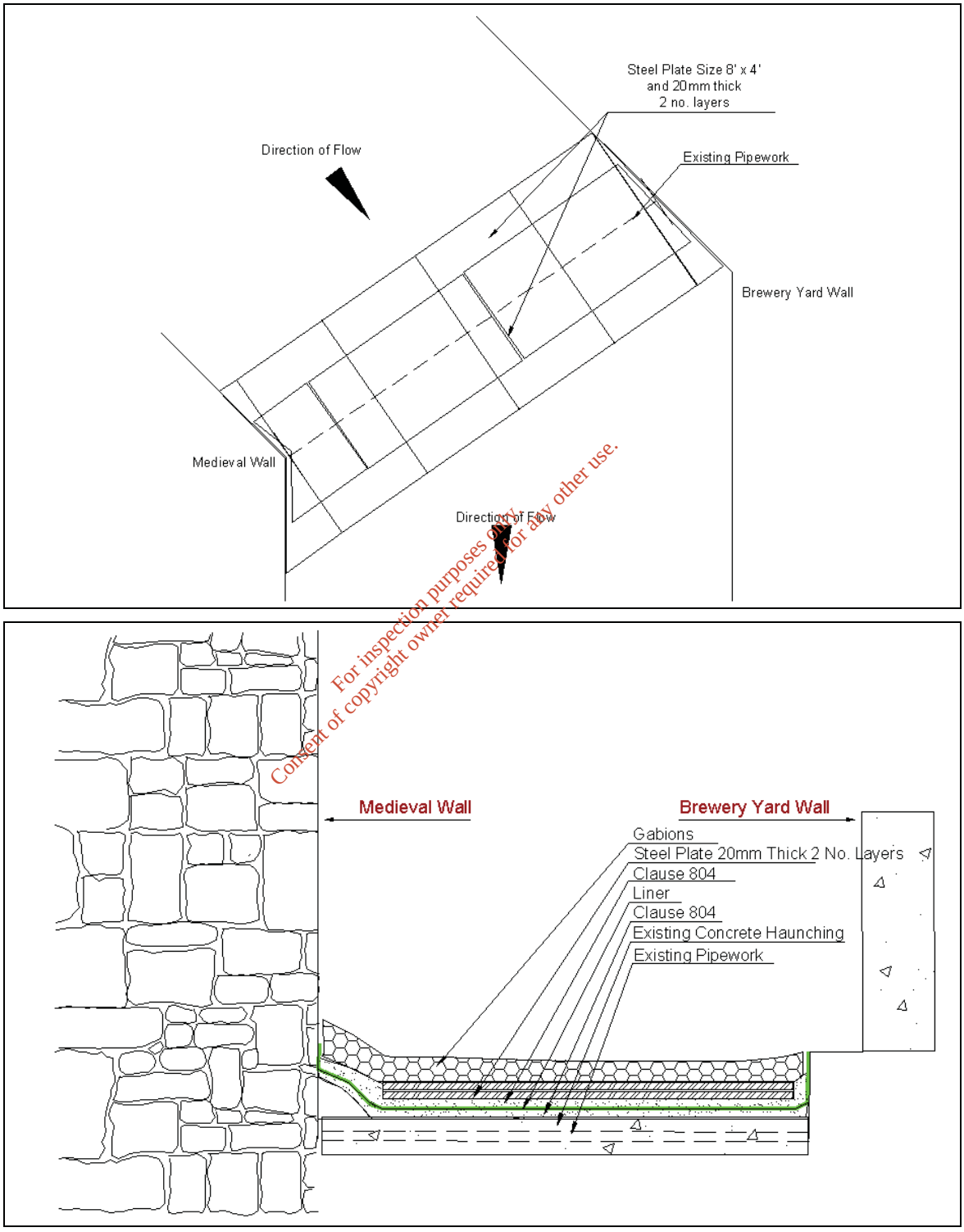


Figure 9: Details of Liner Installation at Chainage 128 (Pipe Crossing), Plan and Cross Section

6.4 Chainage 65: End of Liner

The downstream limit of the lining system is at chainage 65. At this location, the membrane was stepped downwards and back filled with rock armour. The detail of this tie-in point is presented in Figure 10.

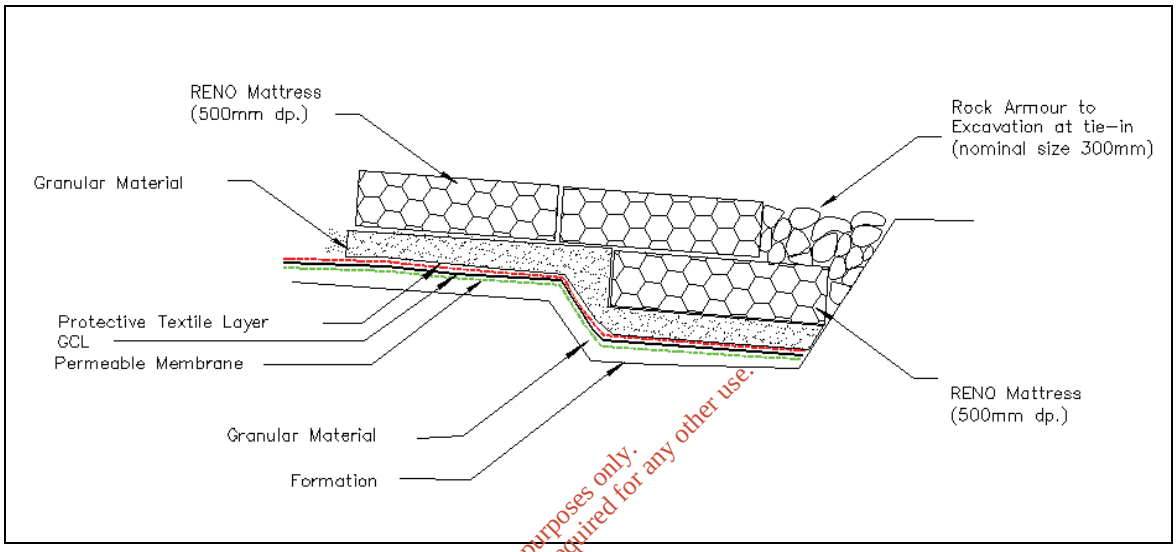


Figure 10: Membrane Tie-in Details at Chainage 65

6.5 Joints

At Walls - In order to complete the barrier effect of the liner, secure fixing at both sides was required. This was achieved using two methods of fastening, each one dependant on the nature the river wall. Where the GCL was fixed to masonry wall, a narrow wedge of bentonite putty was placed at the location of the joint. The GCL was then placed over the putty and fastened to the wall using anchor bolts with flat caps acting as a washer. The bolt holes were drilled in the masonry at 0.3m centres. The joint was protected by extending the Secutex geotextile over the GCL. The gap between the Reno© Mattress and the wall was filled with concrete for further protection against scour.

Where the GCL was fixed to a concrete surface, it was turned up and placed flat on the vertical surface. Along the north wall, additional concrete plinths were cast where no suitable surface existed for making a joint. Flat strips of stainless steel with a neoprene backing were placed on top of the upturned GCL and fastened to the wall, again using anchor bolts. Excess GCL was trimmed. Loose granular material was then placed in the gap to protect the joint and, where necessary, concrete was also used.

Overlaps - Joints were formed by overlapping the sheets of textile as they were laid transversely in the riverbed.

6.6 Monitoring Points

In order to sample the quality of the sub-liner groundwater, particularly in the vicinity of the vent panels, monitoring wells were installed.

The construction of the wells involved installing a slotted 50mm diameter pipe wrapped once with permeable membrane. The pipe was placed transversely in the river from the standpipe, at the north bank, to the centre of the river. It was positioned between the permeable and impermeable liner in the riverbed.

Details of the monitoring points are provided in Figure 11.

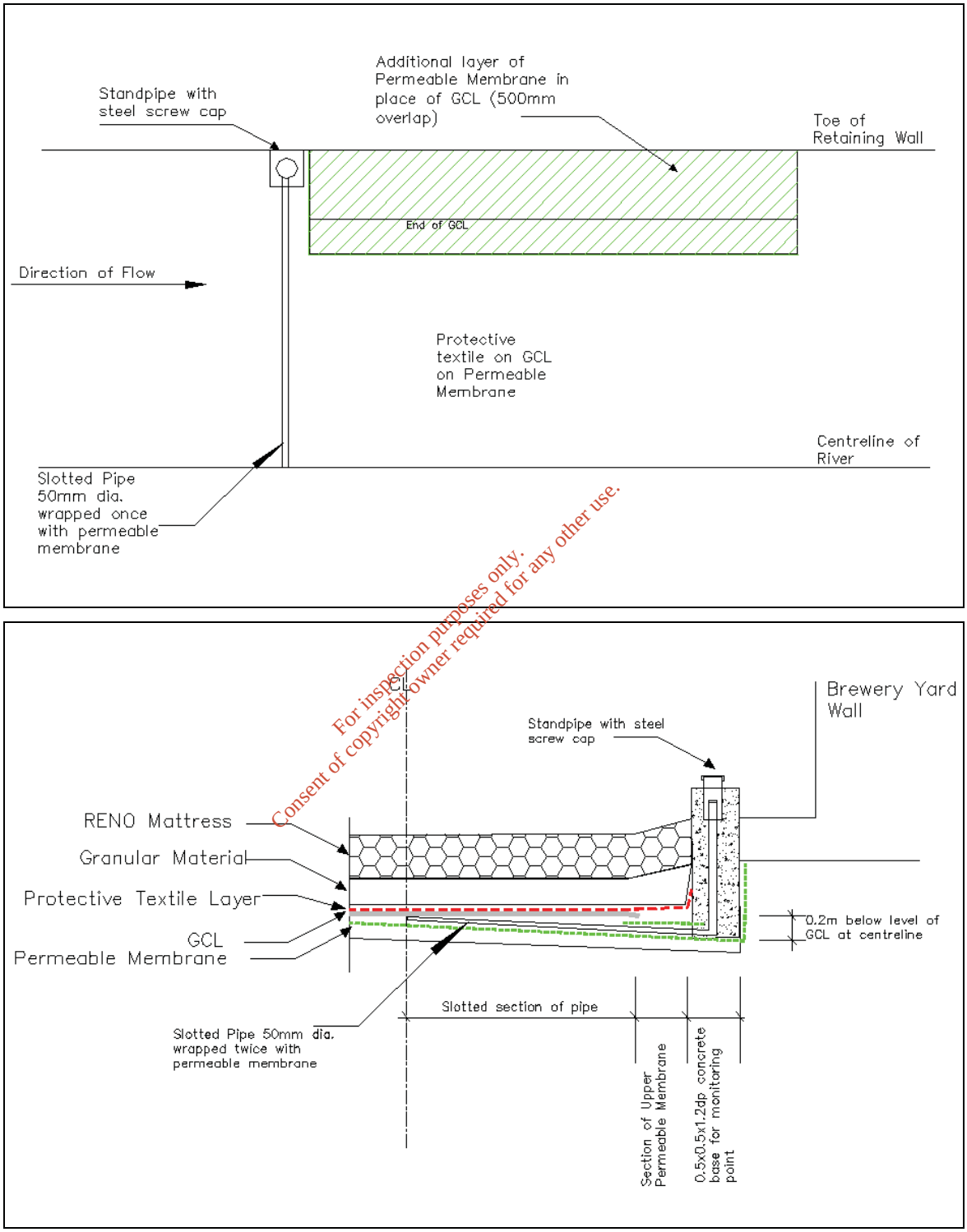


Figure 11: Plan and Cross Section of Monitoring Point

In order to facilitate the extraction of a groundwater sample a stainless steel standpipe was attached to the slotted pipe and brought up to the required level and capped with a steel screw cap. An outer standpipe sleeve of HDPE was filled with concrete to provide protection to and to maintain the stability of the standpipe.

6.7 Weep Hole Installation

In order to relieve artesian pressures that may arise and exert uplift pressure on the lining system, low level weep holes were installed in both walls, at 2-meter centres, between chainage 150 and chainage 65. Once drilled, the weep holes were then filled with a slotted 19mm-25mm pipe, which was wrapped in a filter material so as not to allow fines to pass. In the stretch from chainage 55 to chainage 125 weep holes were provided at a level 0.05m above the level of the proposed OPW weir level of 42.15m above OD.

Weep hole schematics are shown in Figure 12. As shown, a different arrangement for fixing the membrane to the wall was used where the membrane extended up beyond the height of the weep hole.

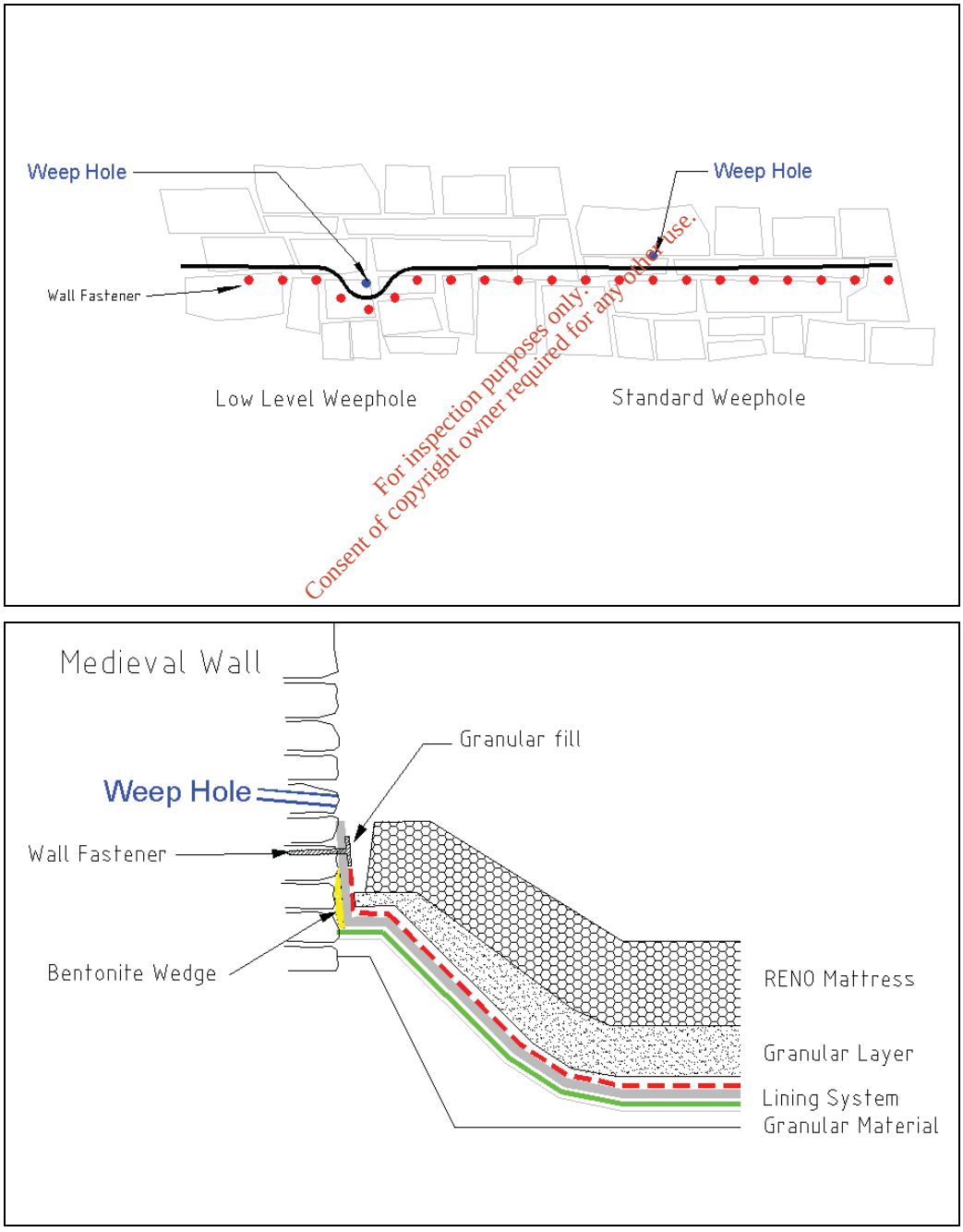


Figure 12: Front View and Details of Standard and Low Level Weep Hole

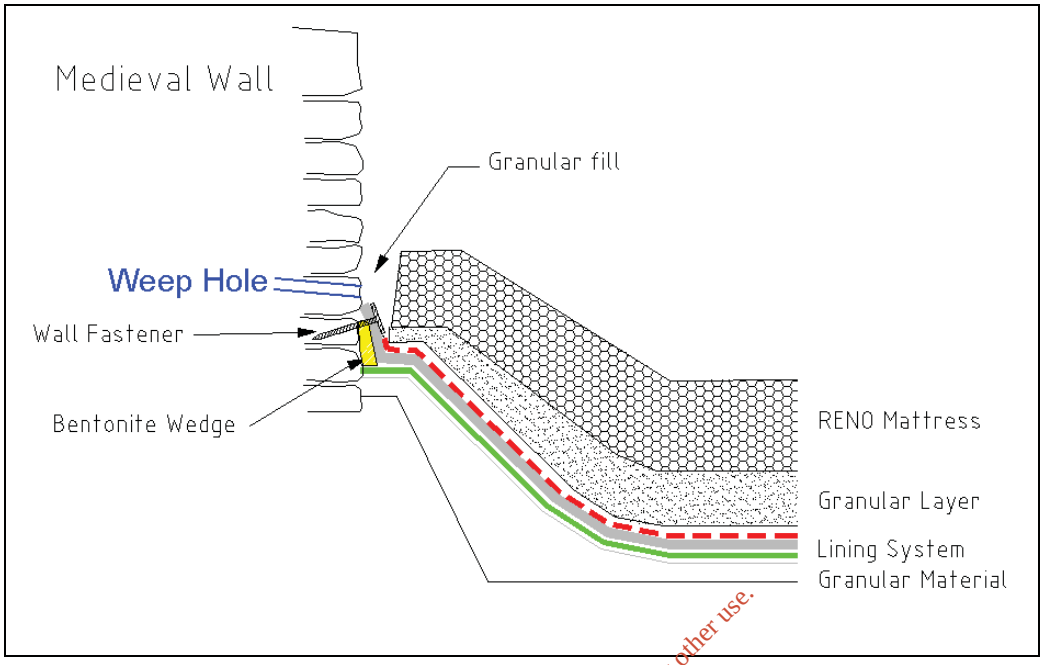


Figure 12 (continued): Front View and Details of Standard and Low Level Weep Hole

Further weep holes were placed at a higher level at every 3 low level weep holes. These new weep holes were installed with a 75mm diameter core. The purpose of these weep holes is to relieve artesian pressure in the event that the lower level ones are silted up.

6.8 Downstream of On Site Bridge, Chainage 65m to 0m

Downstream of the on site bridge, from chainage 65m to 0m, the excavated riverbed material was replaced by 4”-8” stones, which were held in place by a wire mesh from chainage 65m to 30m.

Attachment 1
Membrane Warranty and Specification

F.L.I.
INTERNATIONAL
LINING SYSTEMS

Head Office: Six Cross Roads Business Park, Carriganard, Waterford, Ireland.
Tel.: + 353 (0) 51 353190 Fax: + 353 (0) 51 353177 e-mail: info@fli.ie web addresses: www.fli.ie & www.fli-serrot.com

UK Office: FLI House, 62 Brick Kiln Lane, Chesterton, Newcastle-under-Lyme, Staffordshire, ST5 7AS.
Tel: + 44 (0) 1782 576333 Fax: + 44 (0) 1782 564749 e-mail: info@fli-serrot.co.uk web address: www.fli-serrot.co.uk

Spanish Office: Avenida de Burgos,nº.14, 2ºB,28036 Madrid, Spain.
Tel: +34 91 7680666 Fax: +34 91 3832760 e.mail: avergara@fli.ie

Warranty:

This document is a statement of warranty for the materials installed in the canal Lining works at the Smithwicks brewery Kilkenny.

- The geosynthetic clay liner (Bentofix NSP 4900-S) is guaranteed for a period of twenty years after installation excluding any external causes of degradation.
- The geotextile material (Secutex R 504) is guaranteed for a period of twenty years after installation excluding any external causes of degradation.
- The geosynthetic filter material (Terrafix 813) is guaranteed for a period of twenty years after installation excluding any external causes of degradation.
- The workmanship of F.L.I. technicians is guaranteed for a period of two years after completion of project excluding external causes of degradation.

Signed by: Stephen Buckley

Site manager Stephen Buckley

GCL MAINTAINANCE AND REPAIRS, SMITHWICKS BREWERY KILKENNY

General

1 This document provides procedures for the repair of GCL at Smithwicks brewery in a manner that maximises safety, efficiency, and the physical integrity of the GCL.

2 This procedure is based on several years of experience installing GCL's on a variety of sites. The information contained herein is general and will have to be further enhanced with specific details on site.

Equipment

3 The GCL material will be delivered in rolls weighing approx .1 tonne. It will be necessary to support this weight using an appropriate core pipe that is incorporated in the FLI spreader bar mechanism.

4 Lifting chains or straps each rated for at least twice the load of the GCL will be used in combination with a spreader bar made from an I-beam. The spreader bar ensures the lifting chains or straps do not chafe against the ends of the GCL roll, which must be able to rotate freely during installation.

6 A 360deg backhoe, or other piece of suitable plant will be used with the spreader bar and core bar. Additionally FLI will provide a stinger bar for unloading and moving the rolls prior to deployment.

7 Additional equipment that FLI has used in Smithwicks for the GCL installation includes:

- Spring retractable knives and spare blades (for cutting GCL).
- Granular bentonite for seaming overlapped seams of GCLs and for sealing around the test pipes penetrating the GCL membrane.
- Waterproof covers for temporary cover on installed material as well as for stockpiled rolls.
- Pulling clamps for positioning GCL panel

Subgrade Preparation:

8 As the GCL is placed over the subgrade, the surface will be well compacted as required by the project specifications. The R.E.'s approval of the subgrade must be obtained prior to installation

9 The subgrade surface must be free of vegetation, sharp-edged rocks, stones, sticks, construction debris, and other foreign material that could pierce the GCL. The subgrade should be rolled with a smooth-drum compactor to remove any wheel ruts, footprints, or other abrupt grade changes. Furthermore, all protrusions extending more than 12 mm from the subgrade surface shall be removed, crushed, or pushed into the surface with a smooth-drum compactor. The GCL may be installed on a frozen subgrade, but the subgrade soil in the unfrozen state should meet the above requirements.

Unloading

10 FLI expects that the GCL will be delivered to Smithwicks on flatbed trucks. To unload the rolls from the flatbed, FLI' s technicians will insert the core pipe through the roll. This will require removal of the core plug, which should be replaced after the roll is unloaded. Secure the lifting straps or chains to each end of the core pipe and to the spreader bar mounted on the lifting equipment. Hoist the roll straight up; make sure its weight is evenly distributed so that it does not tilt or sway when lifted. To expedite the unloading procedure FLI may utilize a stringer spike attached to a 360 excavator or all terrain forklifts.

11 It's unlikely that FLI will have deliveries of GCL to Smithwicks in closed shipping containers. Should this occur all deliveries would be unloaded with the stringer spike. To remove the roll from the container, guide the stinger as far as possible through the core and lift the roll up and out of the container.

Installation

12 GCL rolls will be taken to the working area of the site in their original packaging, the size and location of the main stockpile and intermediate stockpiles will be agreed with earthworks company depending on access and direction of deployment. Immediately prior to their deployment, the packaging will be carefully removed without damaging the GCL.

Plant and equipment, which could damage the GCL, will not be allowed to travel directly on it. Acceptable installation, therefore, will be accomplished such that the GCL is unrolled in front or beside backward-moving equipment. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues.

14 Care must be taken to minimise the extent to which the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL.

15 The GCL should be placed so that seams are overlapped to the direction of the slope. End-of-roll seams should also be located at least 1 meter from the toe and crest of slopes steeper than 4H:1V

16 All GCL panels should lie flat on the underlying surface, with no wrinkles or folds, especially at the exposed edges of the panels.

17 Only as much GCL shall be deployed as can be covered at the end of the working day with the cover material, or a temporary waterproof tarpaulin. The GCL shall not be left uncovered overnight. If the GCL is damaged by hydration when no confining stress is present, it may be necessary to remove and replace the hydrated material.

Seaming

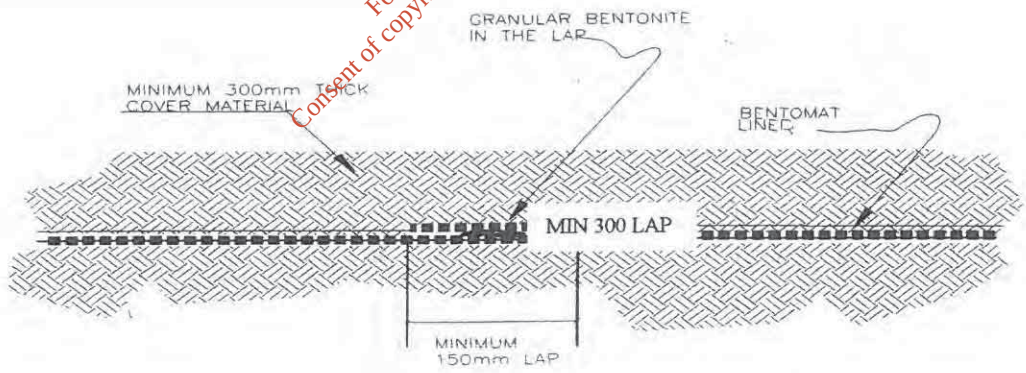
19 The GCL seams will be constructed in the overlap interface between the adjacent panel edges. Care will be taken to ensure that the overlap zone is not contaminated with loose soil or other debris. Supplemental bentonite is added to form the seam or joint between the panels.

20 In accordance with the Smithwicks project specification, the minimum dimension of the longitudinal overlap should be 300 mm. End-of-roll overlapped seams should be similarly constructed, and the minimum overlap should measure 300 mm.

21 Seams at the ends of the panels will be constructed such that they are shingled in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone.

22 Bentonite-enhanced seams are constructed first by overlapping the adjacent panels, exposing the underlying edge and applying a continuous layer of granular sodium bentonite (supplied by FLI with the GCL) along an area defined by the edge of the underlying panel and the 150 mm line (Figure 1). The minimum application rate at which the bentonite is applied is 0.4 kg/m.

Figure 1.corss-section of bentonite enhanced seams



Sealing around Gas Vent Pipes

23 Cutting the GCL will be performed by the FLI technician using a spring retractable knife. Frequent blade changes are recommended to avoid irregular tearing of the geotextile components of the GCL during the cutting process.

24 The GCL shall be sealed around the gas vent penetrations in the subgrade in accordance with Figures 2 & 3. Granular bentonite will be used liberally (approximately 3 kg/m) to seal the GCL to the vent pipes. A "notch" should be excavated into the subgrade around the vent pipe penetration. The notch will then be backfilled with granular bentonite.

Figure 2. Cross-section of a vertical penetration

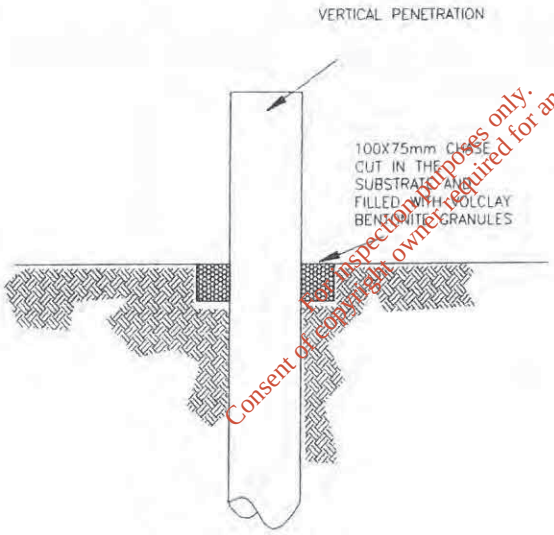
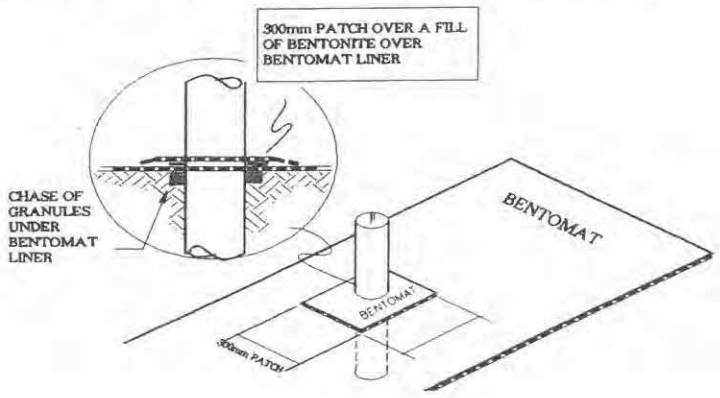


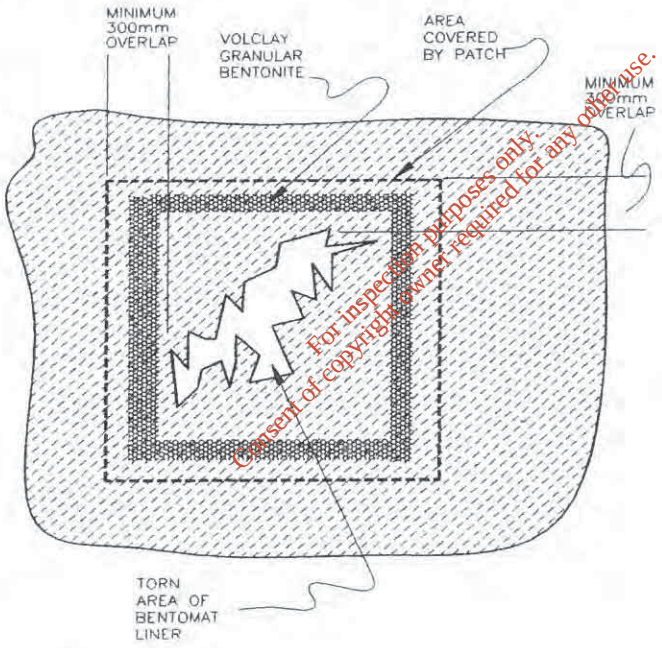
Figure 3. Isometric view of completed vertical penetration.



Damage Repair

30 If the GCL is damaged (torn, punctured, perforated, etc.) during installation, it is possible to repair it by placing a patch over the damaged area (Figure 4). The patch shall be obtained from a new GCL roll and shall be cut to size such that a minimum overlap of 300 mm is achieved around all parts of the damaged area. Granular bentonite should be applied around the damaged area prior to placement of the patch. Smaller patches also may be tucked *under* the damaged area to prevent patch movement during placement of cover material.

A MINIMUM OF 300mm OVERLAP IS REQUIRED .



Cover Placement

38 Where no protective layer of geotextile is used cover soils shall be free of angular stones or other foreign matter, which could damage the GCL. The Engineer should approve cover soils.

39 Soil cover shall be placed over the GCL using construction equipment that minimises stresses on the GCL. A minimum thickness of 300 mm of cover should be maintained between the equipment tracks/tires and the GCL at all times during the covering process. This thickness recommendation does not apply to frequently trafficked areas or roadways, for which a minimum thickness of 600 mm is required.

40 Soil cover should be placed in a manner that prevents the soil from entering the GCL overlap zones.

41 Although direct vehicular contact with the GCL is to be avoided, lightweight, low ground pressure vehicles (such as 4-wheel all-terrain vehicles with LGP tires) may be used to facilitate the installation of geosynthetic products placed over the GCL.

Geotextiles for filtration, erosion control and scour protection

Terrafix®

NAUE FASERTECHNIK
QM-system TÜV DIN EN ISO 9001
Naue Fasertechnik GmbH & Co. KG
Wartturmstrasse 1, 32312 Luebbecke
Germany
fon: +49 (57 41) 4008-0
fax: +49 (57 41) 4008-40
e-mail: info@naue.com
internet: www.naue.com

Product description: **Needle-punched staple fibre nonwoven for application in hydraulic engineering according to TLG of the Federal Institute for Waterway Engineering (BAW), Karlsruhe**

Technical Data	Test method (based on)	Unit	609	813
Raw material	-		polyester/ polypropylene coloured	polypropylene/ polyester
Mass per unit area	DIN EN 965	g/m²	642	828
Thickness (x-s)*	DIN EN 964-1	mm	5.3 / ≥ 4.5	6.7 / ≥ 6.0
Max. tensile strength (x-s)*, md / cmd**	DIN EN ISO 10319	kN/m	≥ 12.0 / ≥ 12.0	≥ 12.0 / ≥ 12.0
Elongation at max. tensile trength, md / cmd**	DIN EN ISO 10319	%	70 / 40	70 / 40
Resistance to static puncture loads on soil type 3	RPG of BAW	1200 Nm	yes	yes
Resistance to abrasion load	RPG of BAW	-	yes	yes
Characteristic opening size	DIN EN ISO 12956	mm	0.10	0,08
Water permeability - VI_{H50}-Index - flow $rate_{H50}$ - $k_{10,H50m}$	DIN EN ISO 11058	m/s l/sm² m/s	3.75×10^{-2} 37.5 2.86×10^{-3}	3.99×10^{-2} 39,9 $3,82 \times 10^{-3}$
Hydraulic filtration efficiency against soil type	RPG of BAW	-	1 / 2 / 3	1 / 2 / 3 / 4
Detector tested	-	-	no	yes
Roll dimensions, width x length	-	m x m	5.80 x 50	5.80 x 50

**(x–s) = average value-standard deviation, **md = machine direction, cmd = cross machine direction*

The a. m. technical values are average values over the roll width. These data are guiding values achieved in our laboratories and/or independent testing institutes. Our products can be subject to changes without prior notice.

2 January 2002

Std-GDB Terrafix, Rev 0_e.doc

NAUE FASERTECHNIK

Technical Data Sheet — Bentofix®NSP 4900-3

Product description:	Shear strength transmitting GCL, continuously needle-punched through all components.
Overlap area:	marked on the bottom side (30 cm)
Standard roll dimensions / diameter:	4.85 m x 30 m / approx. 60 cm

Cover nonwoven			
Mass per unit area:	* DIN EN 965	g/m²	220
Raw material:	-	PP white	

Bentonite layer	**natural sodium bentonite (granular)**		
Mass per unit area:	* DIN EN 965	g/m²	4,670
Montmorillonite content:	* XRD	%	approx. 90
Methylene blue consumption:	* Methylene blue test, VDG P 69	mg/g	≥ 300
Water content:	* DIN 18121 (5 h, 105 °C)	%	≤ 15
Water absorption:	* DIN 18132 (24 h)	%	≥ 600
Swell index:	* ASTM-D-5890	ml	≥ 25
Fluid Loss:	* ASTM-D-5891	ml	< 18

Carrier slit film woven			
Mass per unit area:	* DIN EN 965	g/m²	110
Raw material:	-	PP	

Geosynthetic Clay Liner			
Mass per unit area:	* DIN EN 965	g/m²	5,000
Thickness:	* DIN EN 964 - 1	mm	6
Permittivity:	* DIN 18130 / ASTM-D-5887	1/s	$\leq 5 \times 10^{-9}$
k-value:	* DIN 18130 / ASTM-D-5887	m/s	$\leq 5 \times 10^{-11}$
Index Flux:	* DIN 18130 / ASTM-D-5887	$(m^3/m^2)/s$	approx. 8×10^{-9}
Peel strength:	* DIN EN ISO 10319/ASTM-D-4595	N/10 cm	≥ 60
Max. tensile strength long./trans.:	* DIN EN ISO 10319/ASTM-D-4595	kN/m	10 / 10
Elongation at break long./trans.:	* DIN EN ISO 10319/ASTM-D-4595	%	10 / 6
Puncture force:	* DIN EN ISO 12236	N	1,800
**Trapezoidal tear strength long./tra.:	* ASTM-D-4533	N	350 / 500
**Grab tensile strength long./tra.:	* ASTM-D-4632	N	500 / 500
**Puncture force:	* ASTM-D-4833	N	650

*) = based on
**) = for information only, not included in MQC

(Production Manager) (Quality Control)

Technical Data Sheet

Secutex® (PP coloured)

NAUE FASERTECHNIK

Product Description Filter and protection nonwoven
Raw Material Polypropylene (PP) coloured

Characteristic Value	Test Method (based on)	Unit	R304	R404	R454	R504	R604
Mass per area	DIN EN 965	g/m2	300	400	450	500	600
Thickness	DIN EN 964-1	mm	3.5	4.0	4.5	5.0	6.0
Tensile Strength Longitudinal / transverse	DIN EN ISO 10319	kN/m2	5.0/9.0	6.0/12.0	8.5/14.0	12.0/18.0	20.0/32.0
Elongation at max tensile strength Longitudinal / transverse	DIN EN ISO 10319	%	80/50	80/50	80/50	80/50	80/50
Puncture force	DIN EN ISO 12236	N	1200	1700	2000	2500	4000
Elongation at static puncture strength	DIN EN ISO 12236	%	50	50	40	50	50
Effective opening size	DIN E 60500 Part 6	mm	0.18	0.14	0.14	0.12	0.10
Water permeability coefficient at a load of 2kN/m² k_v	DIN E 60500 Part 4	m/s	5×10^{-3}	5×10^{-3}	5×10^{-3}	5×10^{-3}	3×10^{-3}
k_h	DIN E 60500 Part 7	m/s	1×10^{-2}	1×10^{-2}	1×10^{-2}	9.3×10^{-3}	8×10^{-3}
**Trapezoidal tear strength long / trans.:	ASTM-D-4533	N	150/250	250/300	250/300	500/700	700/1000
**Grab tensile strength long / trans.:	ASTM-D-4632	N	250/400	500/750	500/750	1000/1500	1400/2200
**Puncture force:	ASTM-D-4833	N	300	400	400	450	
Bonding Method			needle punched	needle punched	needle punched	needle punched	needle punched
Detector tested			yes	yes	yes	yes	yes
Standard roll dimension			5.8 x 100	5.8 x 100	5.8 x 100	5.8 x 50	5.8 x 50

*(x-s) = mean value – standard deviation **= for information only, not included in MQC

(Production Manager) (Quality Control Manager)

Naue Fasertechnik
Wartturmstraße 1
32312 Lübbecke
Telefone ++5741/4008-0
Telefax ++5741/400840

The a m. technical data are average values gained from measurings over the production width These data are guiding values achieved in our laboratories and/or independent testing institues. Our products canbe subject to changes without prior notice.

Date: 12.01.1998

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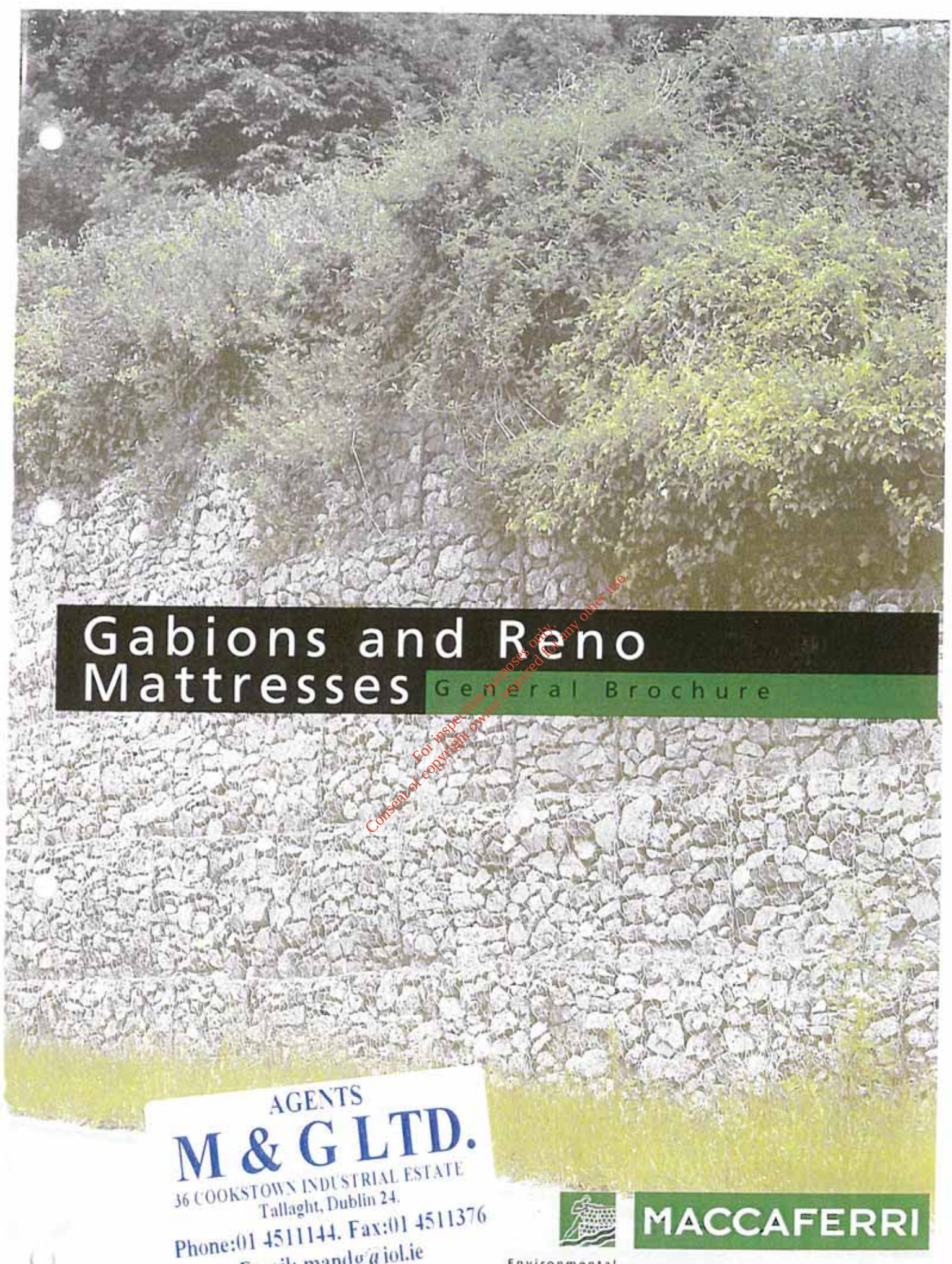

Gabions and Reno Mattresses

General Brochure

AGENTS
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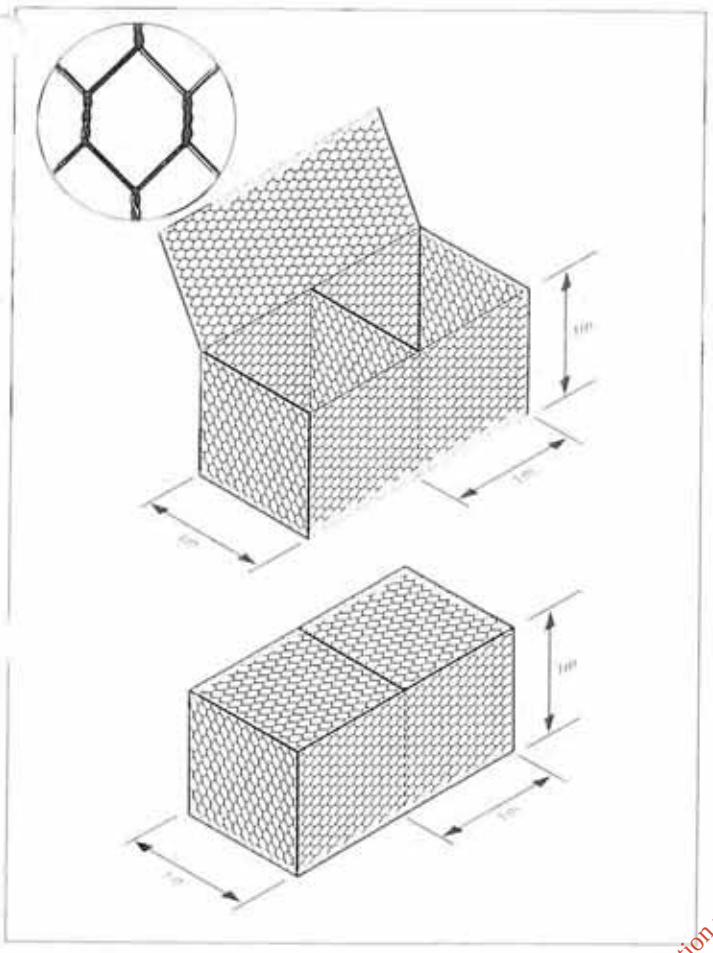
Tallaght, Dublin 24.
Phone:01 4511144. Fax:01 4511376
Email: mandg@iol.ie

MACCAFERRI
Environmental Solutions



Maccaferri box gabions

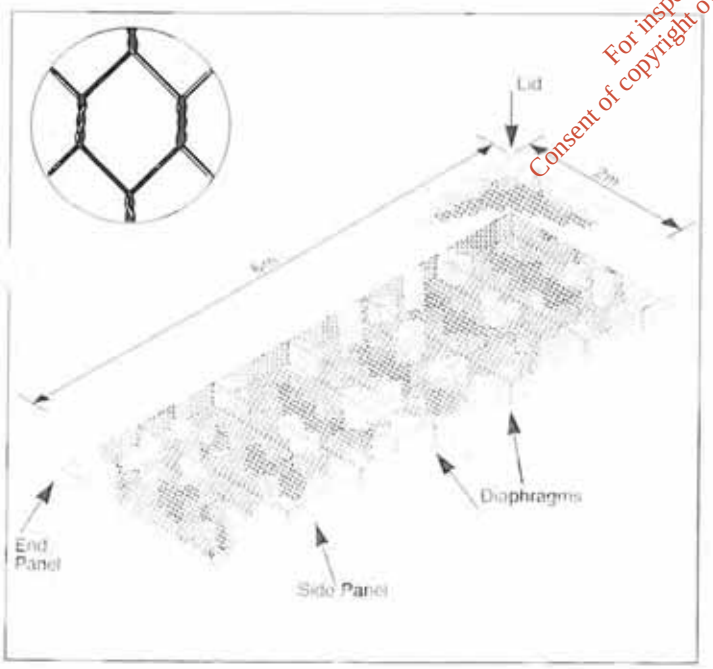
Galvanised box gabions

Box gabions consist of rectangular units, fabricated from a double-twist, hexagonal mesh of soft annealed, heavily galvanised wire. The wire quality and the galvanising meet all international specifications. The mesh panels are reinforced at all edges with wires of a larger diameter than that used for manufacturing the mesh, to strengthen them and to facilitate construction. Gabions are divided into cells by fitting diaphragms which have the function of reinforcing the structure and making assembly and erection easier.

Galvanised box gabions with PVC coating

The characteristics of these products are similar to those of the galvanised gabions; however the wire, prior to manufacturing the mesh, is bonded with a 0.5mm thick special PVC (polyvinyl chloride) continuous coating. A complete protection against possible corrosion is thus obtained making the gabions suitable for use in marine or polluted environments.

Filled with stone, gabions become a large, flexible and permeable building block from which a broad range of structures may be built.



Maccaferri Reno® mattresses

Galvanised Reno® mattress

This is a mattress shaped version of the gabion used mainly for erosion control when the retaining properties of box gabions are not required.

Various thicknesses are available to suit the design requirements.

The base section is divided into 1 metre wide compartments to restrict the movement of stone and strengthen the structure. The lid is supplied as a separate panel.

After assembly on site, mattresses are wired together and filled to form a continuous blanket or lining. The lids are wired to the sides, ends and diaphragms.

Galvanised Reno® mattress with PVC coating

The wire of the Reno® mattress can be coated with PVC in the same manner as that for gabions.

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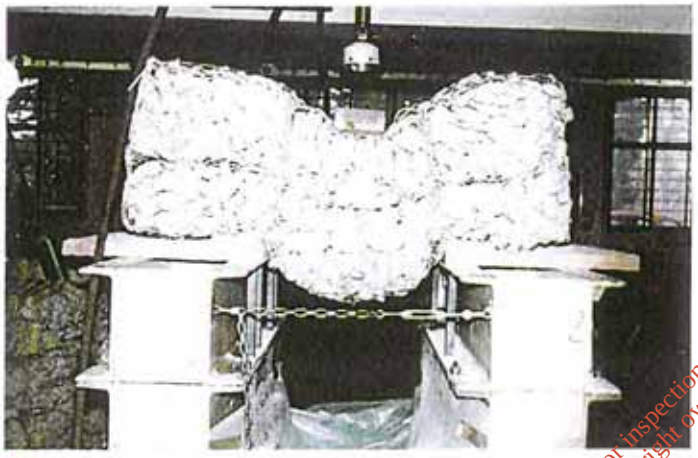
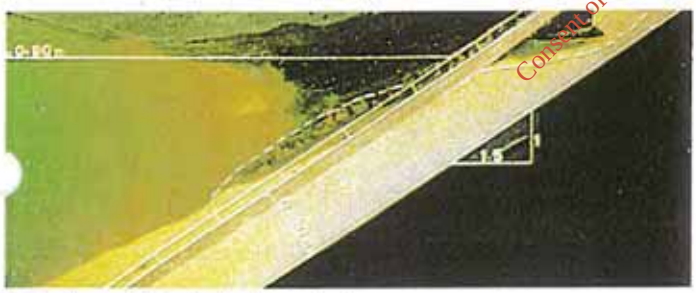
AGRÉMENT CERTIFICATE 95/3141
ROADS & BRIDGES
CERTIFICATE No. 93/75

All Maccaferri products carry BBA certification which includes statements on their 120 year life expectancy and technical approval.

Two full size gabion walls under test programme in Italy.



Tests to destruction, University of Bologna, Italy.



Scale model testing in Sogreah, France.

Wave action tests, Delft Hydraulic Laboratory, Holland.

Maccaferri products have been tested in laboratories throughout the world...

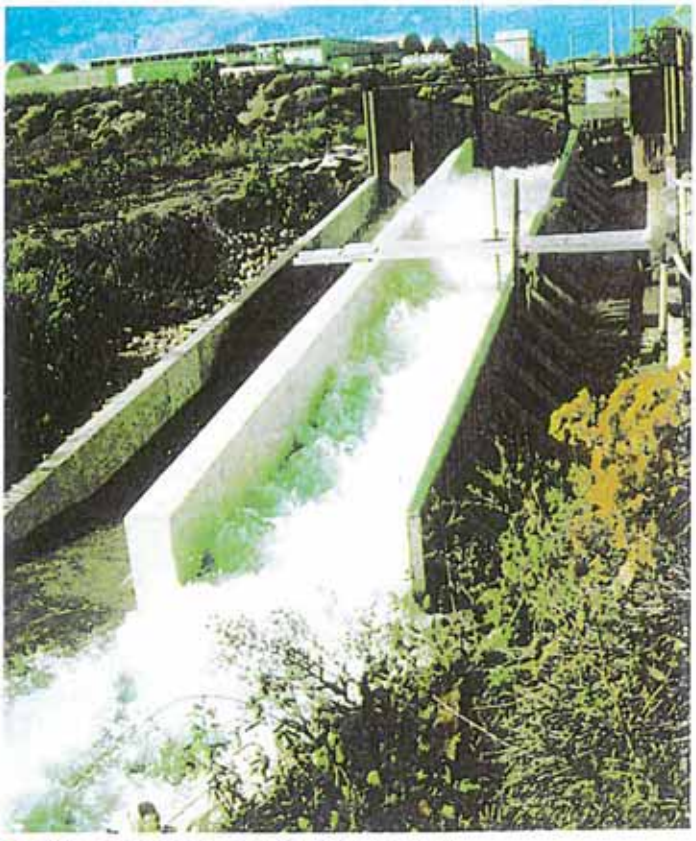
Research into the behaviour of gabions and Reno® mattresses has been carried out in both model and full scale tests in France, Holland, Italy, the U.S.A. and United Kingdom.

In 1992 Hydraulics Research, Wallingford was commissioned by the Department of the Environment to investigate the stability of riprap and loose concrete blocks for channel protection in high turbulent flows. A follow-up project for laboratory tests of gabion mattresses and cabled concrete block was later commissioned.

HR Report SR 427 was published in July 1995 when Reno® mattresses were found to be considerably more stable than equivalent riprap, for example: under normal turbulence conditions the required size of the filling stone in a 300mm thick Reno® mattress is approximately half the size of riprap needed under the same flow conditions.

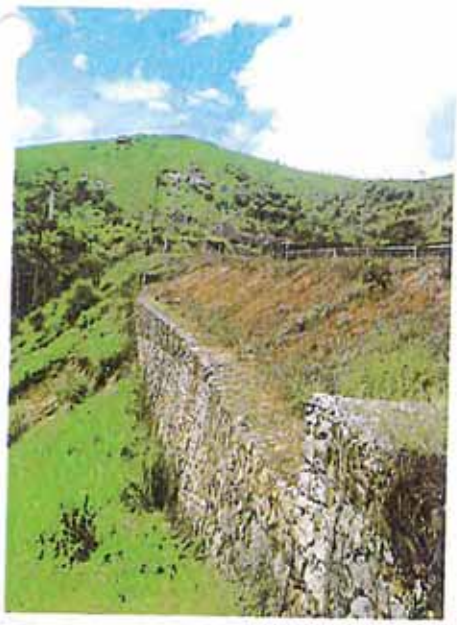
Maccaferri have an ongoing test programme and continue to sponsor research projects.

All the above research data and individual design brochures are available from Maccaferri Ltd.

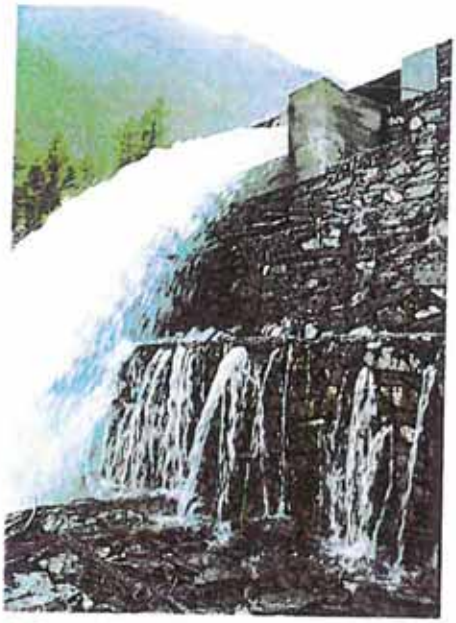


Full scale flume testing on Reno® mattresses, Colorado State University.

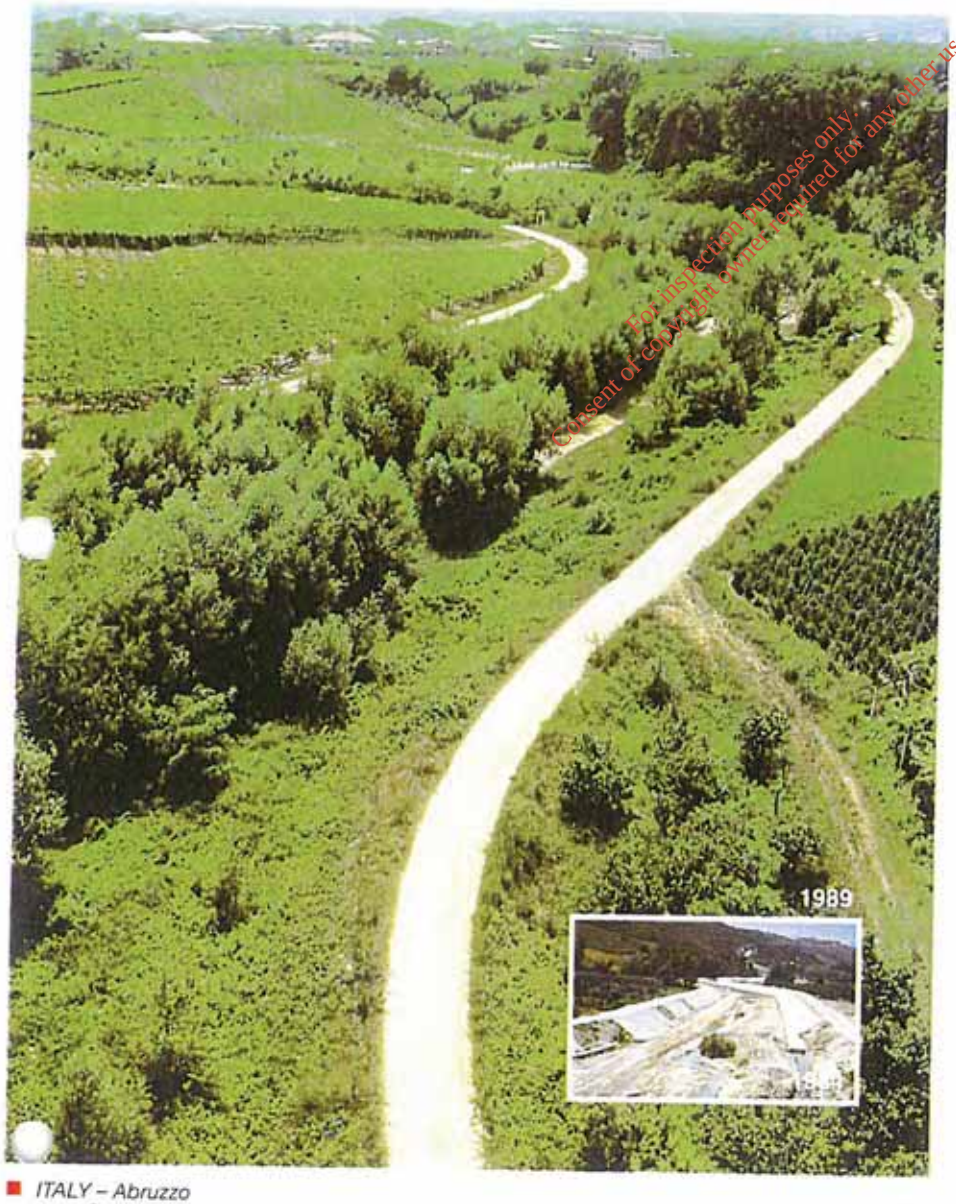
ADVANTAGES of DOUBLE TWIST WIRE MESH



Example of differential settlement without fracture



■ *Example of permeable nature*



■ *ITALY – Abruzzo*
Reno® mattress protection with a gabion toe on the River Foro. After only five years vegetation helps restore the ecological balance

Flexibility

An outstanding advantage of the gabion is its flexibility.

Its double-twist hexagonal mesh construction can tolerate differential settlement without fracture. This property is especially important when a structure is on unstable ground or in an area where scour from waves or currents can undermine it.

Strength

The strength and flexibility of the steel wire hexagonal mesh from which gabions and mattresses are made is utilised to withstand and absorb the forces generated by retained earth or flowing water.

Permeability

Hydrostatic heads do not develop behind gabion structures because of their permeable nature.

Their ability to combine drainage and retention functions make them ideal structures for slope stabilisation.

Durability

A Maccaferri gabion or Reno® mattress is a heavy monolithic gravity unit able to withstand earth thrust.

Its efficiency increases instead of decreasing with age since further consolidation takes place as silt and soil collect in the voids and vegetation becomes established.

Economy

Gabion installations are more economical than rigid or semi-rigid structures for a number of reasons.

The following are the most important ones:

- **Little maintenance is required.**
- **Gabion construction is simple, does not require skilled labour.**
- **Suitable stone fill is available normally on site or from nearby quarries.**
- **Minimum foundation preparation is required, the surface needs to be only reasonably smooth.**
- **No costly drainage systems are required, as gabions are permeable.**

Ecology

Because gabions permit the growth of vegetation and maintain the existing environment, they provide attractive and natural building blocks for decorative landscaping.

■ *ISLE OF MAN*

Gabion river wall at National Sports Centre.

■ *WALES (Far Left)*

Channels and drop structures using Gabions and Reno® mattresses at Mountain Ash, Mid Glamorgan.

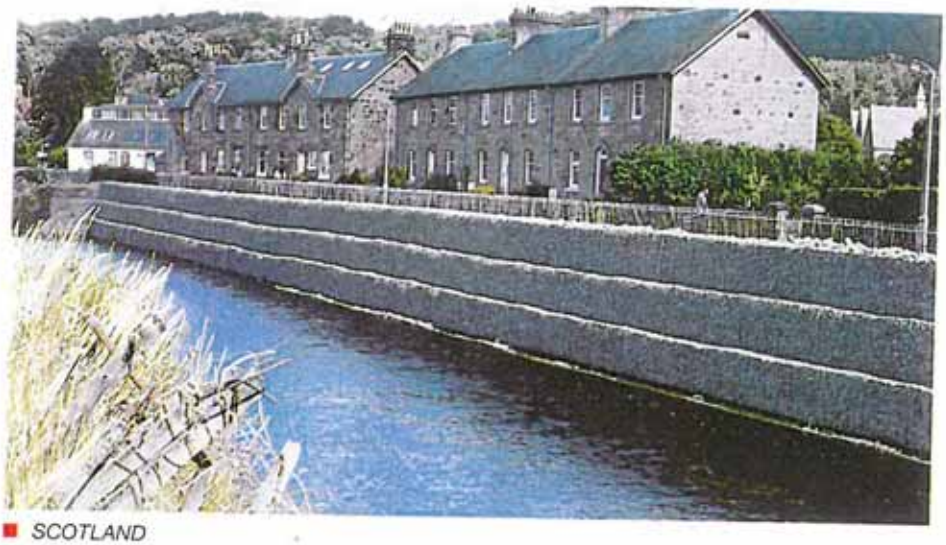
■ *ENGLAND (Left)*

Gabion retaining wall prior to landscaping, supporting road at Rock Cottage, Lydbrook, Gloucester.

■ *ENGLAND*

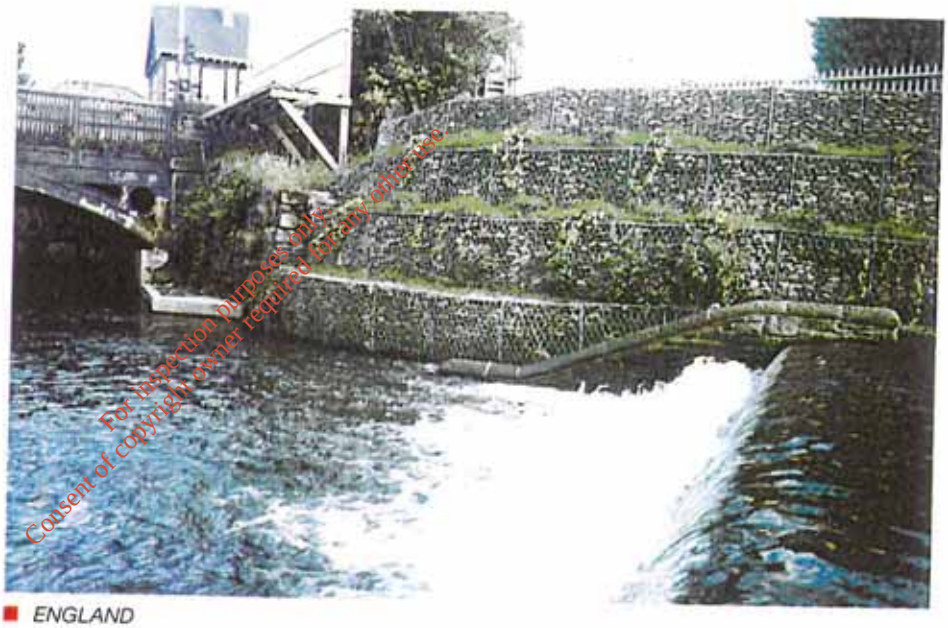
Gabion retaining wall alongside stream at Marsh Mills roundabout, Plymouth, Devon.

SCOTLAND
Rock-netting installation, A835 South Ullapool.



SCOTLAND
Gabion wall flood protection at Bridge of Allan.

SCOTLAND
Gabion retaining wall at Dunkeld House Hotel, Perthshire.



ENGLAND
Weir and river walls, River Sheaf, Sheffield.

ENGLAND
Leicester Road, Ashby de la Zouch

ENGLAND
6m high retaining wall, Thornbury Hospital, Sheffield.

■ *SCOTLAND - Dumfries & Galloway*
Reno® mattress spillway lining and drop structures, Torbeckhill Reservoir.

■ *SCOTLAND - Highland*
Reno® mattress protection at Whin Island on the River Ness.

■ *SCOTLAND - Tayside*
River wall on the River Braan at Dunkeld.

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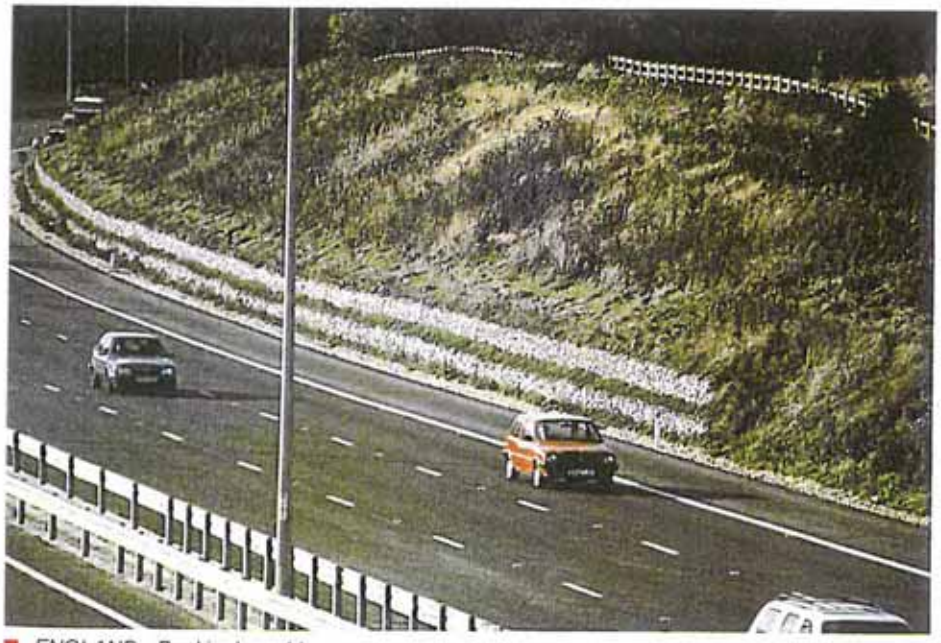
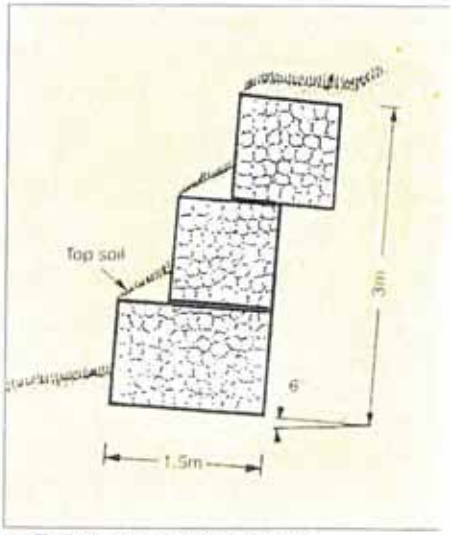


■ *ENGLAND - Buckinghamshire*
M40 motorway widening between junctions 4 and 5. Approximately 5.5km of gabion walling.



■ *Typical cross-section on M40.*

River Training

■ *ITALY - Campania*
Longitudinal walls on River Lete.

■ *MALAWI*
Groynes for the protection of the Salima - Benga Road.

■ *FORMER YUGOSLAVIA*
Weir on the Vranja stream.

■ *USA - New York*
Gabion bank protection near Buffalo.

Earth Control and Soil Conservation

■ *REPUBLIC OF CAPE VERDE*
Series of structures for soil conservation on Santiago Island.

■ *ITALY - Tuscany*
Drainage channel to stabilise a slope near Florence.

Retaining Structures

■ *SWITZERLAND*
Retaining wall for the protection of the railway near Alpnach.

■ *GERMANY*
Retaining wall along a road near Obnerwesel.

Bridge and Culvert Protection

■ *BRAZIL- S.Paulo*
Bridge abutments on Turvo river, near S. José dos Campos.

■ *CANADA - Ontario*
Culvert protection near Cornwall.

Marinas and Seashore Protection

■ *BRAZIL - Paranà*
Protection of the Praia Mansa at Caiobà.

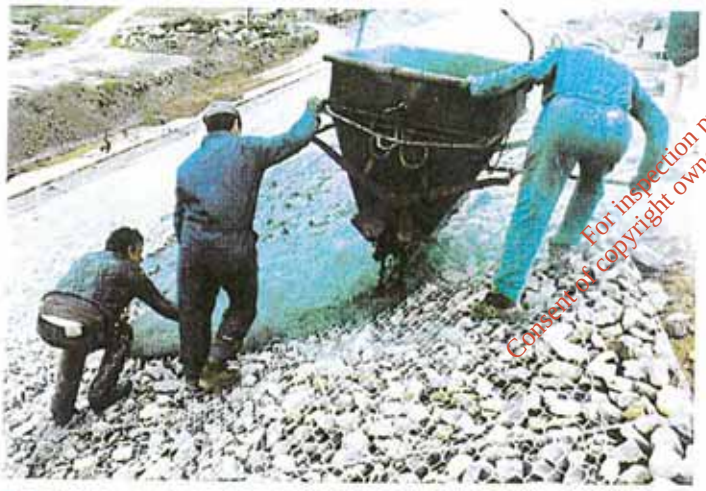
■ *CANADA - Quebec*
Marina walls at Matane; the work was carried out using PVC coated gabions.

Landscaping

■ *CANADA - Quebec*
River wall to a city park along the St.Lawrence in Candiac.

■ *USA - Maryland*
Lining of a stream near Frederich, along highway A40.

Impermeable Lining of Dams

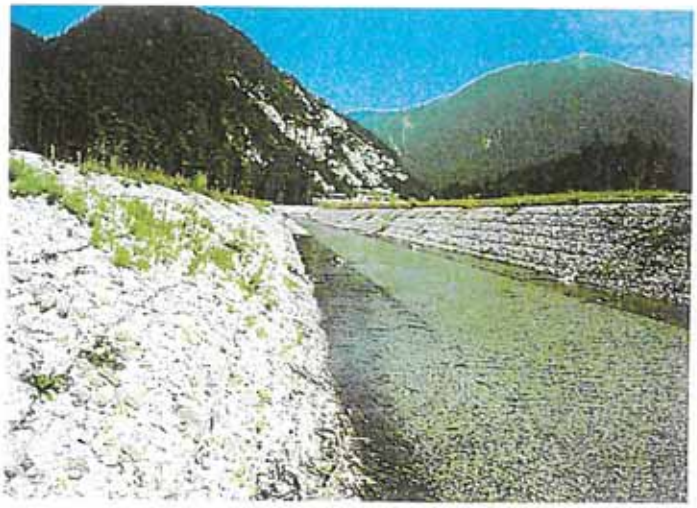


■ *ITALY - Sardegna*
Lochele dam (Nuoro) Reno® mattresses can be sealed by hot poured sand asphalt mastic, in order to provide an impermeable revetment.

Protection of Road and Railway Embankments

■ *ITALY - Calabria*
Reno® mattress lining carried out along the railway line Salerno-Reggio Calabria near Amantea (CS).

Channel Lining

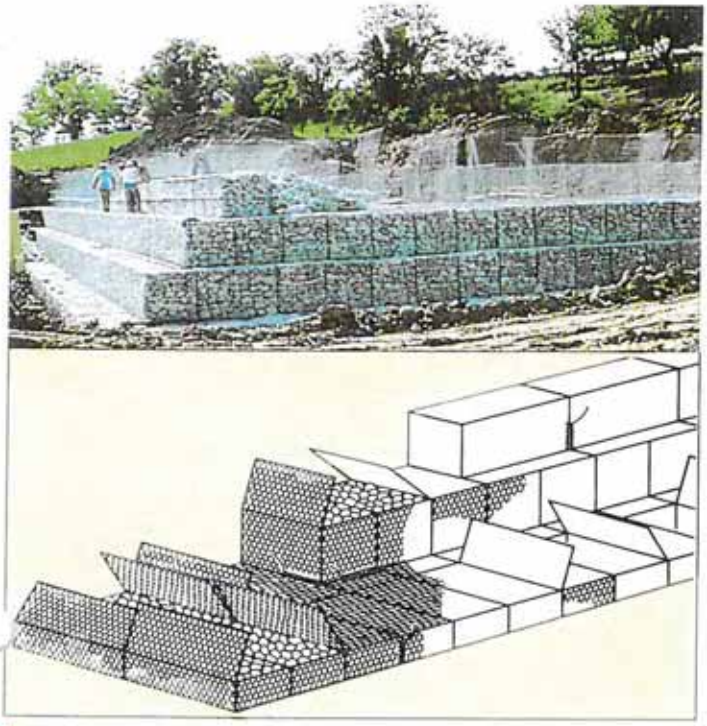


■ *ITALY*
Canalisation and lining of the Fella stream (Udine).

Bundles of gabions ready for shipment.

Gabion filling operation.

Reno® mattresses filling and closing operation.



Assembly of a gabion structure

Gabions and Reno® Mattresses

Assembly

Gabions and mattresses are shipped folded and packed together in bundles, in order to occupy less space and make transportation to sites economical and easy.

On site, they are opened and assembled as follows: corners are wired together and diaphragms are fixed to the side panels. Empty units are subsequently joined together along all adjacent edges, both horizontally and vertically.

Filling

This is usually carried out by mechanical means using rounded river shingle or quarry stone having a size slightly larger than that of the mesh, so as to have minimum percentage of voids. The use of hard material of high specific gravity is recommended.

Pneumatic Assembly Tool

The magazine of this new tool holds up to 80 galvanised or stainless steel "C" rings for rapid assembly.

The system ensures a strong joint of consistent high standard reducing labour cost by increased production.

Notes for Guidance

Gabions can be supplied in a variety of different specifications to meet durability, performance and economy requirements of the specifier.

Individual specification should always include the following basic points:

- **The mesh type** – example: *flexible hexagonal woven wire mesh of 80mm opening size.*
- **The mesh wire** – The British Standard for the steel wire with diameter of the mesh wire and if PVC coated, the overall diameter including the PVC – example: steel wire to *BS 1052, 2.7mm diameter galvanised mesh wire PVC coated to 3.7mm overall diameter.*
- **Details of the reinforced selvedges** – example: *all mesh edges shall be reinforced with a galvanised PVC coated selvedge wire of 3.4mm core diameter overall 4.4mm diameter.*
- **Protective coating** – The British Standard for the galvanising and protective coating of the mesh wire - example: *mesh wire to be galvanised to BS 443 OR wire to be galvanised to BS 443 with a bonded grey PVC coating of mean wall thickness of 0.5mm.*
- **Certification** – example: *BBA certification requirement for durability and Technical Approval.*

SPECIFICATION EXAMPLES

PVC COATED GABIONS

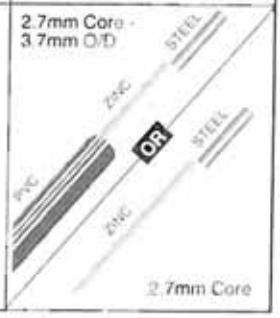
The gabion shall be 2x1x1m with fixed diaphragms at 1.0m centres. The gabion shall be manufactured from steel wire to BS 1052 of 2.7mm diameter and galvanised to BS 443 with a bonded grey PVC coating of mean wall thickness of 0.5mm to give overall diameter 3.7mm. The mesh fabric shall be formed in flexible double twist hexagonal woven wire mesh of 80mm opening size. All mesh edges shall be reinforced with a galvanised PVC coated selvedge wire of 3.4mm core diameter, overall 4.4mm diameter. All joints and connections of gabion units are to be formed using continuous lacing wires and/or high tensile stainless steel "C" rings from 3.0mm wire, attached with a pneumatic assembly tool. PVC coated lacing wire shall be 2.2mm core diameter and be to the same specification as the body mesh.

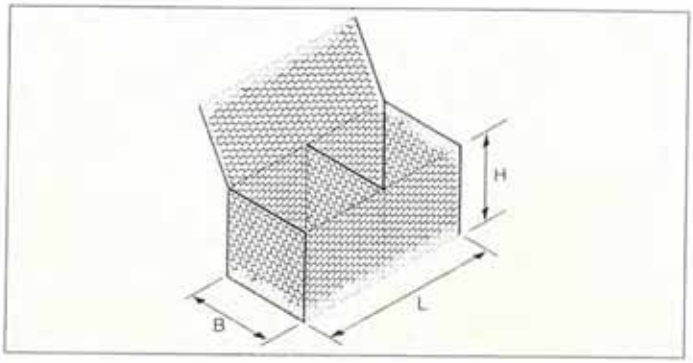
BBA Certification is required for the product for up to 120 year life expectancy.

GALVANISED RENO® MATTRESSES

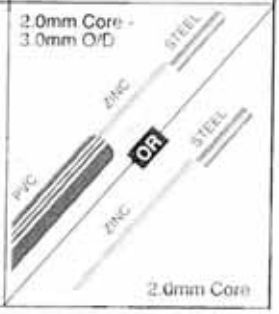
The mattress shall be 6x2x0.23m with fixed diaphragms at 1.0m centres. The mattress shall be manufactured from steel wire to BS 1052 of 2.0mm diameter and galvanised to BS 443. The mesh fabric shall be formed from flexible double twist hexagonal woven wire mesh of 60mm opening size. All mesh edges shall be reinforced with a selvedge wire of 2.4mm diameter. All joints and connections of mattress units are to be formed using continuous lacing wires and/or high tensile steel "C" rings attached with a pneumatic assembly tool. The 2.2mm diameter lacing wire and 3.0mm diameter "C" rings are to be zinc coated to the same specification as the body mesh. BBA Certification is required for the product.

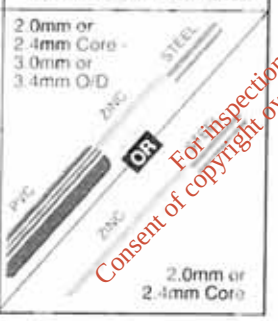
MACCAFERRI GABIONS

LxBxH	Nominal Mesh Size	Mesh Wire Diameter
1 x 1 x 1 2 x 1 x 1 4 x 1 x 1 1.5 x 1 x 1 2 x 1 x 0.5 4 x 1 x 0.5 2 x 0.5 x 0.5 6 x 2 x 0.5		

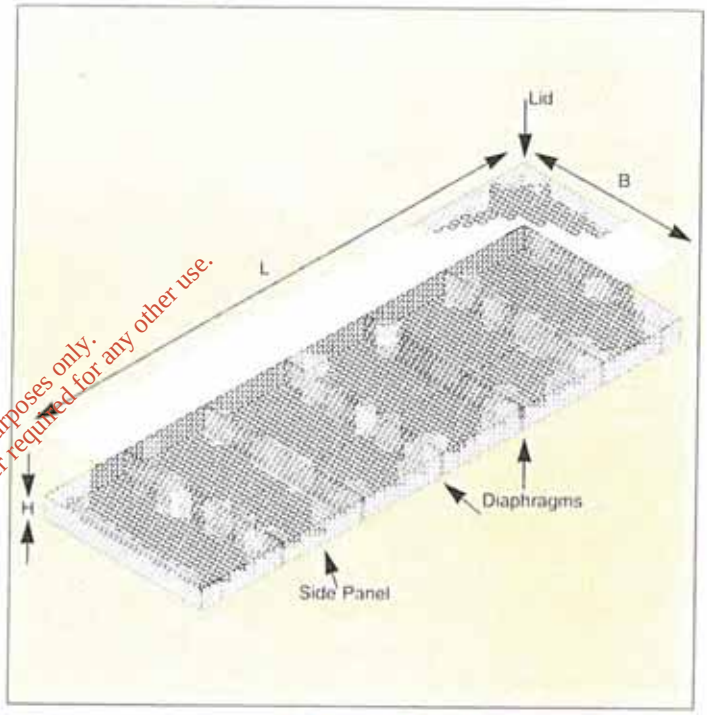


RENO® MATTRESS

LxBxH	Nominal Mesh Size	Mesh Wire Diameter
6 x 2 x 0.17 6 x 2 x 0.23 3 x 2 x 0.17 3 x 2 x 0.23		

LxBxH	Nominal Mesh Size	Mesh Wire Diameter
6 x 2 x 0.3 3 x 2 x 0.3		

Note: Other mesh gauge combinations are available on request.



Quality Standards

- Maccaferri products meet the following standards:
  - All manufactured under ISO 9002.
  - BS 8002 for gabions in all aspects.
  - Specification for Highway Works.
- BBA Certification for up to 120 years life expectancy.

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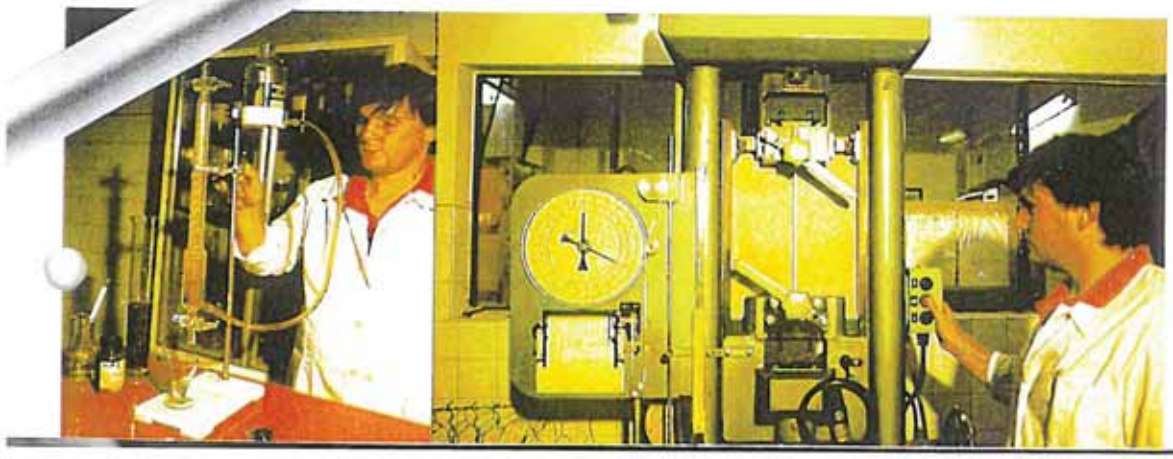
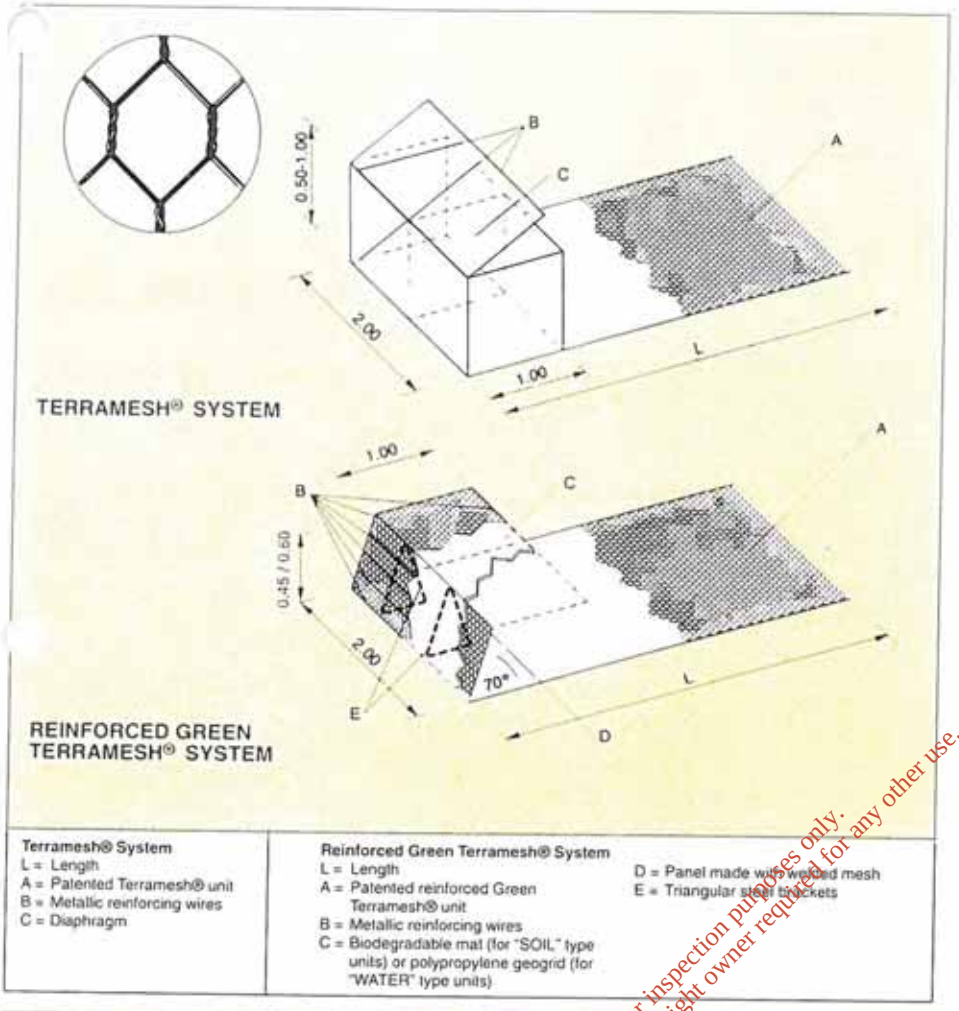
CERTIFICATE No. 93/75



One of our laboratories where wire quality control tests are carried out.



Terramesh® System
L = Length
A = Patented Terramesh® unit
B = Metallic reinforcing wires
C = Diaphragm

Reinforced Green Terramesh® System
L = Length
A = Patented reinforced Green Terramesh® unit
B = Metallic reinforcing wires
C = Biodegradable mat (for "SOIL" type units) or polypropylene geogrid (for "WATER" type units)
D = Panel made with welded mesh
E = Triangular steel brackets

This is a reinforced soil system where units forming the front face and anchorage element are made from one continuous mesh panel.

There are two types:

1. **Terramesh® System**

   Where the front face is either flat or stepped and similar to stone filled box gabions 0.5 or 1.0 metre high.

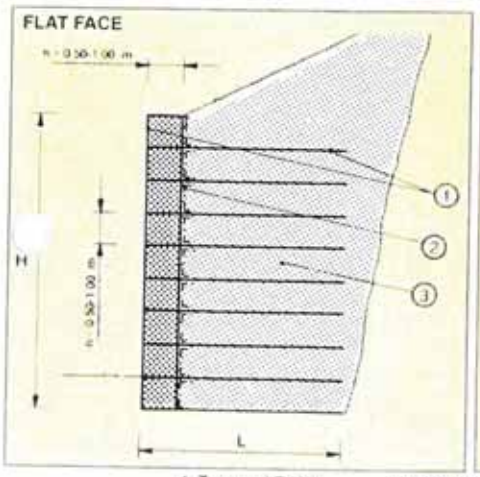
2. **Reinforced Green Terramesh®**

   Where the maximum face angle of 70° is fixed by a triangular reinforcing steel bracket and the unit is entirely filled with soil.

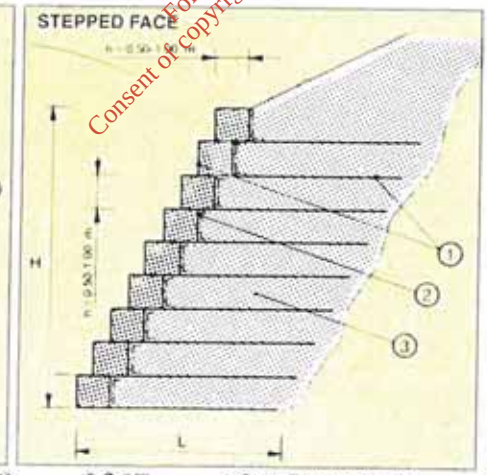
The exposed face is lined with:

a) a biodegradable mat for "soil" type units suitable for hydroseeding.

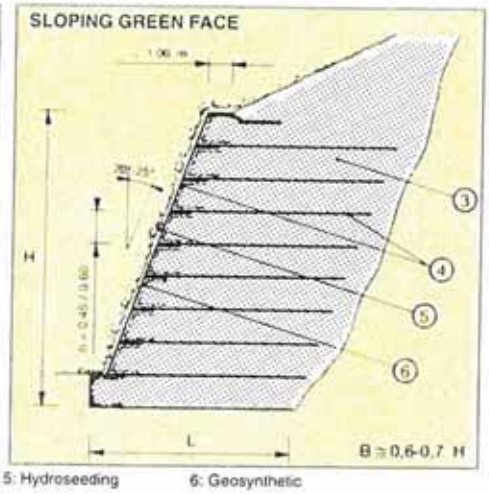
b) a three-dimensional geogrid on "water types". The "water" type can be used for bank protection of water courses.



1: Terramesh® Unit 2: Geotextile



3: Soil fill 4: Green Terramesh® Unit

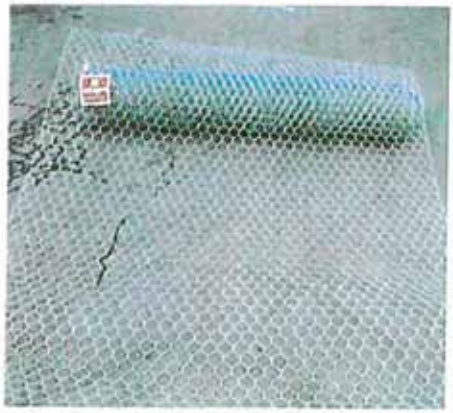


5: Hydroseeding 6: Geosynthetic

■ *AUSTRALIA - Homebush, Sydney*
Site of the Olympic Games in 2000

■ *ITALY - Sardegna*
Retaining works carried out with Green Terramesh® units along the road Bitti-Lula which connects the SS131 to the SS389.

■ *ITALY - Liguria*
Erection of netting by means of a helicopter, near Arenzano.

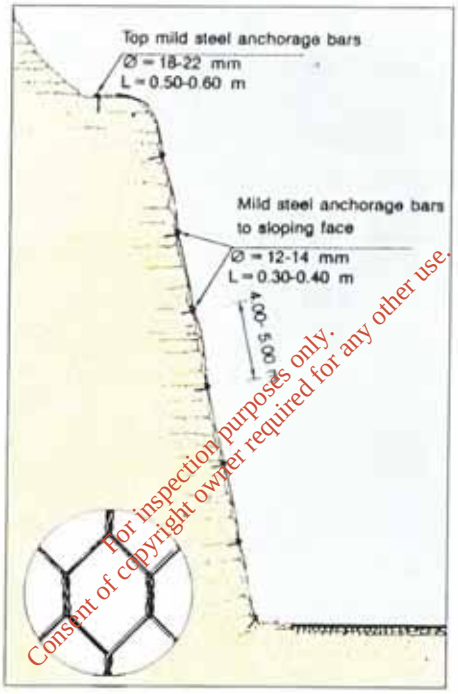


Wire mesh netting is often used to prevent rocks and debris from falling on to roads and railways.

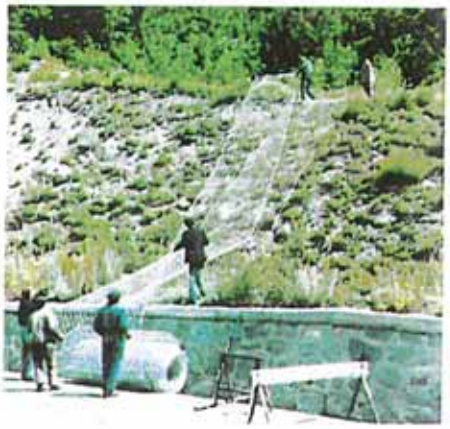
This solution can also help to establish vegetation.

Maccaferri rockfall mesh has the same characteristics as that used for gabions and Reno® mattresses.

Thanks to the double-twist weaving, it is strong enough to withstand the force of the falling rocks and, unlike chain-link mesh, does not unravel should some of the wires break.



■ *ITALY - Valle D'Aosta*
Erection of netting carried out manually.



■ *USA - Tennessee*
Erection of netting by means of a crane, along Interstate 40.

■ *ITALY*
Lacing the netting.

Italy - Trentino-Alto Adige
Protection with MacMat-R® of slope overlooking a railway in Brunico-Bolzano, near Perca (BZ).

MACMAT - R®

MacMat-R® is a composite material consisting of a three dimensional geomat made of polypropylene monofilaments which are integrated during the manufacturing process with Maccaferri double-twist hexagonal mesh. This new product extends the range of Maccaferri products used to protect slopes and banks of watercourses with a low erosive action. MacMat-R® combines the anti-erosive ability of a three-dimensional geomat to the strength of a double-twist wire mesh.

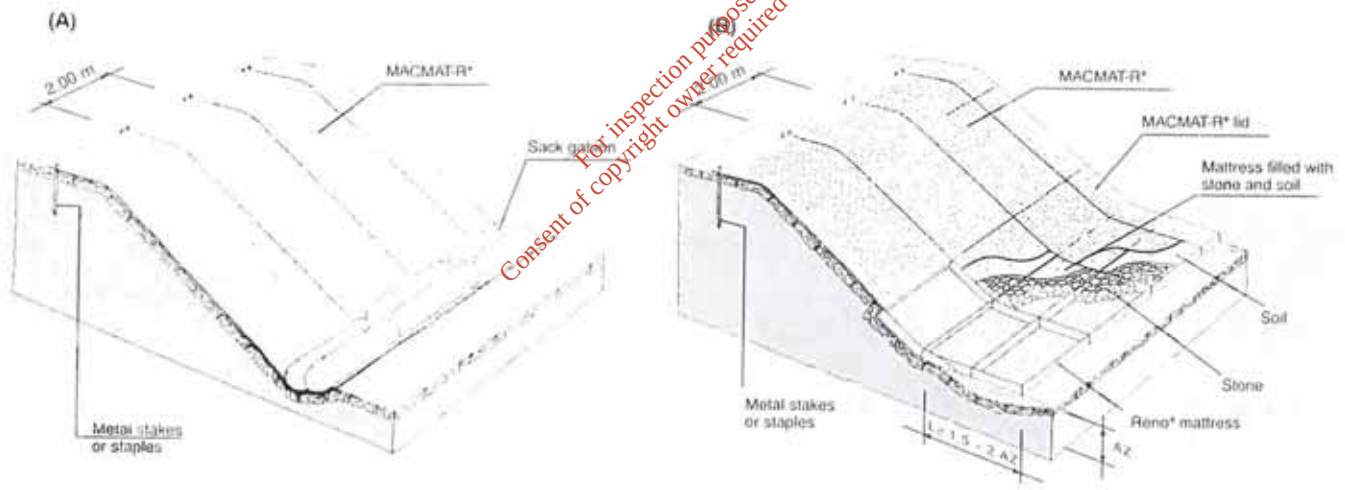
It may be used on its own for light duty revetments or in combination with other Maccaferri products such as Reno® and Geomac® mattresses.

MacMat-R® thanks to its synthetic component, offers an effective solution to the problem of grassing steep slopes which has particular applications in the capping of landfill sites.

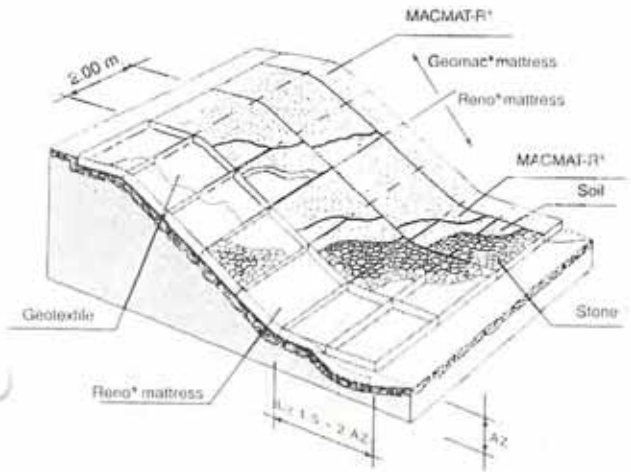
In addition to re-establishing vegetation MacMat-R® is also suitable for rockfall protection where there is a need to prevent rocks from falling onto roads and railways.

In this case MacMat-R® combines the containment effect of the metal mesh and the enhancement of the vegetation growth through the supporting three dimensional matting. The density of the matting allows for easy hydromulching and accelerating a successful vegetation growth.

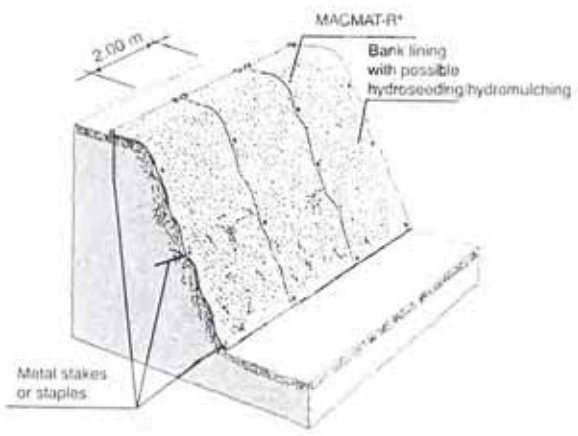
Slope stabilization with MacMat-R* and different toe protection: (A) with sack gabions; (B) with Reno* mattress



Slope protection with MacMat-R* combined with Reno* mattress



Protection of very steep slopes.



Maccaferri Gabions are strong enough to be pre-filled and lifted by crane.

Additional lacing wire is required to double tie the units during assembly and 20mm reinforcing bars may be incorporated along the top edges to help maintain shape during lifting.

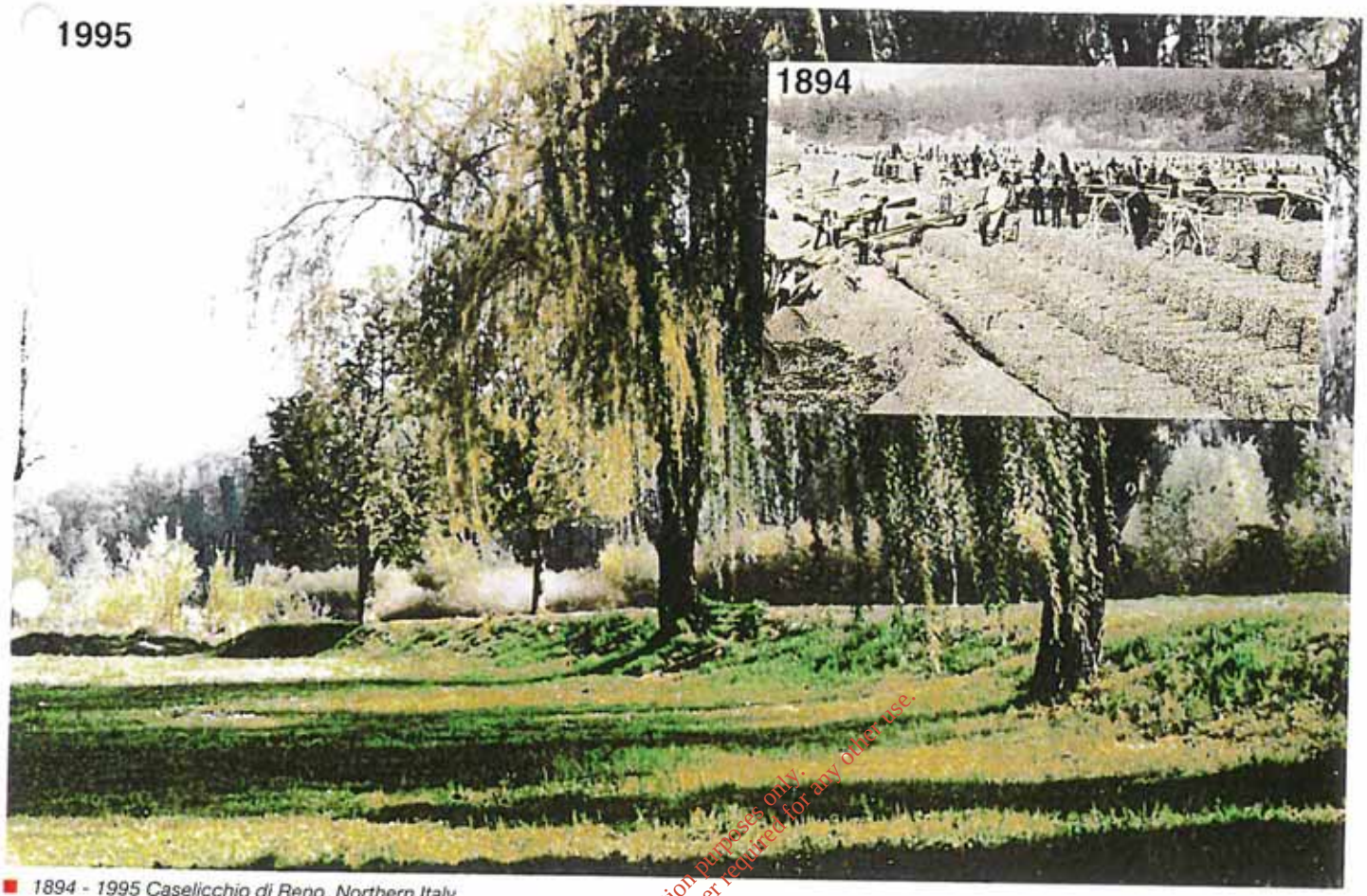
Purpose made lifting frames have proved to be the best method for lifting the filled units and these can either be fabricated or hired from Maccaferri Ltd.

Maccaferri Reno® mattresses can be pre-filled and lifted in a similar way using special lifting frames to suit 3m x 2m and 6m x 2m units.

A geotextile can easily be wired to the underside of the mattress.

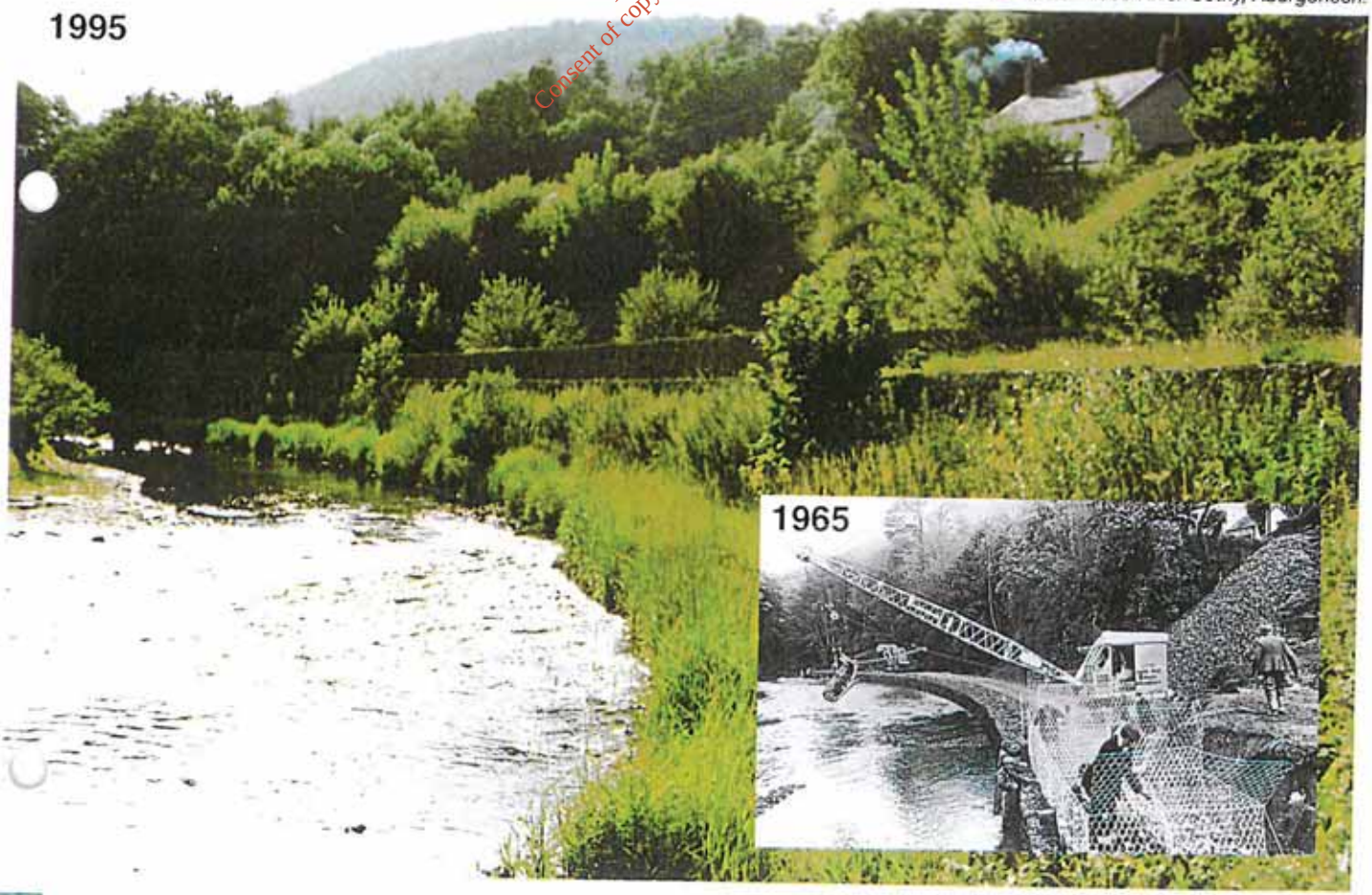
For placing large areas of mattress, more sophisticated methods are available using purpose built pontoons etc.

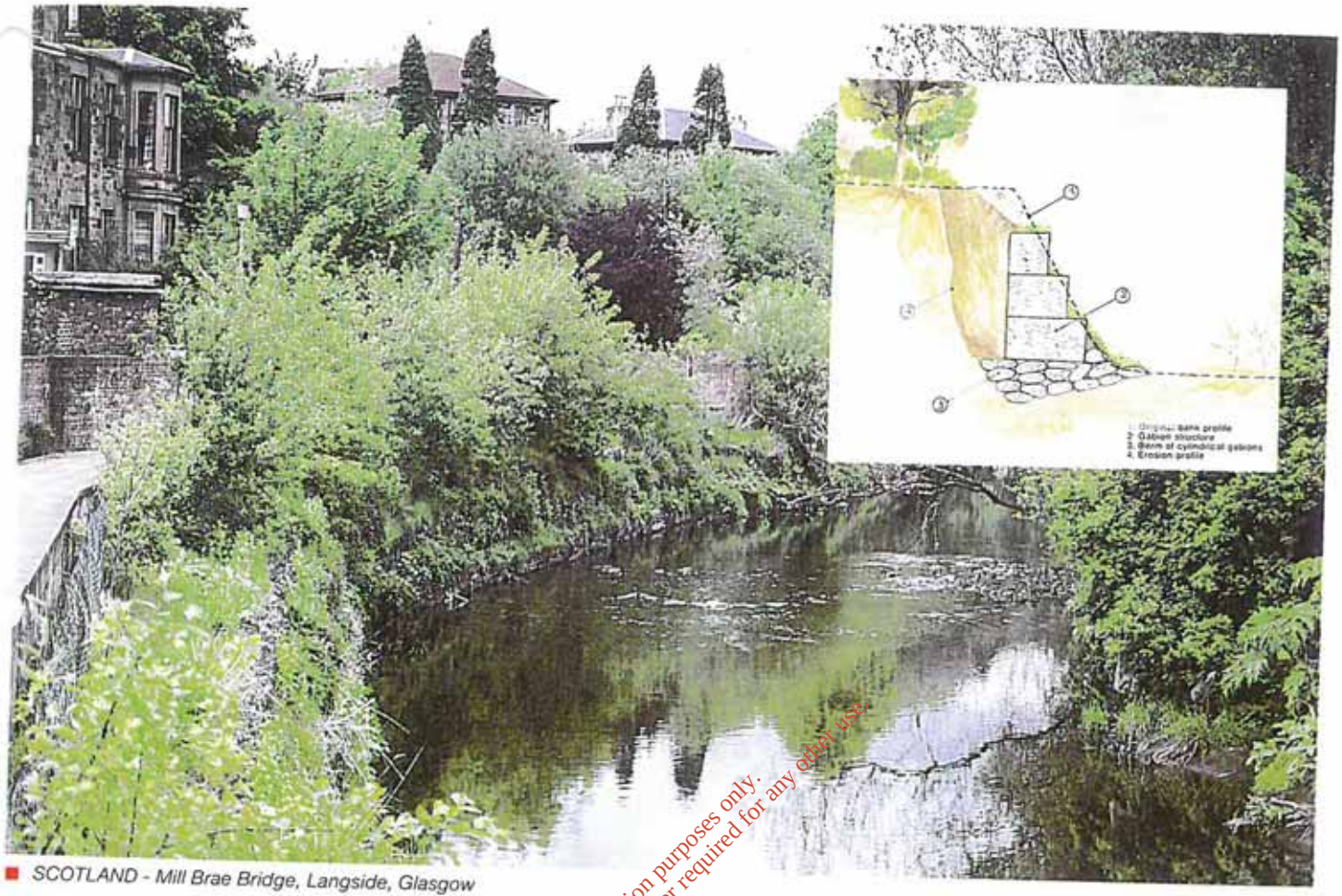
Maccaferri Ltd will be pleased to give detailed examples.



■ 1894 - 1995 Caselicchio di Reno, Northern Italy

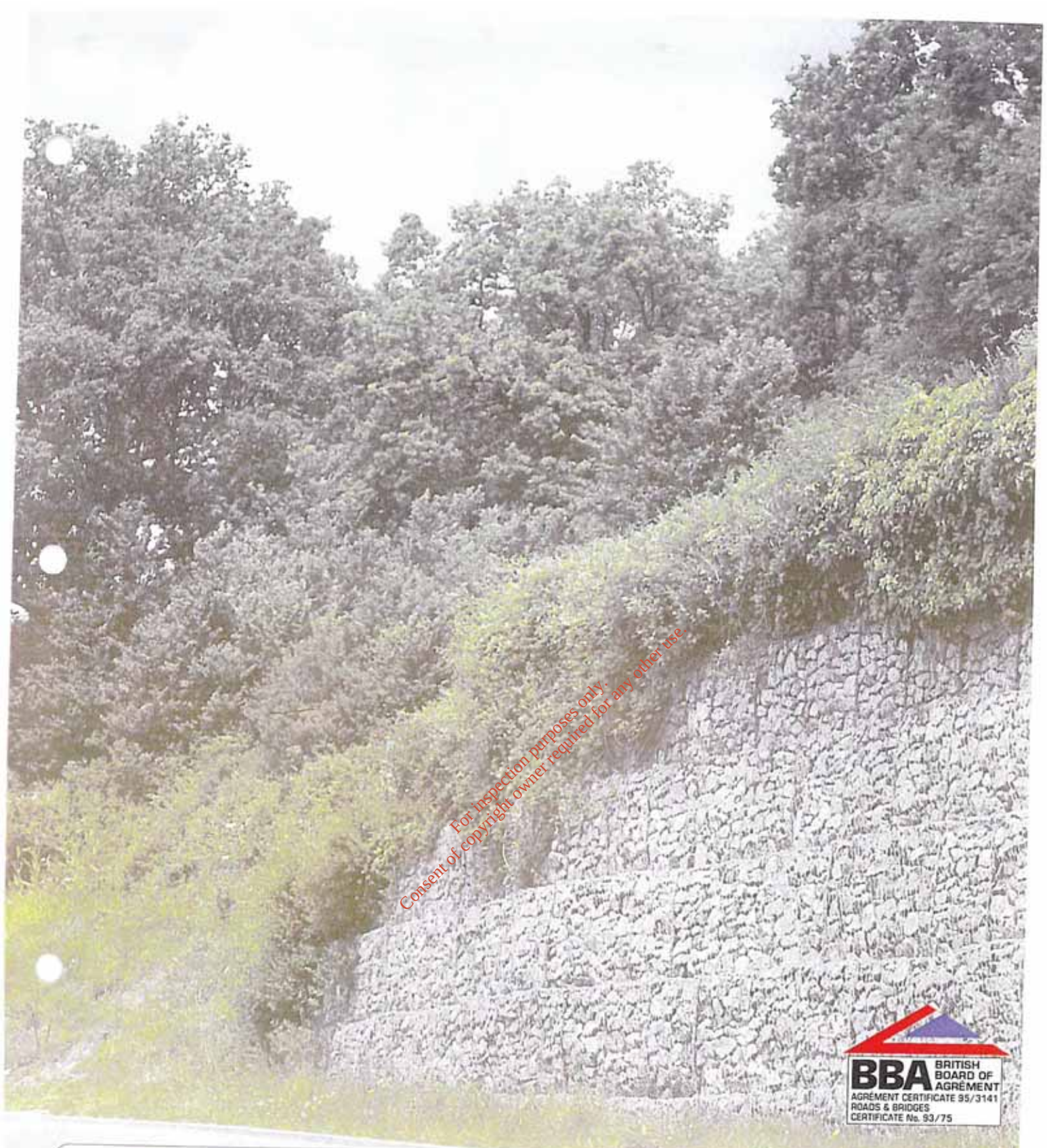
■ 1965 - 1995 River Cothy, Abergorlech.





■ SCOTLAND - Mill Brae Bridge, Langside, Glasgow

■ NORTHERN IRELAND - River Bann



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CERTIFICATE No. 93/75

MACCAFERRI

Environmental Solutions

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Email: belfast@maccaferri.co.uk

Designed and Produced by SEL Birmingham
BH 9 6b

Attachment 2

Membrane Weight Requirement & Puncture Resistance Calculations

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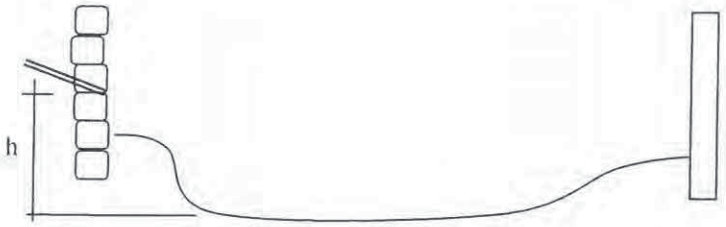
e-mail: info@caraet.com

Check for Buoyancy Condition

Determination of maximum allowable hydrostatic pressure on impermeable liner and corresponding weep hole level



Parameters

Reno + Stone $\gamma_{st} = 17$ kN/m^3
Water $\gamma_w = 9.81$ kN/m^3
Factor of Safety F = 1.2
Depth of Reno + Stone, d = 0.9m
Height to Weep Hole, h

Upstream of Pipe Crossing

Chainage	Liner Level Centre of River	Liner Level Med. Wall	Difference	Liner Level North Wall	Difference (m)
157	41.350	42.628	1.278		
149	41.350	42.688	1.338	42.750	1.400
147	41.335	42.628	1.303	42.730	1.395
145	41.325	42.758	1.433	42.575	1.250
143	41.320	42.648	1.328	42.470	1.150
141	41.310	42.618	1.308	42.415	1.105
139	41.300	42.563	1.263	42.230	0.930
137	41.275	42.598	1.323	42.240	0.965
135	41.250	42.594	1.344	42.265	1.015

Determine h of Weep holes

$$\text{Max } h = \frac{\gamma_s}{\gamma_w} \times \frac{d}{F}$$

$$= \frac{17}{9.81} \times \frac{0.9}{1.2}$$

$h < 1.3$m (for material depth of 0.9m, h must be less than 1.3m)

γ_w = unit weight of water kN/m^3
γ_{st} = unit weight of soil kN/m^3

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Downstream of Pipe Crossing

Chainage	Liner Level Centre of River	Weep Hole Level (Med Wall)	Difference (m)
120	41.175	42.2	1.025
115	41.150	42.2	1.050
110	41.125	42.2	1.075
105	41.100	42.2	1.100
100	41.075	42.2	1.125
95	41.050	42.2	1.150
90	41.025	42.2	1.175
85	40.975	42.2	1.225
80	40.950	42.2	1.250
75	40.925	42.2	1.275
70	40.900	42.2	1.300
65	40.675	42.2	1.344*

*@ Ch 65 depth of material over liner = 1.10m, i.e. >0.9m typically used

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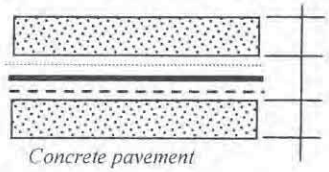
Objective

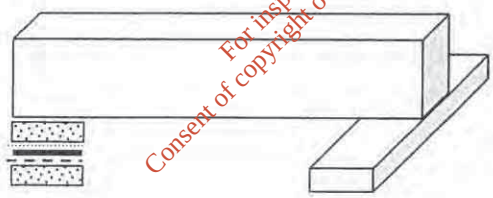
To demonstrate that GCL (Bentofix) is adequately projected by Terrafix (under layer) and Secutex (over layer)

Methodology

Test pad 900 x 900 mm constructed comprising:



Load from concrete block 0.9m x 0.9m x 4.75m applied to test pad weighing 8.6t (crane wt)



Loading

Test Assume load is evenly distributed from concrete.
i.e. 4.3t acting on test pad

Load = 4.3 x 9.81
= 2.2 kN

Area of Pad = 0.9 x 0.9
= $0.81 m^2$

Pressure = 42.2/0.81
= $52 kN/m^2$

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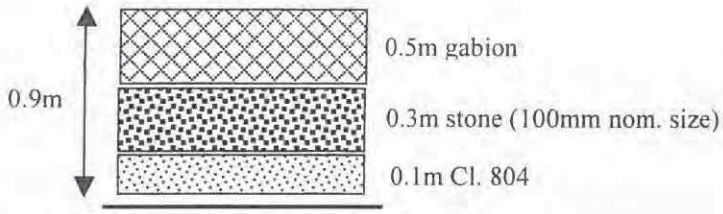
Loading

Reality



Assume density = 1.8 x 9.81
= 17.7 kN/m^3

=>Pressure = 17.7 kN/m^3 x 0.9m
= 15.93 kN/m^2

F o S > 3

Visual Inspection

- Photographs taken
- No visible damage to any element of barrier system
- Minor indentations visible

Conclusions

- On the basis of test, the system satisfactorily resists puncture and remains fully intact

Appendix B

River Breagagh Remediation Project – Post Closure Monitoring Plan

B1 River Breagagh Remediation Project – Post Closure Monitoring Plan

Please see River Breagagh Remediation Project – Post Closure Monitoring Plan overleaf.

P0448-01 River Breagagh Remediation Project

Post Closure Monitoring Plan

Diageo Kilkenny
PCB Surveys
IE0310690-22-RP-0004, Issue: B

Issue date: 21 August 2014

Document Sign Off

P0448-01 River Breagagh Remediation Project
Post Closure Monitoring Plan

Diageo Kilkenny
PCB Surveys
IE0310690-22-RP-0004, Issue B

File No: IE0310690.22.150

CURRENT ISSUE					
Issue No: B	Date: 21/08/14	Reason for issue: For Inclusion in CRAMP			
Sign Off	Originator	Checker	Reviewer	Approver	Customer Approval (if required)
Print Name	Tim O'Shea		Eileen Lee	Tim O'Shea	
Signature	**Authorised Electronically**				
Date	21/08/2014		21/08/2014	21/08/2014	

PREVIOUS ISSUES							
Issue No	Date	Originator	Checker	Reviewer	Approver	Customer	Reason for issue
A	15/05/2014	Tim O'Shea		Eileen Lee	Tim O'Shea		For Information

Contents

1 Introduction

1.1 Background

This report documents the proposals for continuation of a PCB survey (monitoring) programme to be carried out at the Diageo St. Francis Abbey Brewery (SFAB) site, located in Kilkenny. The purpose of this update is to formalise the survey proposals for future monitoring following cessation of commercial operations at the site in May 2014, further to consultation with the EPA and Kilkenny County Council.

The PCB survey programme has been carried out annually at the Kilkenny site following the completion of a remediation project on a section of the river Breagagh in 2001. Details of the remediation project completed are reported separately (PM Group report no. IE0310690-22-RP-0005 Issue A).

1.2 Annual PCB Monitoring Programme (2003-2013)

Following the completion of the remediation project, a programme of proposed ongoing monitoring for PCBs was agreed between Diageo and the EPA (May 2002). This programme of monitoring is summarised in Table 1.1.

Table 1.1: Summary of Annual PCB Survey Programme (Post Remediation – Present)

Monitoring of PCB Levels	Frequency
Fish Tissue	Annual
Biota	Annual
Riverbed Sediment	Annually
Groundwater through vent panels	Twice annually (aligned with IPPC monitoring)
Groundwater from (new) boreholes	Twice annually (aligned with IPPC monitoring)
Groundwater - Production Well	Twice annually (aligned with IPPC monitoring)
River Water	Annually

Since the remediation project was completed, results of the ongoing surveys have been submitted by Diageo to the EPA as part of the site Annual Environmental Report (AER) or as results became available depending on the particular time of year.

The main purpose of the survey programme is to identify if any residual PCB material has been released to the river Breagagh (e.g. due to possible deterioration of or damage to the installed membrane over time) and if there is any possible pollution impact. The indicators for PCB pollution and the standards to which measured PCB levels are compared are summarised in Table 1.2 overleaf.

Table 1.2: Current Indicators for PCB pollution in Fish, Biota, Sediment & Water and Legislative/Best Practice Guidelines

Survey Element	Indicator Parameter	Reference for Limit / Threshold
Fish Tissue	ΣPCB7	European Regulation No. 1259/2011 (EU Food Safety Standard) EU Directive 2013/39/EU (from 2014)
Biota	Q-value	Water Framework Directive / South Eastern River Basin Management Plan Objective
Riverbed Sediment	ΣPCB7	Dutch Intervention Value for Soils
Groundwater	ΣPCB7	Dutch Intervention Value for Groundwater
River Water	ΣPCB7	EPA Guidelines [Note] EU Directive 2013/39/EU (from 2014)

Note: Most recent guidance relevant to PCBs contained within EPA guidance, namely *"Towards Setting Guideline Values for the Protection of Groundwater in Ireland"*, which in addition to groundwater standards, also references the Lowest Drinking Water Guideline Value (or Intervention Value) of the countries reviewed.

2 Long Term Monitoring Strategy

In the context of the site closure, the following section provides the proposed update to the previously agreed annual monitoring programme for PCBs, taking into account the results of surveys completed since the original remediation project.

In summary, a continued survey programme is proposed incorporating the following elements:

- Fish Sampling
- Biota Sampling
- Sediment Sampling
- Visual Inspection of Membrane & Assessment of Integrity

Where changes to the existing monitoring programme are proposed, justification is included based on a review of existing survey results.

2.1 Fish Sampling

2.1.1 Review of Existing Data

Results for fish samples have been compared insofar as possible to relevant EU Food Safety Limits (European Regulation No. 1259/2011).

For trout and salmon, PCB levels have been shown to be within relevant EU Food Safety limits for all samples between 2003 and 2013, i.e. post remediation, with the exception of a single sample of trout in 2008 (Figure 2.1 below).

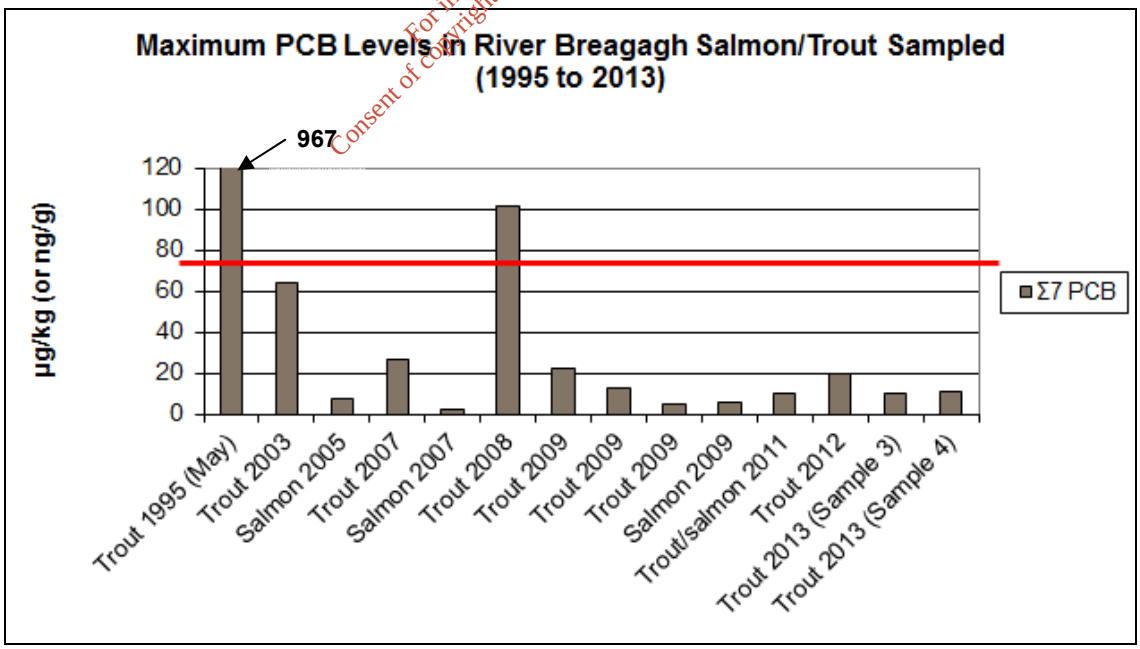


Figure 2.1: Maximum Σ7 PCB Levels in River Breagagh Salmon/Trout (1995 – 2013)

Note: The red line in Figure 2.1 reflects the strictest food safety limit of 75ng/g for PCB levels (Σ6 PCB) in salmon/trout set down in the European regulation (EC No. 1259/2011). It is noted that graph values reflect Σ7 PCB results.

A number of eel samples have continued to show results in excess of the EU maximum value for sum of non dioxin-like PCBs (Figure 2.2 overleaf), again with regard to food safety. It is noted that the results for sum of dioxin-like PCBs in the same samples were within the corresponding EU maximum value.

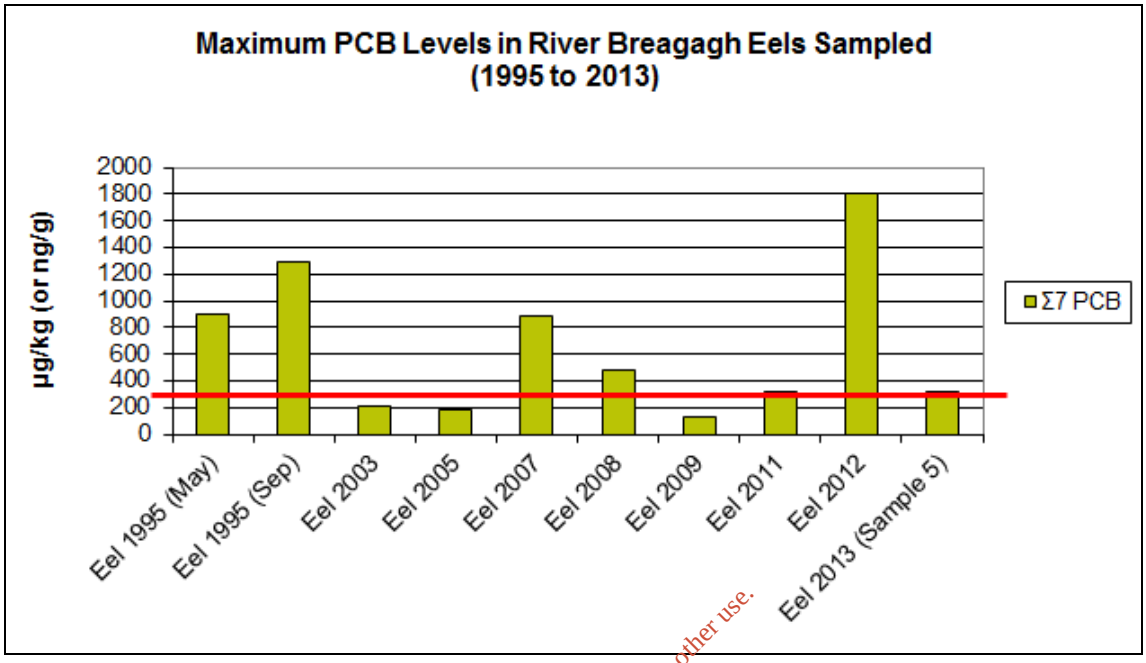


Figure 2.2: Maximum Σ7 PCB Levels in River Breagagh Eel (1995 – 2013)

Note: The red line in Figure 2.2 reflects the strictest food safety limit of 300ng/g for PCB levels (Σ6 PCB) in eels set down in the European regulation (EC No. 1259/2011). It is again noted that graph values reflect Σ7 PCB results.

Overall, the results of the fish surveys of recent years show general compliance with relevant EU food safety limits, with the exception of non dioxin-like PCBs in eels (2007, 2008, 2011, 2012, 2013) and an isolated result in trout (2008).

It is noted that since 2012, the fishing of eel is illegal under the *Conservation of Eels Fishing Bye Law* (No. C.S. 312, 2012). This ban on eel fishing is subject to review in 2015.

Updated Environmental Quality Standard (EQS)

In 2013, the European Union agreed revised standards for dioxins and dioxin like PCBs (DL-PCBs) in water. Dioxins and DL-PCBs have been added to the European list of priority substances and associated limits have been established as part of Directive 2013/39EU[1].

Under the 2013 Directive, the Environmental Quality Standard (EQS) for dioxins and dioxin like PCBs is 0.0065µg/kg TEQ (sum of PCDD+PCDF+PCB-DL). The TEQ limit value is based on toxic equivalency and has been reported for PCB by Diageo annually since 2011, further to the introduction of the EU Food Safety Regulations in 2011 (EC No. 1259/2011). The summary results shown in Table 2.1 may now be compared to this new limit of 0.0065µg/kg.

[1] Directive 2013/39/EU of the European Parliament and of the Council of 12 August 2013 amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy

Table 2.1: Summary of Fish Survey (PCB TEQ) Results (2011-2013)

Year	TEQ Result Range (µg/kg)	No. of Fish Samples
2011	0.00019 – 0.00109	4
2012 (Brewery Yard eels sample excluded)	0.00004 – 0.00068	5
2012 (Brewery Yard eels sample included)	0.00004 – 0.00768	6
2013	0.00006 – 0.00221	9

Comparison of all TEQ results reported since 2011 shows ongoing compliance for levels of PCB with the latest European EQS (0.0065µg/kg) with a single exception noted in 2012 (1 no. eels sample). It is noted that dioxins and furans (PCDD+PCDF) are not expected in significant quantities owing to the nature of the original source of contamination (transformer oil spill) and reported data for levels of dioxins and furans in Irish freshwater fish[2].

2.1.2 Scope of Future Sampling

The review of existing survey data shows that EU Food Safety limits have generally been met since remediation with the exception of a number of exceedances for non-dioxin like PCBs in eels at the Brewery Yard site and a single trout sample in 2008. Since 2012, the fishing of eels has been prohibited for conservation purposes. No food safety issue is foreseen on this basis.

The most recent survey data since 2011 shows that TEQ values for dioxin like PCBs (DL PCBs) have been compliant with the newest European Environmental Quality Standard (EQS) for PCB, again with the exception of a single eels sample in 2012.

It is therefore recommended that continued monitoring of fish tissue be continued but that the survey be limited to eel samples at the River Breagagh (Brewery Yard/spill site and upstream control location). Since reporting of TEQ values commenced in 2011 in line with European Regulation No. 1259/2011, a review of results for salmon and trout (2011-2013) shows compliance was achieved with the latest European EQS described above (Directive 2013/39EU). As the PCB results for salmon and trout do not exceed the EU EQS (Table 2.1), it is considered that sampling of trout and salmon will no longer be required. Monitoring of eel should be continued for comparison with the EU EQS.

Consistent with the previous survey methodology and subject to ongoing permission (in consultation with Inland Fisheries Ireland), muscle samples will be taken from collected fish and the sample will be taken from the same portion of the fish in all cases (a square cut from below and slightly in front of the dorsal fin and down to the lateral line). Fish muscle is appropriate for monitoring, particularly in light of the human consumption perspective. Lipid content will also be measured. Fish of similar age/size will be used for all the samples insofar as possible. It is noted that the fish surveys of previous years have been constrained significantly due to naturally occurring factors including river size and consistent sample availability (i.e. age, size, species of fish).

2.1.3 Frequency of Analysis

It is proposed that the frequency of fish sampling is not altered and that fish samples will continue to be collected annually.

[2] Investigation into levels of dioxins, furans, polychlorinated biphenyls and brominated flame retardants in fishery produce in Ireland, Tlustos *et al*, 2006.

2.1.4 Responsibility

It is proposed that, subject to continued availability of resources and necessary permission, the sampling will be carried out by Inland Fisheries Ireland.

The samples will be sent to an approved laboratory for analysis. Since the remediation project, the Marine Institute has provided ongoing specialist laboratory analysis services by sub-contract. As the Marine Institute (MI) is obliged to fulfil its core services under statute, the availability of MI resources cannot be guaranteed for this task. However MI is positioned to advise the agreed monitoring plan regarding appropriate alternative laboratories, if required.

2.1.5 Reporting

The results of any future fish survey(s) will be compared with the current EU Food Safety limits (EC No. 1259/2011) and the latest EU Environmental Quality Standard (2013/39/EU). It is expected the latter European Directive will be implemented into Irish law, by way of amendment to the Surface Water Regulations 2009, as amended. Comparison will also be made with the previous survey results.

It is proposed that results from the fish survey will be compiled with those from other survey elements agreed, e.g. sediment, biota, etc. and a final annual report compiling all results for a given year based on the agreed overall survey programme will be submitted to the Regulatory Authority.

2.2 Biota Sampling

Since remediation, sampling of river bed biota has been undertaken annually. The biota sampling completed provides an indication of the long-term quality of the water since remediation, rather than an instantaneous snapshot at the moment of sampling (as in the case of chemical analysis). It is noted that Q-value is not a direct measurement of PCB level, but rather an indicator of biological health within the river environment.

The sampling procedure used is that commonly known as ‘kick sampling’ where the bottom fauna on the river bed are disturbed at a sample location by kicking the bed for a fixed time interval. Dislodged invertebrates are caught in a hand net held on the bottom immediately downstream of the disturbed zone.

A study of the relative abundance of the macroinvertebrate groupings captured at each sample location allows for the determination of biological water scoring, known as Q-value. The Q-value is a five point scale of biological water quality, ranked as follows:

- Q1 Bad
- Q2 Poor
- Q3 Doubtful
- Q4 Fair
- Q5 Good

2.2.1 Review of Existing Data

The Q-value scores assigned over the last seven surveys, including the most recent survey of June 2013, are summarised in Table 2.2 below. The four sites referenced include two points on the river Breagagh (1 upstream, 1 downstream) and two points on the river Nore (1 upstream of river confluence, 1 downstream of river confluence).

Table 2.2: Q-Value of Rivers Nore and Breagagh at locations adjacent to SFAB site (2006 to 2013)

Survey Location	Q-Value						
	2013	2012	2011	2009	2008	2007	2006
Site 1 Upper Breagagh (Control)	4	4	4	3-4	3-4	3	3
Site 2 Breagagh Remediated Zone	4	4	4	3	3	4	4
Site 3 Downstream of Confluence of River Breagagh & Nore	3	4	3-4	4	3-4	2-3	2
Site 4 River Nore at Green's Bridge (upstream of confluence)	5	4	4	5	5	5	3

Q1 = Bad
Q2 = Poor
Q3 = Doubtful
Q4 = Fair
Q5 = Good

As noted above the biological river water quality at the sample locations adjacent to the brewery site has been consistently scored Q3 or higher since 2008. Within the remediated zone (sample site 2), there has been no significant deterioration or downward trend in recent years that would indicate a pollution impact on riverbed invertebrate life. Overall the results show a consistent trend over recent years at all survey locations.

Regarding Site 3, the Q value for this site in 2013 was Q3. This was a slight reduction to the value for 2012 (Q4). As reported by Enterprise Ireland survey personnel, it is believed that this reduction was due to the significant siltation of the streambed at this monitoring location.

2.2.2 Scope of Future Sampling

To date, the biota surveys have consistently concluded the ongoing absence of a contaminant in the remediated zone. This is demonstrated by the consistency observed between invertebrate numbers upstream of and within the remediated zone.

As biota sampling is an established method of assessing long term water quality, it is recommended that this monitoring be continued within the River Breagagh only. Monitoring should be continued both upstream of the remediated zone and within the remediated zone. Any deterioration in Q value within the remediated zone, which is not also apparent with the upstream control site, will signal the presence of a contaminant. This can then be assessed against results for fish and sediments surveys in parallel.

It is considered that monitoring of biota at sites in the river Nore is no longer required and that biota results from the Brewery Yard (spill site) are best compared with upstream results from the same river, i.e. Breagagh.

2.2.3 Frequency of Analysis

As the Q value is a measure of longer term biological quality, it is proposed that this biota sampling will continue to be carried out annually.

2.2.4 Responsibility

Since the remediation project, biota monitoring has been carried out by by staff of Enterprise Ireland (Shannon Aquatic Toxicity Laboratory). In November 2013, the acquisition of the Shannon Aquatic Toxicity Laboratory was completed by City Analysts Ltd.

Accordingly, it will be required to review the biota survey service provider for any survey programme commissioned following closure of the site. A wide number of environmental laboratories and survey companies are equipped to undertake biological water surveys.

2.2.5 Reporting

The results of the surveys will continue to be compared with the standards established by the European Water Framework Directive, as implemented locally through the objectives contained in the South Eastern River Basin Management Plan. Comparison will also be made against the previous survey results.

It is proposed that results from the biota survey will be compiled with those from other survey elements agreed, e.g. fish, sediment, etc. and a final annual report based on the agreed overall survey programme will be submitted to the Regulatory Authority.

2.3 Sediment Sampling

2.3.1 Review of Existing Data

Sediment sampling of the river bed has been undertaken annually since the completion of the remediation project at locations on the rivers Breagagh and Nore, to identify any PCB contaminated material that may be released from beneath the existing barrier installed on the river bed, i.e. release caused by damage to or deterioration of the liner.

In recent years, there has been no value for sediment analysis of riverbed material found to be in excess of the laboratory limit of detection with the exception of 2009 when PCB levels of 0.174mg/kg and 0.029mg/kg were measured in two sediment samples. The first of these values, 0.174mg/kg, was a sample from within the remediated zone. The second value, 0.029 mg/kg, was from downstream of the Nore-Breagagh river confluence. These values are both within the Dutch Intervention Value (1mg/kg) used in the original remediation plan.

Based on the survey dataset available since completion of the remediation project, there is no significant evidence of PCB contamination of river bed sediment sampled from locations on the rivers Breagagh and Nore (including within the remediated zone).

2.3.2 Scope of Future Sampling

Subject to further consultation with the EPA regarding a relatively new and emerging methodology for sediment analysis, i.e. passive sampling as outlined in Section 2.3.6 below, it is proposed to continue monitoring the riverbed sediment by means of grab sample.

It is proposed that sediment sampling be focused at two locations only, one within the remediated zone and the other at an upstream control location in the River Breagagh.

It is considered that continued sediment monitoring in the River Nore is not required.

2.3.3 Frequency of Analysis

It is proposed that this sediment monitoring will continued to be carried out annually. However, if liner damage is observed at a particular location, follow up monitoring should be initiated as appropriate.

2.3.4 Responsibility

Riverbed sediment was previously collected by Cara Environmental and in more recent years directly by the appointed consultants.

A wide number of environmental service providers are equipped to undertake riverbed surveys and the existing survey locations remain easily accessible during summer months when waters are shallow, particularly with reference to the river Breagagh.

Sediment samples collected will be transported under chain of custody to an accredited laboratory for analysis.

2.3.5 Reporting

The results of the surveys will continue to be compared with the Dutch Intervention Value standards (1 mg/kg). Comparison will also be made against the previous survey results.

It is proposed that results from the biota survey will be compiled with those from other survey elements agreed, e.g. fish, sediment, etc. and a final annual report based on the agreed overall survey programme will be submitted to the Regulatory Authority.

2.3.6 Temporal Changes in PCB Level

Further to consultation with the Marine Institute regarding persistent levels of PCB detected in a number of fish samples (Section 2.1), it is noted that the existing annual monitoring programme (based on grab samples) provides a method of monitoring and reporting levels of PCB at a particular time, for comparison to available regulatory limits which are set for environmental exposure to PCB and/or human health. Based on this comparison, the requirement for more detailed investigation can be determined.

There is an emerging method for assessment of water based pollutants, namely passive sampling. This may enable greater investigation of temporal changes in PCB level at the Breagagh site by installation of passive device samplers. However research is ongoing into the effectiveness of such methodology.

The Marine Institute and its project partners have published a number of articles and presentations regarding passive sampling[3]. Between 2008 and 2012, a project was completed for the '*Development of a Risk-based Model for use in Water Quality Monitoring'*. This project identified the need to investigate alternative sampling techniques with specific reference to passive sampling. A number of related research projects involving passive sampling have been ongoing since 2005.

In 2013, a project was initiated to test the use of passive sampling technologies (and biota analysis) in surface water monitoring of priority substances in Ireland. As noted by this project team, *"the widely accepted method for water monitoring involves grab sampling which is both expensive and labour intensive, and is limited by the fact that it identifies only compounds present at a single point in time. Passive sampling is proving to be a valuable tool for the monitoring of priority substances in water, sediment and biota"*. This project is due to be concluded in 2016.

Subject to further consultation with the Regulatory Authority regarding suitability of passive sampling, it is proposed that the existing grab sample method for sediment sampling be continued. For passive sampling, a further review would also be required to confirm (i) the reliability of equipment and (ii) availability of survey resources in this emerging field.

It has been confirmed that the Marine Institute does not have availability at this present time for the execution of a newly designed survey programme at the river Breagagh.

2.4 Visual Inspection & Assessment of Integrity

2.4.1 Review of Existing Data

It is noted that the riverbed membrane layers are designed to be impermeable, scour resistant and self-repairing. The installed liner is only approximately half way through its design life and there has been no visual evidence to date to suggest damage to the liner.

A programme of documented visual inspection was not part of the original monitoring programme agreed previously with the EPA. However on the basis that Diageo will not be the future occupant of the site, it is considered sensible that a more formal schedule of visual inspection and assessment of integrity be agreed.

[3] Irish Passive Sampling Research website (https://sites.google.com/site/irishpassivesampling/home), accessed 21 August 2014

2.4.2 Scope of Future Monitoring

Further to EPA feedback regarding the Closure, Restoration & Aftercare Management Plan (CRAMP) for the site, it is noted that regular visual monitoring is required to check the containment system's integrity. Areas of damage or deterioration observed should be repaired accordingly.

During periods of low water, i.e. summer months, a suitably qualified engineer should visit the site to visually inspect the installed liner for possible deterioration or other damage. The locations to be monitored include:

- Upstream and downstream ends of Reno mattress covering the liner;
- Sides of the Reno mattress along both northern and southern river banks;
- Exposed sections of Reno mattress observed.

An inspection report should be completed including photographs verifying the condition of the liner and any defects observed. The report should also contain an explicit statement that the full extent of the liner was inspected (insofar as possible) and note any difficulties encountered.

2.4.3 Frequency of Analysis

It is proposed that the liner be visually inspected annually. The optimum time to carry out this inspection would be during periods of low water levels in the river, i.e. May – September, assuming relatively dry weather in the weeks prior to survey.

2.4.4 Responsibility

Diageo shall engage the services of a suitably qualified Senior Engineer, experienced in the design and installation of membranes/liners, to inspect the integrity of the installed liner.

2.4.5 Reporting

The results of the inspection survey will be documented in a report.

It is proposed that this report will be compiled with those from other survey elements agreed, e.g. fish, sediment, etc. and a final annual report based on the agreed overall survey programme will be submitted to the Regulatory Authority.

If damage to the liner is observed, the Regulatory Authority shall be immediately notified and a specific follow-up investigation and remedial plan will be agreed with the Regulatory Authority.

2.5 Other Considerations

Both groundwater and river water have previously been sampled for PCBs as part of the annual survey programme. The results to date for water samples have shown no evidence to indicate the presence of PCBs.

It is considered that grab samples of water are not merited as any possible future contamination by released PCBs will be more readily detected by means of the survey elements described above.

If damage to the installed liner is observed, groundwater and/or surface water monitoring may be considered as part of a follow-up investigation.

2.6 Duration of Monitoring Strategy

An annual monitoring programme has been in place since completion of the remediation project (2003-2013). It is proposed that this monitoring programme be continued annually on the basis of the above recommendations.

Results for fish, biota and sediment should be compared to the legislative limits described and any future revisions or updates of these standards which may arise. In particular, reference is made to the new European Environmental Quality Standard (EQS) for dioxins and dioxin-like compounds including PCB in water (fish) contained in Directive 2013/39/EU.

Following a period of six years from 2014, the latest body of results should be reviewed in consultation with the Regulatory Authority and an update of the monitoring strategy completed and agreed.

Assuming annual implementation in the years 2014 to 2019, a formal review of the available results and ongoing monitoring requirements should be completed with the Regulatory Authority in 2020.

2.7 Agreement & Review of Monitoring Plan with Regulatory Authorities

Diageo has engaged in a process of consultation with both the EPA and Kilkenny County Council (KCC), regarding the requirements for future environmental monitoring. As part of the Written Agreement between KCC and Diageo, documented separately to this report, the following is noted regarding the post closure monitoring plan for PCBs:

Subject to indemnification by KCC, in the manner provided for in the Written Agreement (Clause 5.1), Diageo agrees to comply or procure that its Affiliate complies with the monitoring requirements agreed by KCC, the Environmental Protection Agency and Diageo and detailed in this report for a period of 6 years from the date of the Written Agreement in respect of the Breagagh River and the lining affixed by Diageo or its Affiliate to that portion of the bank and base of the Breagagh River set out and described in the map attached to the Written Agreement (Schedule 3). If such monitoring indicates that further investigation is required in relation to an Environmental Matter then Diageo shall:

a) appoint such consultants it deems necessary to conduct such further investigation and review of the results of the monitoring and produce a report in relation thereto (a "Report") giving its recommendations for treatment and/or remediation (if any); and

b) take such actions (to be agreed with KCC) as reasonably required in respect of the treatment and/or remediation (if any) set out in a Report at Diageo's cost.

Prior to the end of the 6 year period referred to above (Clause 4.1 of the Written Agreement), the parties shall meet and agree whether any further monitoring will be required after the expiry of such 6 year period.

In the event that any dispute or disagreement arises between the parties in relation to any such technical matter in the Written Agreement (Clause 4.1) the parties shall use all reasonable endeavours to resolve such dispute or disagreement within one month or such other period as may be agreed. If agreement still cannot be reached between the parties within such time period the relevant provisions contained in the Written Agreement (Clauses 6.8 – 6.12 (inclusive)) shall apply (mutatis mutandis).

3 Summary

A summary of the proposed long term monitoring strategy is included in Table 3.1.

Table 3.1: Summary of Long Term Monitoring Strategy

Monitoring	Frequency	Remarks
Fish Sampling	Annual	Eel samples to be collected at locations on the River Breagagh, both upstream and within the remediated zone. This will be subject to permission and carried out by/ in consultation with Inland Fisheries Ireland.
Biota Sampling	Annual	Survey locations to include the River Breagagh, both upstream and within the remediated zone.
Sediment Sampling	Annual	Survey locations to include the River Breagagh, both upstream and within the remediated zone.
Integrity Assessment & Visual Inspection of Installed Liner	Annual (May-September).	Where defects/damage is observed, the Regulatory Authority shall be notified and a remedial plan agreed based on the extent of the damage reported. Assuming no defects/damage observed, a written report shall be prepared annually to document the findings of the assessment completed for a given year.

Further consultation with the Regulatory Authority (and Marine Institute) is advised regarding the suitability, reliability and Regulatory Authority approval of passive sampling, as an emerging method in Ireland for the assessment of priority substances in water.

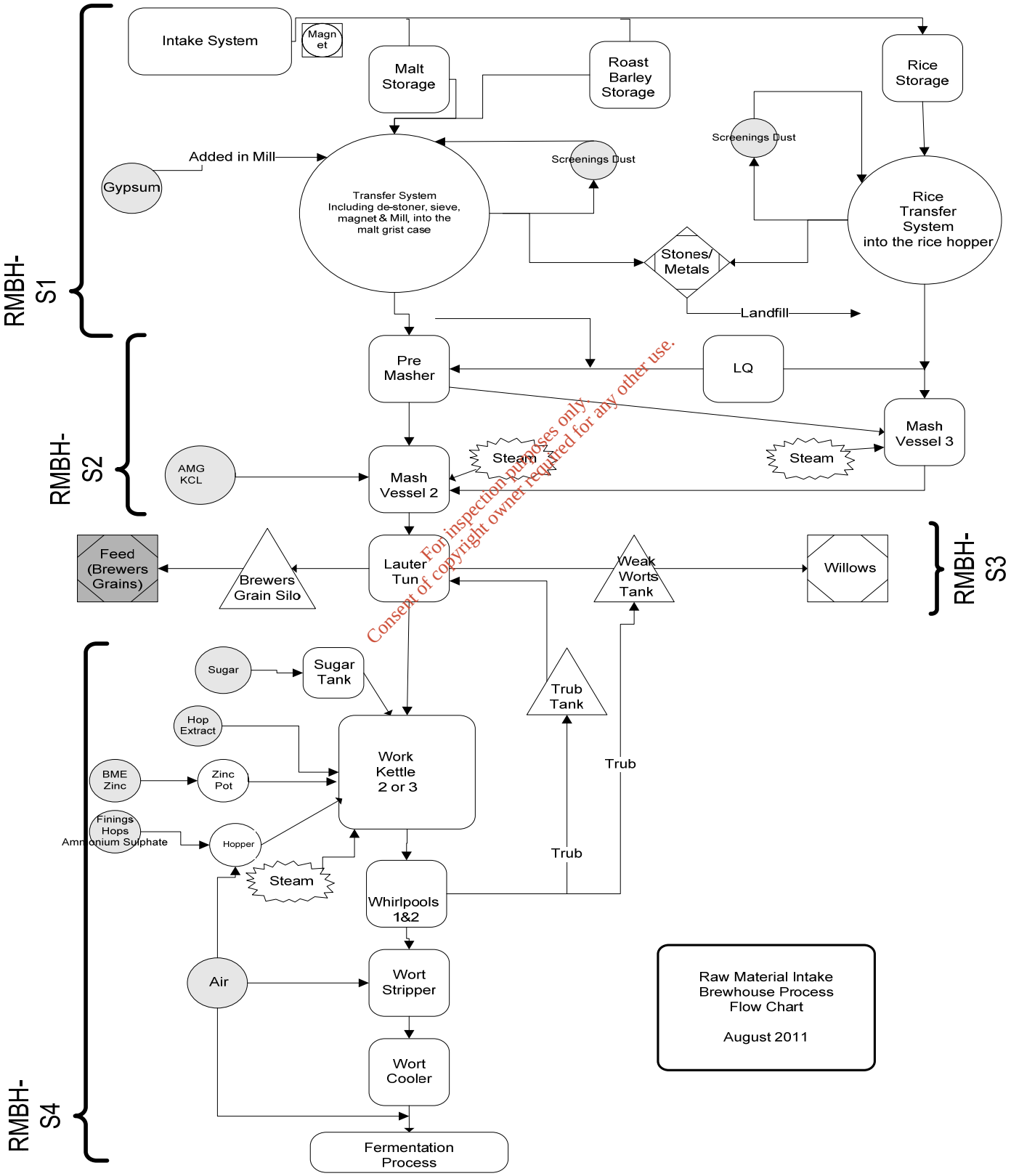
Appendix C

Process Flow Schematics

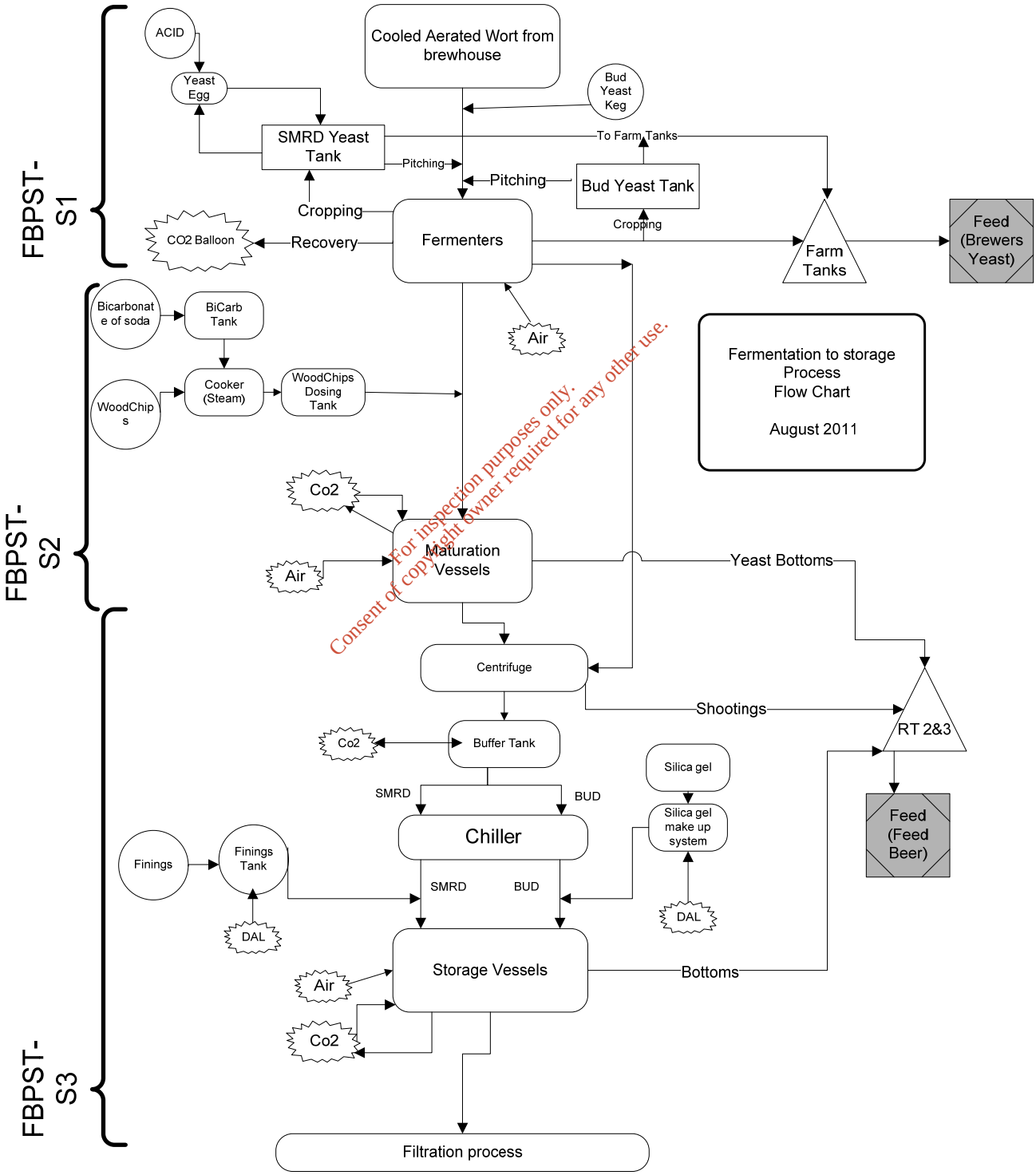
C1 Process Flow Schematics

Please see Process Flow Schematics overleaf.

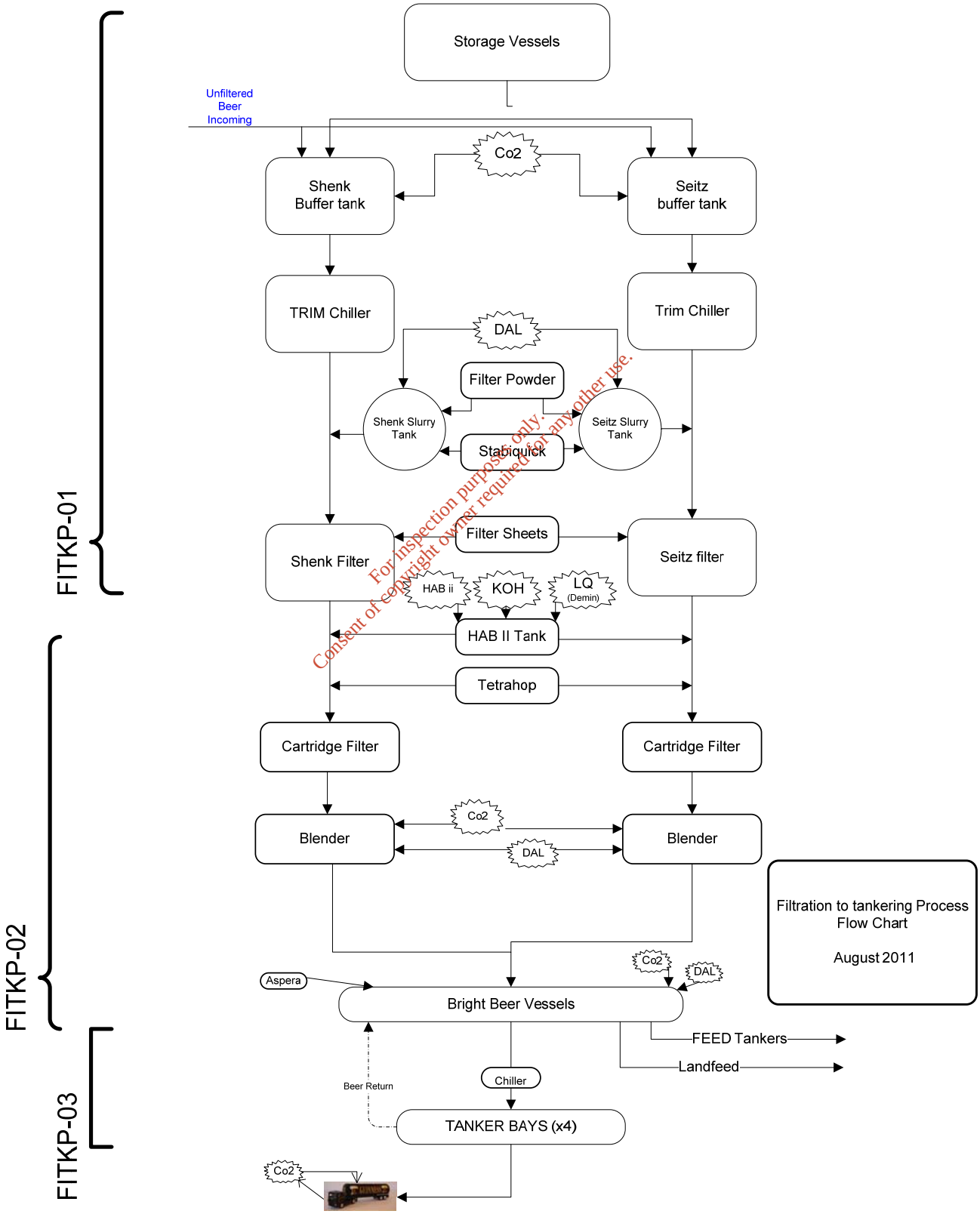
PROCESS FLOW DESCRIPTION PLUS FLOW DIAGRAMS



PROCESS FLOW DESCRIPTION PLUS FLOW DIAGRAMS



PROCESS FLOW DESCRIPTION PLUS FLOW DIAGRAMS



Appendix D

Decommissioning Checklist

D1 Decommissioning Checklist

Please see decommissioning checklist overleaf.

Area	Asset	Vessel Empty?	Is the vessel clean? (CIP etc) Date CIP Completed, Completed By	List of Associated Waste Material	Waste Drained for treatment in effluent plant and subsequent discharge to sewer?	Waste Purged for treatment in effluent plant and subsequent discharge to sewer?	CO2 Vented?	Waste Material Disposed?	Disconnected from Power - made safe/ LOTO - lock out tag out)? Disconnection Completed	Sign off Verification & Date. Equipment is Decomissioned (Asset is safe, No power, Clean)
Raw Materials	Grain Intake System	N/A	Dermot Keating Yes - May 8th 2014	N/A	N/A	NA	Na		Yes	Dermot Keating
	Grain Lifting Devices	N/A	Dermot Keating Yes - May 8th 2014	N/A	N/A	NA	NA		Yes	Dermot Keating
	Malt Silo 1	✓	No - 5 Star cleaners on site May 7th 201	N/A	No	NA	NA	No	Yes	Dermot Keating
	Malt Silo 2	✓	No - 5 Star cleaners on site May 7th 201						Yes	Dermot Keating
	Malt Silo 3	✓	No - 5 Star cleaners on site May 7th 201						Yes	Dermot Keating
	Malt Silo 4	✓	No - 5 Star cleaners on site May 7th 20						Yes	Dermot Keating
	Malt Silo 5	✓	Dermot Keating Yes - May 8th 2014						Yes	Niall Holden
	~~Malt Silo 6 (NA)~~			N/A	Yes	NA	NA	Yes		Niall Holden
	Malt Silo 7	✓	Dermot Keating Yes - May 8th 2014						Yes	Niall Holden
	Malt Silo 8	✓	Dermot Keating Yes - May 8th 2014						Yes	Niall Holden
	Malt Silo 9	✓	Dermot Keating Yes - May 8th 2014	N/A	Yes	NA	NA	Yes	Yes	Niall Holden
	Malt Silo 10	✓	Dermot Keating Yes - May 8th 2014						Yes	Niall Holden
	Malt Silo 11	✓	Dermot Keating Yes - May 8th 2014						Yes	Niall Holden
	Malt Silo 12	✓	Dermot Keating Yes - May 8th 2014						Yes	Niall Holden
	Malt Rice 13	✓	No - 5 Star cleaners on site May 7th 201	N/A	No	NA	NA	No	Yes	Niall Holden
	Malt Rice 14	✓	No - 5 Star cleaners on site May 7th 201						No	Niall Holden
	Malt Rice 15	✓	No - 5 Star cleaners on site May 7th 201						No	Niall Holden
	Grain Dust Extraction System	✓	No - 5 Star cleaners on site May 7th 201	N/A	Yes, and Rinsed	NA	NA	NA	No	Niall Holden
Brewhouse	Rice Transfer/ Milling	✓	No - 5 Star cleaners on site May 7th 201	N/A	Yes, and Rinsed	NA	NA		Yes	dermot Keating
	Malt Milling System	✓	No - 5 Star cleaners on site May 7th 201	N/A	Yes, and Rinsed	NA	NA		Yes	dermot Keating
	Pre Masher	✓	yes Dermot Keating - June 10th 2014	N/A	Yes, and Rinsed	NA	NA	NA	Yes	dermot Keating
	MV2	✓	yes Dermot Keating - June 10th 2014	N/A	Yes, and Rinsed	NA	NA		Yes	dermot Keating
	MV3	✓	yes Dermot Keating - June 10th 2014	N/A	Yes, and Rinsed	NA	NA		Yes	dermot Keating
	WWT 1	✓	yes Dermot Keating - June 10th 2014	N/A	Yes, and Rinsed	NA	NA	Tank Disposed/Flushed	Yes	dermot Keating
	WWT 2	✓	yes Dermot Keating - June 10th 2014	N/A	Yes, and Rinsed	NA	NA	Tank Disposed/Flushed	Yes	dermot Keating
	Wort Aeration Unit	✓	yes Dermot Keating - June 10th 2014	N/A	Yes, and Rinsed	NA	NA	NA	Yes	dermot Keating
	Wort Cooler 1	✓	yes Dermot Keating- May 30th 2014	Chilled Water/IMS	Yes, and Rinsed	NA	NA		Yes	dermot Keating
	Wort Cooler 2	✓	yes Dermot Keating- May 30th 2014	Chilled Water/IMS	Yes, and Rinsed	NA	NA		Yes	dermot Keating
	Wort Stripper	✓	yes Dermot Keating- May 30th 2014	N/A	Yes, and Rinsed	NA	NA	NA	Yes	dermot Keating
	Lauter Tun	✓	yes Dermot Keating- May 30th 2014	N/A	Yes, and Rinsed	NA	NA	Grain Removed	Yes	dermot Keating
	Wort Kettle 2	✓	yes Dermot Keating- May 30th 2014	N/A	Yes, and Rinsed	NA	NA	NA	Yes	dermot Keating
	Wort Kettle 3	✓	yes Dermot Keating- May 30th 2014	N/A	Yes, and Rinsed	NA	NA	NA	Yes	dermot Keating
	Hops Dosing System	✓	yes Dermot Keating- May 30th 2014	N/A	Yes, and Rinsed	NA	NA	NA	Yes	dermot Keating
	Whirlpool 1	✓	yes Dermot Keating- May 30th 2014	N/A	Yes, and Rinsed	NA	NA	NA	Yes	dermot Keating
	Whirlpool 2	✓	yes Dermot Keating- May 30th 2014	N/A	Yes, and Rinsed	NA	NA	NA	Yes	dermot Keating
	Trub System	✓	yes Dermot Keating- May 30th 2014	N/A	Yes, and Rinsed	NA	NA	NA	Yes	dermot Keating
	Spent Grains Silo	✓	yes Dermot Keating- May 30th 2014	N/A	Yes, and Rinsed	NA	NA		Yes	dermot Keating
	Brewhouse Liquor System	✓	yes Dermot Keating- May 30th 2014	N/A	Yes, and Rinsed	NA	NA	NA	Yes	dermot Keating
	Vapour Condenser 1	✓	yes Dermot Keating- May 30th 2014	N/A	Yes, and Rinsed	NA	NA	NA	Yes	dermot Keating
	Vapour Condenser 2	✓	yes Dermot Keating- May 30th 2014	N/A	Yes, and Rinsed	NA	NA	NA	Yes	dermot Keating
	Brewhouse CIP Centre	✓	yes Dermot Keating- May 30th 2014	acid (super dilac), caustic (Blend G Winter)	Yes, and Rinsed	NA	NA	Yes, and Rinsed	Yes	dermot Keating
	Sugar Tank	✓	5/12/13 - S. Carberry	N/A	Yes, And rinsed	NA	NA	Yes, and Rinsed	Yes	dermot Keating
	Brewhouse Steam	✓	yes Dermot Keating- May 30th 2014	N/A	NA	NA	NA	NA	Yes	dermot Keating
	Brewhouse Condensate tank	✓	yes Dermot Keating- May 30th 2014	N/A	NA	NA	NA	NA	Yes	dermot Keating
Fermentation	FV 1	✓	yes Dermot Keating- May 30th 2014	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 2	✓	yes Dermot Keating- May 30th 2014	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 3	✓	yes Dermot Keating- May 30th 2014	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 4	✓	yes Dermot Keating- May 30th 2014	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 5	✓	yes Dermot Keating- May 30th 2014	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 6	✓	yes Dermot Keating- May 30th 2014	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 7	✓	yes Dermot Keating- May 30th 2014	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 8	✓	yes Dermot Keating- May 30th 2014	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 9	✓	yes Dermot Keating- May 30th 2014	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 10	✓	yes Dermot Keating- May 30th 2014	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden

Area	Asset	Vessel Empty?	Is the vessel clean? (CIP etc) Date CIP Completed, Completed By	List of Associated Waste Material	Waste Drained for treatment in effluent plant and subsequent discharge to sewer?	Waste Purged for treatment in effluent plant and subsequent discharge to sewer?	CO2 Vented?	Waste Material Disposed?	Disconnected from Power - made safe/ LOTO - lock out tag out)? Disconnection Completed	Sign off Verification & Date. Equipment is Decomissioned (Asset is safe, No power, Clean)
Fermentation	FV 11	✓	3/10/13 - S. Carberry	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 12	✓	31/10/13 - S. Carberry	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 13	✓	yes Dermot Keating- May 30th 2014	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 14	✓	01/11/2013 - S. Carbery	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 15	✓	22/10/13 - S. Carberry	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 16	✓	29/10/13 - S. Carberry	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 17	✓	yes Dermot Keating- May 30th 2014	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 18	✓	31/10/13 - S. Carberry	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 19	✓	14/11/13 - S. Carberry	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 20	✓	13/11/13 - S.Carberry	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 21	✓	12/11/13- S.Carberry	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 22	✓	30/11/13 - S. Carberry	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 23	✓	13/11/13 - S.Carberry	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 24	✓	17/11/13 - S.Carberry	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 25	✓	17/10/13 - S.Carberry	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 26	✓	23/10/13 - S.Carberry	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 27	✓	31/10/13 - S.Carberry	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 28	✓	1/11/13 - S. Carberry	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 29	✓	1/11/13 - S. Carberry	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 30	✓	8/11/13 - S.Carberry	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	FV 31	✓	8/11/13 - S. Carberry	N/A	✓	NA	**CO2 Vented**	NA	Yes	Niall Holden
	Fob Tank 1	✓	20/5/2014- D. Keating	Empty	✓		**CO2 Vented**	NA	Yes	Dermot Keating
	Fob Tank 2	✓	20/5/2014- D. Keating	Empty	✓		**CO2 Vented**	NA	Yes	Dermot Keating
Maturation and Storage	MPV 68	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 69	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 70	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 71	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 72	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 73	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 74	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 75	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 76	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 77	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 78	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 79	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 80	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 81	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 82	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 83	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 84	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 85	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 86	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 87	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 88	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	MPV 89	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	Centrifuge 1	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	Centrifuge 2	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	Centrifuge Buffer Tank	✓	20/5/2014- D. Keating	N/A	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	Centrifuge Chiller	✓	20/8/2014-D Keating	IMS- Drained	✓	✓	**CO2 Vented**	NA	Yes	Dermot Keating
	SV 56	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	SV 57	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	SV 58	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	SV 59	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	SV 60	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating

Area	Asset	Vessel Empty?	Is the vessel clean? (CIP etc) Date CIP Completed, Completed By	List of Associated Waste Material	Waste Drained for treatment in effluent plant and subsequent discharge to sewer?	Waste Purged for treatment in effluent plant and subsequent discharge to sewer?	CO2 Vented?	Waste Material Disposed?	Disconnected from Power - made safe/ LOTO - lock out tag out)? Disconnection Completed	Sign off Verification & Date. Equipment is Decomissioned (Asset is safe, No power, Clean)
Maturation and Storage	SV 61	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	SV 62	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	SV 63	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	SV 64	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	SV 65	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	SV 66	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	SV 67	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 32	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 33	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 34	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 35	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 36	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 37	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 38	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 39	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 40	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 41	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 42	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 43	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 44	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 45	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 46	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 47	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 48	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 49	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 50	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 51	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 52	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 53	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 54	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	MV 55	✓	20/11/2013 S. Carberry	N/A	✓	NA	CO2 Vented	NA	Yes	Niall Holden
	Wood Chips Plant	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	Silica Gel Plant	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
Filtration	Seitz Filter	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	Schenk Filter	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	Seitz Buffer Tank	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	Schenk Buffer Tank	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	Chiller 1	✓	15/05/2014 Dermot keating	IMS - Drained	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	Chiller 2	✓	15/05/2014 Dermot keating	IMS - Drained	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	HAB 2 Dosing Tank	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	Trap Filter 1	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	Trap Filter 2	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	Kiselger System	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	Schenk Blender	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
Bright Beer	BBT1	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	BBT2	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	BBT3	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	BBT4	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	BBT5	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	BBT6	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	BBT7	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	BBT8	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	BBT9	✓	15/05/2014 Dermot keating	IMS-Drained	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	BBT10	✓	15/05/2014 Dermot keating	IMS-Drained	✓	NA	CO2 Vented	NA	Yes	Dermot Keating

Area	Asset	Vessel Empty?	Is the vessel clean? (CIP etc) Date CIP Completed, Completed By	List of Associated Waste Material	Waste Drained for treatment in effluent plant and subsequent discharge to sewer?	Waste Purged for treatment in effluent plant and subsequent discharge to sewer?	CO2 Vented?	Waste Material Disposed?	Disconnected from Power - made safe/ LOTO - lock out tag out)? Disconnection Completed	Sign off Verification & Date. Equipment is Decomissioned (Asset is safe, No power, Clean)
Bright Beer	BBT11	✓	15/05/2014 Dermot keating	IMS-Drained	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	BBT12	✓	15/05/2014 Dermot keating	IMS-Drained	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	BBT13	✓	15/05/2014 Dermot keating	IMS-Drained	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	BBT14	✓	15/05/2014 Dermot keating	IMS-Drained	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	BBT15	✓	15/05/2014 Dermot keating	IMS-Drained	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	BBT 16	✓	15/05/2014 Dermot keating	IMS-Drained	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	BBT CIP Centre	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
Tanker Station	Tanker Bay 1	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	Tanker Bay 2	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	Tanker Bay 3	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	Tanker Bay 4	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	FOB Tank	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	Chiller	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
	CIP Centre	✓	15/05/2014 Dermot keating	N/A	✓	NA	CO2 Vented	NA	Yes	Dermot Keating
Yst Management	Yst Prop Tank 1	✓	12/ 12/2013 S. Carberry	IMS	✓	✓	CO2 Vented	✓	Yes	Dermot Keating
	Yst Prop Tank 2	✓	12/ 12/2013 S. Carberry	IMS	✓	✓	CO2 Vented	✓	Yes	Dermot Keating
	Yst Prop Tank 3	✓	12/ 12/2013 S. Carberry	IMS	✓	✓	CO2 Vented	✓	Yes	Dermot Keating
	PHE - Pitched Yeast	✓	12/ 12/2013 S. Carberry	IMS	✓	✓	CO2 Vented	✓	Yes	Dermot Keating
	BYST 1	✓	04/12/13-Michael Cantwell	IMS	✓	NA	Co2 Vented	✓	Yes	Dermot Keating
	BYST 2	✓	04/12/13-Michael Cantwell	IMS	✓	NA	Co2 Vented	✓	Yes	Dermot Keating
	BYST 3	✓	04/12/13-Michael Cantwell	IMS	✓	NA	Co2 Vented	✓	Yes	Dermot Keating
	BYST 4	✓	12/ 12/2013 S. Carberry	IMS	✓	NA	Co2 Vented	✓	Yes	Dermot Keating
	BYST 5	✓	12/ 12/2014 S. Carberry	IMS	✓	NA	Co2 Vented	✓	Yes	Dermot Keating
	Ale Yst Tank 1	✓	03/12/13-Michael Cantwell	IMS	✓	NA	Co2 Vented	✓	Yes	Dermot Keating
	Ale Yst Tank 2	✓	03/12/13-Michael Cantwell	IMS	✓	NA	Co2 Vented	✓	Yes	Dermot Keating
	Ale Yst Tank 3	✓	03/12/13-Michael Cantwell	IMS	✓	NA	Co2 Vented	✓	Yes	Dermot Keating
	Ale Yst Egg	✓	12/ 12/2013 S. Carberry	IMS	✓	NA	Co2 Vented	✓	Yes	Dermot Keating
	Farm Tank 1	✓	20/04/2014 Dermot keating	IMS	✓	✓	✓	✓	Yes	Dermot Keating
	Farm Tank 2	✓	20/04/2014 Dermot keating	IMS	✓	✓	✓	✓	Yes	Dermot Keating
Beer Reprocessing	RT 1	✓	20/05/2014-dermot keating	N/A	✓	NA	NA	✓	Yes	Niall Holden
	RT 2	✓	20/05/2014-dermot keating	N/A	✓	NA	NA	✓	Yes	Dermot Keating
	RT 3	✓	20/05/2014-dermot keating	N/A	✓	NA	NA	✓	Yes	Dermot Keating
	RT 4	✓	20/05/2014-dermot keating	N/A	✓	NA	NA	✓	Yes	Niall Holden
	RT 5	✓	20/05/2014-dermot keating	N/A	✓	NA	NA	✓	Yes	Niall Holden
	RT 6	✓	20/05/2014-dermot keating	N/A	✓	NA	NA	✓	Yes	Niall Holden
	RT 7	✓	20/05/2014-dermot keating	N/A	✓	NA	NA	✓	Yes	Niall Holden
Lab	General Lab Equipment	N/A	20/05/2014-dermot keating	N/A	✓	✓	NA	✓	Yes	Dermot Keating
	Micro Lab	N/A	20/05/2014-dermot keating	N/A	✓	✓	NA	✓	Yes	Dermot Keating
	Weighers	N/A	20/05/2014-dermot keating	N/A	✓	✓	NA	✓	Yes	Dermot Keating
	Temperature Control Equipment	N/A	20/05/2014-dermot keating	N/A	✓	✓	NA	✓	Yes	Dermot Keating
	Centrifuge	N/A	20/05/2014-dermot keating	N/A	✓	✓	NA	✓	Yes	Dermot Keating
	Centrifuge	N/A	20/05/2014-dermot keating	N/A	✓	✓	NA	✓	Yes	Dermot Keating
	Sundry Equipment	N/A	20/05/2014-dermot keating	N/A	✓	✓	NA	✓	Yes	Dermot Keating
	Gas Analysis System	N/A	20/05/2014-dermot keating	N/A	✓	✓	NA	✓	Yes	Dermot Keating
	Spectrophotometer	N/A	20/05/2014-dermot keating	N/A	✓	✓	NA	✓	Yes	Dermot Keating
	Gas liquid Chromatography	N/A	20/05/2014-dermot keating	N/A	✓	✓	NA	✓	Yes	Dermot Keating
	Conductivity Meters	N/A	20/05/2014-dermot keating	N/A	✓	✓	NA	✓	Yes	Dermot Keating
	Haze Measurement	N/A	20/05/2014-dermot keating	N/A	✓	✓	NA	✓	Yes	Dermot Keating
	Malt Analysis	N/A	20/05/2014-dermot keating	N/A	✓	✓	NA	✓	Yes	Dermot Keating
	Temperature Measuring equipment	N/A	20/05/2014-dermot keating	N/A	✓	✓	NA	✓	Yes	Dermot Keating
	Pressure Measurement equipment	N/A	20/05/2014-dermot keating	N/A	✓	✓	NA	✓	Yes	Dermot Keating
	pH Meter	N/A	20/05/2014-dermot keating	N/A	✓	✓	NA	✓	Yes	Dermot Keating
	Scuba	N/A	20/05/2014-dermot keating	N/A	✓	✓	NA	✓	Yes	Dermot Keating

Area	Asset	Vessel Empty?	Is the vessel clean? (CIP etc) Date CIP Completed, Completed By	List of Associated Waste Material	Waste Drained for treatment in effluent plant and subsequent discharge to sewer?	Waste Purged for treatment in effluent plant and subsequent discharge to sewer?	CO2 Vented?	Waste Material Disposed?	Disconnected from Power - made safe/ LOTO - lock out tag out)? Disconnection Completed	Sign off Verification & Date. Equipment is Decomissioned (Asset is safe, No power, Clean)
Cip	Caustic Day Tank	N/A	20/05/2014-dermot keating	Caustic	✓	✓	NA	✓	Yes	Dermot Keating
	Acid Tank	N/A	20/05/2014-dermot keating	Acid	✓	✓	✓	✓	Yes	Dermot Keating
	Hot Caustic Tank	N/A	20/05/2014-dermot keating	Caustic	✓	✓	✓	✓	Yes	Dermot Keating
	Cold Caustic Tank	N/A	20/05/2014-dermot keating	Caustic	✓	✓	✓	✓	Yes	Dermot Keating
	Return Water Tank	N/A	20/05/2014-dermot keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	Fresh Water Tank	N/A	20/05/2014-dermot keating	N/A	✓	NA	✓	✓	Yes	Dermot Keating
	Bulk Caustic Tank 1	N/A	20/05/2014-dermot keating	Caustic	✓	NA	✓	✓	Yes	Dermot Keating
	Bulk Caustic Tank 2	N/A	20/05/2014-dermot keating	Caustic	✓	NA	✓	✓	Yes	Dermot Keating
No Production Buildings	H/E - Welfare Facility	N/A	20/05/2014-dermot keating	N/A	✓	NA	✓	✓	Yes	Dermot Keating
	H/E - Engineering Block	N/A	20/05/2014-dermot keating	N/A	✓	NA	✓	✓	Yes	Dermot Keating
	H/E Steam Trap	N/A	20/05/2014-dermot keating	N/A	✓	NA	✓	✓	Yes	Dermot Keating
CO2	CO2 tank 3	N/A	20/05/2014-dermot keating	N/A	✓	NA	✓	✓	Yes	Dermot Keating
	CO2 tank 4	N/A	20/05/2014-dermot keating	N/A	✓	NA	✓	✓	Yes	Dermot Keating
	CO2 tank 5	N/A	20/05/2014-dermot keating	N/A	✓	NA	✓	✓	Yes	Dermot Keating
	Perry Atkins system	N/A	20/05/2014-dermot keating	Ammonia and oil, ammonia and water,	✓	✓	✓	✓	Yes	Dermot Keating
	Deoderiser & Drier package	N/A	20/05/2014-dermot keating	carbon and dessicant from drier	✓	✓	✓	✓	Yes	Dermot Keating
	CO2 compressors	N/A	20/05/2014-dermot keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	Washtower	N/A	20/05/2014-dermot keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	Balloon	N/A	20/05/2014-dermot keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	Feedwater pumps	N/A	20/05/2014-dermot keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	Hotwell	N/A	20/05/2014-dermot keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	Boilers	N/A	20/05/2014-dermot keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	Water treatment chemicals	✓	20/8/2014- Dermot Keating	Performax, Drewbrom TA, Biosperse	✓	✓	✓	✓	Yes	Dermot Keating
	Brine Tanks	✓	20/8/2014- Dermot Keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	Qater softners	✓	20/06/2014- Dermot Keating	resin	✓				Yes	Dermot Keating
	PLC enclosure	✓	20/06/2014- Dermot Keating		✓				Yes	Dermot Keating
Refidgeration	IMS	✓	20/06/2014- Dermot Keating	IMS	✓	✓	✓	✓	Yes	Dermot Keating
	Chilled water	✓	20/06/2014- Dermot Keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	Ammonia drainage	✓	20/8/2014 - Dermot Keating	Ammonia and oil, ammonia and water,	✓	✓	✓	✓	Yes	Dermot Keating
	Compressors	✓	20/8/2014 - Dermot Keating	waste oil and ammonia	✓	✓	✓	✓	Yes	Dermot Keating
	Ammonia drainage from compressors	✓	20/8/2014 - Dermot Keating	Ammonia	✓	✓	✓	✓	Yes	Dermot Keating
	Evaporator skids/condensors	✓	20/8/2014 - Dermot Keating	Performax, Drewbrom TA, Biosperse	✓	✓	✓	✓	Yes	Dermot Keating
	IMS & CW distribution pumps	✓	20/8/2014 - Dermot Keating	IMS	✓	✓	✓	✓	Yes	Dermot Keating
Water	Well pumps Indoor	✓	20/06/2014- Dermot Keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	Well pumps outdoor	✓	20/06/2014- Dermot Keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	Well water buffer tank	✓	20/06/2014- Dermot Keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	Sand filters	✓	20/06/2014- Dermot Keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	Carbon filters	✓	20/06/2014- Dermot Keating	carbon	✓	✓	✓	✓	Yes	Dermot Keating
	FTW storage tanks	✓	20/06/2014- Dermot Keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	FTW Chlorine points	✓	20/06/2014- Dermot Keating	chlorine (300litres)	✓	✓	✓	✓	Yes	Dermot Keating
	Feed pumps	✓	20/06/2014- Dermot Keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	Resin columns	✓	20/06/2014- Dermot Keating	Resin	✓	✓	✓	✓	Yes	Dermot Keating
	HCL day tank	✓	20/8/2014 - Dermot Keating	HCL	✓	✓	✓	Indaver	Yes	Dermot Keating
	Dolomite Tank	✓	20/8/2014 - Dermot Keating	Magnopel	✓	✓	✓	✓	Yes	Dermot Keating
	DAL feed pumps	✓	20/8/2014 - Dermot Keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	DAL tower	✓	20/8/2014 - Dermot Keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	DAL storage tanks	✓	20/8/2014 - Dermot Keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	De-min feed pumps	✓	20/8/2014 - Dermot Keating	N/A	✓	✓	✓	✓	Yes	Dermot Keating
	De-min storage tanks and columns	✓	20/06/2014- Dermot Keating	resin	✓	✓	✓	✓	Yes	Dermot Keating
	Caustic IBC & bunded day tanks	✓	20/06/2014- Dermot Keating	Caustic	✓	✓	✓	✓	Yes	Dermot Keating

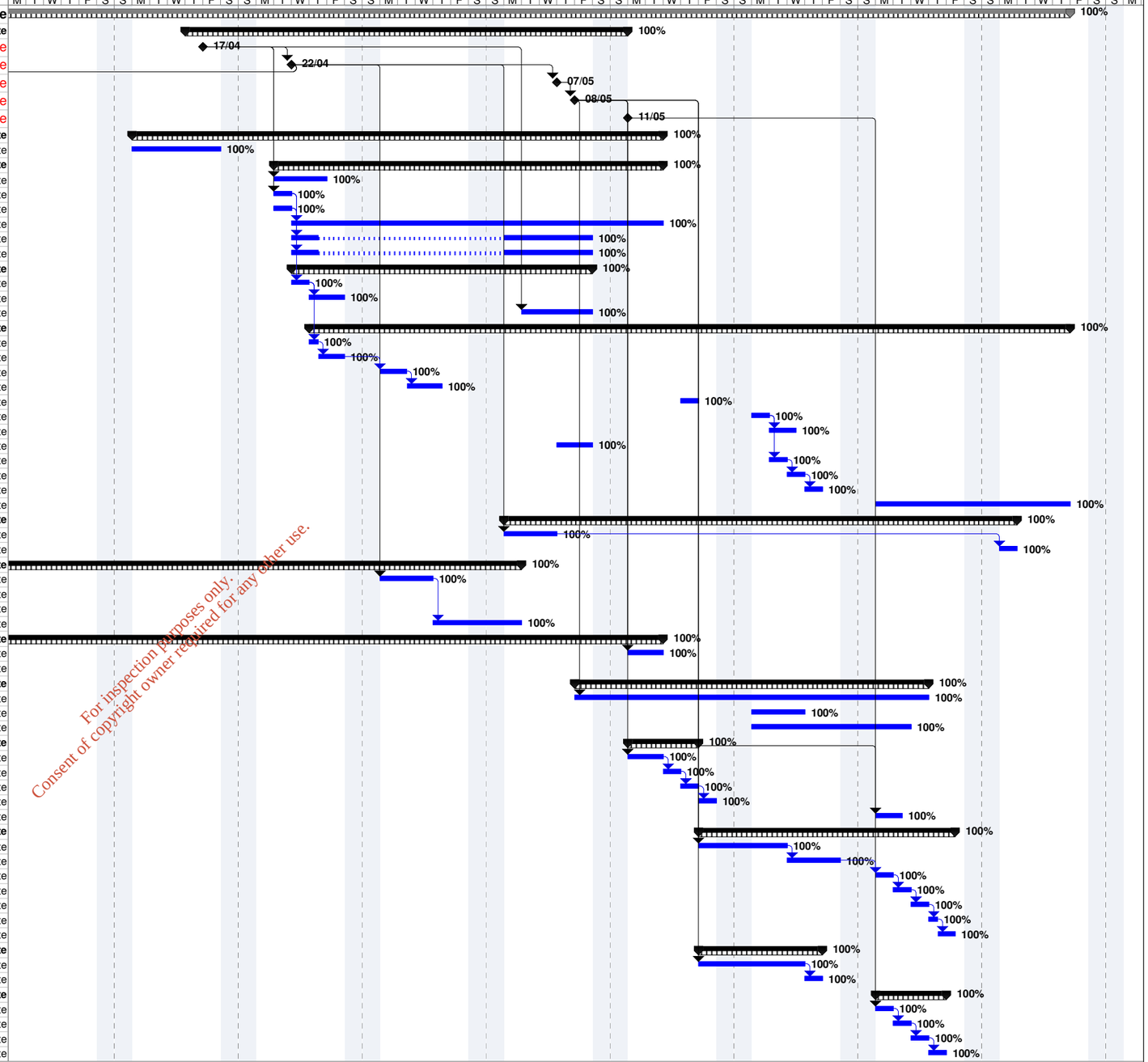
Appendix E

Revised Decommissioning Programme

E1 Revised Decommissioning Programme

Please see revised decommissioning programme overleaf.

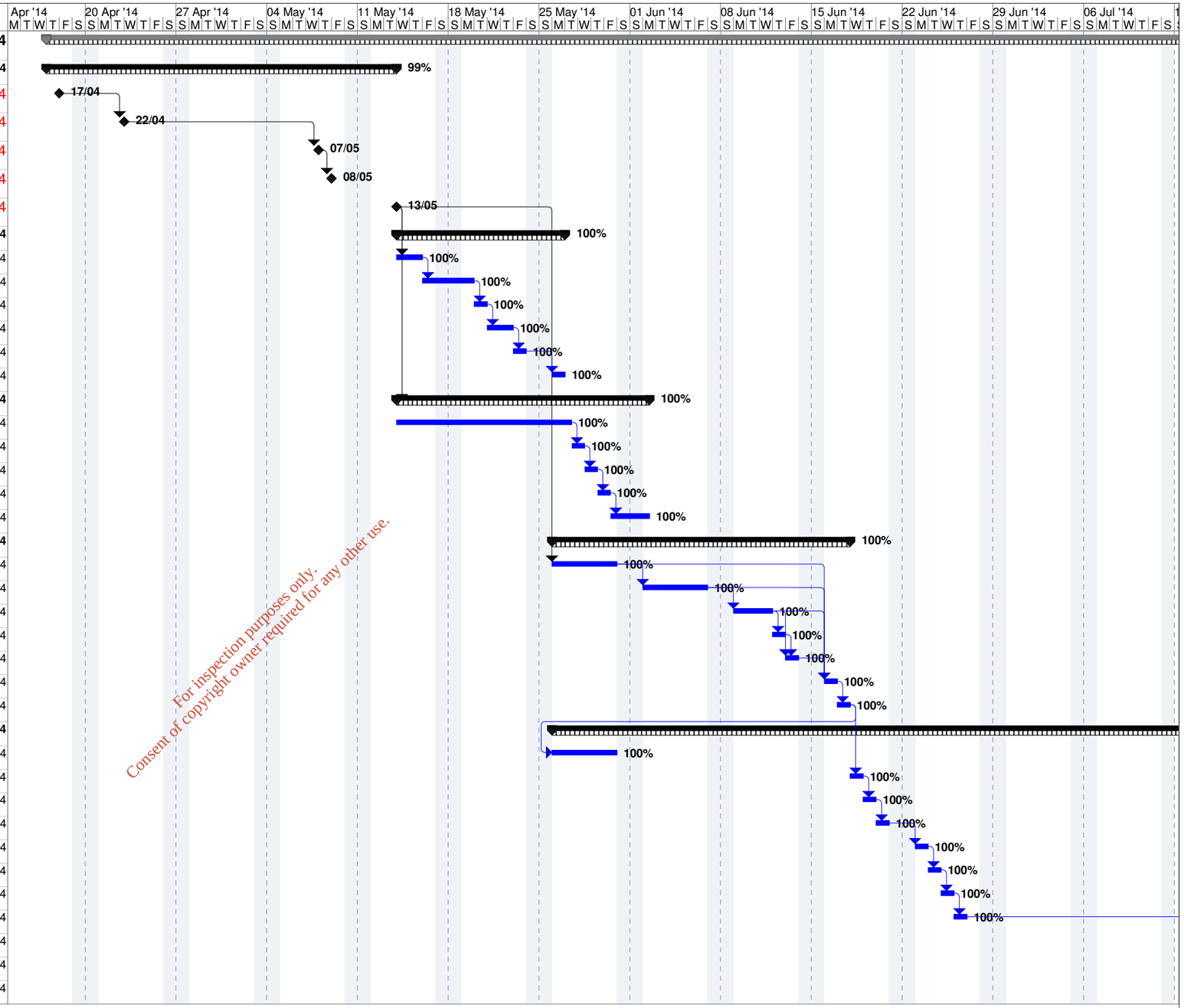
ID	Task Name	Duration	% Complete	Start	Finish	Predecessors	Status
0	**Decommissioning Project**	**79 days?**	**100%**	**Mon 17/02/14**	**Thu 05/06/14**		**Complete**
1	**1 Production Schedule**	**17 days?**	**100%**	**Thu 17/04/14**	**Sun 11/05/14**		**Complete**
2	1.1 Brewing Ceased	1 day?	100%	Thu 17/04/14	Thu 17/04/14		Complete
3	1.2 Fermentation Ceased	3 days	100%	Fri 18/04/14	Tue 22/04/14	2	Complete
4	1.3 Maturation Ceased	11 days	100%	Wed 23/04/14	Wed 07/05/14	3	Complete
5	1.4 Filtration Ceased	1 day	100%	Thu 08/05/14	Thu 08/05/14	4	Complete
6	1.5 Tankering Ceased	5 days	100%	Mon 05/05/14	Sun 11/05/14		Complete
7	**2 Raw Materials**	**22 days?**	**100%**	**Mon 14/04/14**	**Tue 13/05/14**		**Complete**
8	2.1 Grain Intake system	5 days	100%	Mon 14/04/14	Fri 18/04/14		Complete
9	**2.2 Malt Silos**	**16 days**	**100%**	**Tue 22/04/14**	**Tue 13/05/14**		**Complete**
10	2.2.1 Slides (augers)	3 days	100%	Tue 22/04/14	Thu 24/04/14	2FS+2 days	Complete
11	2.2.2 Bucket elevators	1 day	100%	Tue 22/04/14	Tue 22/04/14	2	Complete
12	2.2.3 Upstairs Malt Transfer	1 day	100%	Tue 22/04/14	Tue 22/04/14		Complete
13	2.2.4 Silo cleaning	15 days	100%	Wed 23/04/14	Tue 13/05/14	12	Complete
14	2.2.5 Destoner Cleaning	6.5 days	100%	Wed 23/04/14	Fri 09/05/14	11	Complete
15	2.2.6 Swing Sieve Cleaning	6.5 days	100%	Wed 23/04/14	Fri 09/05/14	11	Complete
16	**2.3 Malt Mill**	**13 days?**	**100%**	**Wed 23/04/14**	**Fri 09/05/14**		**Complete**
17	2.3.1 Electronically isolate Mills (Miag & Porte	1 day	100%	Wed 23/04/14	Wed 23/04/14	12	Complete
18	2.3.2 Malt milling system	2 days	100%	Thu 24/04/14	Fri 25/04/14	17	Complete
19	2.3.3 Clean Miag & Porteus	4 days?	100%	Tue 06/05/14	Fri 09/05/14	2FS+4 days	Complete
20	**3 Brewhouse**	**31 days**	**100%**	**Thu 24/04/14**	**Thu 05/06/14**		**Complete**
21	3.1 Pre-masher	0.5 days	100%	Thu 24/04/14	Thu 24/04/14	17	Complete
22	3.2 MV2	1.5 days	100%	Thu 24/04/14	Fri 25/04/14	21	Complete
23	3.3 MV3	1.5 days	100%	Mon 28/04/14	Tue 29/04/14	22	Complete
24	3.4 Lauter Tun	2 days	100%	Tue 29/04/14	Thu 01/05/14	23	Complete
25	3.5 Weak Wort Tanks 1 & 2	1 day	100%	Thu 15/05/14	Thu 15/05/14		Complete
26	3.6 Wort Kettle 2 & 3	1 day	100%	Mon 19/05/14	Mon 19/05/14		Complete
27	3.7 Vapour Condenser	1.5 days	100%	Tue 20/05/14	Wed 21/05/14	26	Complete
28	3.8 Hops Dosing System	2 days	100%	Thu 08/05/14	Fri 09/05/14		Complete
29	3.9 Whirlpool 1 & 2	1 day	100%	Tue 20/05/14	Tue 20/05/14	26	Complete
30	3.10 Wort Stripper	1 day	100%	Wed 21/05/14	Wed 21/05/14	29	Complete
31	3.11 Wort Cooler 1 & 2	1 day	100%	Thu 22/05/14	Thu 22/05/14	30	Complete
32	3.12 CIP Centre	9 days	100%	Mon 26/05/14	Thu 05/06/14		Complete
33	**4 Fermentation**	**21 days**	**100%**	**Mon 05/05/14**	**Mon 02/06/14**		**Complete**
34	4.1 FVs 1 - 31	3 days	100%	Mon 05/05/14	Wed 07/05/14	3	Complete
35	4.2 Fob tank 1 & 2	1 day	100%	Mon 02/06/14	Mon 02/06/14	34	Complete
36	**5 Yeast Management**	**56 days**	**100%**	**Mon 17/02/14**	**Mon 05/05/14**		**Complete**
37	5.1 BYST 1-3	3 days	100%	Mon 28/04/14	Wed 30/04/14	3	Complete
38	5.2 Ale yeast tank 1-2	5 days	100%	Mon 17/02/14	Fri 21/02/14	3	Complete
39	5.3 Ale yeast egg	7 days	100%	Mon 17/02/14	Tue 25/02/14	3	Complete
40	5.4 Farm tank 1 & 2	3 days	100%	Thu 01/05/14	Mon 05/05/14	37	Complete
41	**6 Beer Reprocessing**	**62 days**	**100%**	**Mon 17/02/14**	**Tue 13/05/14**		**Complete**
42	6.1 RT 2 & 3	2 days	100%	Mon 12/05/14	Tue 13/05/14	5	Complete
43	6.2 RT 1, 4, 5, 6	3 days	100%	Mon 17/02/14	Wed 19/02/14		Complete
44	**7 Maturation & Storage**	**14 days**	**100%**	**Fri 09/05/14**	**Wed 28/05/14**		**Complete**
45	7.1 MPVs 68 - 89	14 days	100%	Fri 09/05/14	Wed 28/05/14	5	Complete
46	7.2 SVs 56 - 67	3 days	100%	Mon 19/05/14	Wed 21/05/14		Complete
47	7.3 MVs 32 - 55	7 days	100%	Mon 19/05/14	Tue 27/05/14		Complete
48	**7.4 Centrifuge**	**4 days**	**100%**	**Mon 12/05/14**	**Thu 15/05/14**		**Complete**
49	7.4.1 Centrifuge 1 &2	2 days	100%	Mon 12/05/14	Tue 13/05/14	5FS+1 day	Complete
50	7.4.2 Centrifuge chiller	1 day	100%	Wed 14/05/14	Wed 14/05/14	49	Complete
51	7.4.3 Centrifuge buffer tank	1 day	100%	Thu 15/05/14	Thu 15/05/14	50	Complete
52	7.5 Wood chipping plant	1 day	100%	Fri 16/05/14	Fri 16/05/14	51	Complete
53	7.6 Silica gel plant	1.5 days	100%	Mon 26/05/14	Tue 27/05/14	48	Complete
54	**8 Filtration**	**10.5 days**	**100%**	**Fri 16/05/14**	**Fri 30/05/14**		**Complete**
55	8.1 Seitz filter	3 days	100%	Fri 16/05/14	Tue 20/05/14	5FS+5 days	Complete
56	8.2 Schenk filter	3 days	100%	Wed 21/05/14	Fri 23/05/14	55	Complete
57	8.3 Schenk buffer tank	1 day	100%	Mon 26/05/14	Mon 26/05/14	56	Complete
58	8.4 Chiller 1 & 2	1 day	100%	Tue 27/05/14	Tue 27/05/14	57	Complete
59	8.5 Kiselguhr system	1 day	100%	Wed 28/05/14	Wed 28/05/14	58	Complete
60	8.6 Schenk blender	0.5 days	100%	Thu 29/05/14	Thu 29/05/14	59	Complete
61	8.7 Seitz buffer tank	1 day	100%	Thu 29/05/14	Fri 30/05/14	60	Complete
62	**9 BBTs**	**5 days**	**100%**	**Fri 16/05/14**	**Thu 22/05/14**		**Complete**
63	9.1 BBT 1-16	4 days	100%	Fri 16/05/14	Wed 21/05/14	5FS+5 days	Complete
64	9.2 BBT CIP Centre	1 day	100%	Thu 22/05/14	Thu 22/05/14	63	Complete
65	**10 Tanker Station**	**4 days**	**100%**	**Mon 26/05/14**	**Thu 29/05/14**		**Complete**
66	10.1 Tanker bay 1-4	1 day	100%	Mon 26/05/14	Mon 26/05/14	6FS+10 days	Complete
67	10.2 FOB tank	1 day	100%	Tue 27/05/14	Tue 27/05/14	66	Complete
68	10.3 Chiller	1 day	100%	Wed 28/05/14	Wed 28/05/14	67	Complete
69	10.4 CIP Centre	1 day	100%	Thu 29/05/14	Thu 29/05/14	68	Complete



Project: Decommissioning Project
Date: Wed 15/10/14

Critical	Split	Baseline Milestone	Project Summary	Inactive Summary	Manual Summary	External Milestone	
Critical Split	Task Progress	Milestone	External Tasks	Manual Task	Start-only	Deadline	
Critical Progress	Baseline	Summary Progress	External Milestone	Duration-only	Finish-only		
Task	Baseline Split	Summary	Inactive Milestone	Manual Summary Rollup	External Tasks		

ID	Task Name	Duration	% Complete	Start	Finish
0	**Utilities Shut Down Plan V3**	**140 days?**	**90%**	**Thu 17/04/14**	**Wed 29/10/14**
1	**1 Production Schedule**	**19 days?**	**99%**	**Thu 17/04/14**	**Tue 13/05/14**
2	1.1 Brewing Ceased	1 day?	100%	Thu 17/04/14	Thu 17/04/14
3	1.2 Fermentation Ceased	3 days	100%	Fri 18/04/14	Tue 22/04/14
4	1.3 Maturation Ceased	11 days	100%	Wed 23/04/14	Wed 07/05/14
5	1.4 Filtration Ceased	1 day	100%	Thu 08/05/14	Thu 08/05/14
6	1.5 Tankering Ceased	1 day	100%	Tue 13/05/14	Tue 13/05/14
7	**2 Co2 Recovery**	**9 days**	**100%**	**Wed 14/05/14**	**Mon 26/05/14**
8	2.1 CO2 Storage	2 days	100%	Wed 14/05/14	Thu 15/05/14
9	2.2 Perry Atkins System	2 days	100%	Fri 16/05/14	Mon 19/05/14
10	2.3 Deodorizer & Drier Package	1 day	100%	Tue 20/05/14	Tue 20/05/14
11	2.4 CO2 Compressors	2 days	100%	Wed 21/05/14	Thu 22/05/14
12	2.5 Wash Tower	1 day	100%	Fri 23/05/14	Fri 23/05/14
13	2.6 Balloon	1 day	100%	Mon 26/05/14	Mon 26/05/14
14	**3 Steam**	**13.5 days**	**100%**	**Wed 14/05/14**	**Mon 02/06/14**
15	3.1 Gas Isolation	9.5 days	100%	Wed 14/05/14	Tue 27/05/14
16	3.2 Electrical Isolation	1 day	100%	Tue 27/05/14	Wed 28/05/14
17	3.3 Water	1 day	100%	Wed 28/05/14	Thu 29/05/14
18	3.4 Softeners	1 day	100%	Thu 29/05/14	Fri 30/05/14
19	3.5 Compressed Air	1 day	100%	Fri 30/05/14	Mon 02/06/14
20	**4 Refrigeration**	**17 days**	**100%**	**Mon 26/05/14**	**Tue 17/06/14**
21	4.1 IMS	5 days	100%	Mon 26/05/14	Fri 30/05/14
22	4.2 Chilled Water	5 days	100%	Mon 02/06/14	Fri 06/06/14
23	4.3 Ammonia	3 days	100%	Mon 09/06/14	Wed 11/06/14
24	4.4 Compressors	1 day	100%	Thu 12/06/14	Thu 12/06/14
25	4.5 Condensers	1 day	100%	Fri 13/06/14	Fri 13/06/14
26	4.6 Evaporator Skids	1 day	100%	Mon 16/06/14	Mon 16/06/14
27	4.7 Ims and CW Pumps	1 day	100%	Tue 17/06/14	Tue 17/06/14
28	**5 Water Treatment**	**111 days**	**67%**	**Mon 26/05/14**	**Mon 27/10/14**
29	5.1 Disconnection of Towns water supply	5 days	100%	Mon 26/05/14	Fri 30/05/14
30	5.2 Well Pumps	1 day	100%	Wed 18/06/14	Wed 18/06/14
31	5.3 Buffer Tank	1 day	100%	Thu 19/06/14	Thu 19/06/14
32	5.4 Sand filers	1 day	100%	Fri 20/06/14	Fri 20/06/14
33	5.5 Carbon Filters	1 day	100%	Mon 23/06/14	Mon 23/06/14
34	5.6 FTW	1 day	100%	Tue 24/06/14	Tue 24/06/14
35	5.7 DAL	1 day	100%	Wed 25/06/14	Wed 25/06/14
36	5.8 De-Min	1 day	100%	Thu 26/06/14	Thu 26/06/14
37	5.9 Effluent Plant	6 days	0%	Mon 20/10/14	Mon 27/10/14
38	6 Compressed Air	1 day	0%	Tue 28/10/14	Tue 28/10/14
39	7 Electricirty to site	1 day	0%	Wed 29/10/14	Wed 29/10/14



Project: Utilities Shut Down Plan V3.m
Date: Wed 15/10/14

Critical	Task Progress	Summary Progress	Inactive Milestone	Manual Summary	Deadline
Critical Split	Baseline	Summary	Inactive Summary	Start-only	
Critical Progress	Baseline Split	Project Summary	Manual Task	Finish-only	
Task	Baseline Milestone	External Tasks	Duration-only	External Tasks	
Split	Milestone	External Milestone	Manual Summary Rollup	External Milestone	