Wool Rich Carpet for Land Benefit

Paul Gibbs and Mike Holt
4Recycling Ltd
What is 4Recycling Ltd?

A unique combination of consultancy and contracting skills focused on the design and delivery of recycling services

Smart contracting
4R Materials recycled to land

Bio-solids
Water treatment sludge
Paper Crumble
Gypsum
Lime
Ash
Timber
Green waste
Green + MSW Compost
Dredgings
Wool rich carpet
Current 4Recycling projects

- Agriculture
- Land restoration
Organic Resources
– land recycling
UK Waste drivers

• **European Landfill Directive**
  – Serious restrictions on types and quantities of waste that may be landfilled - no untreated biodegradable and reduction in amounts from 1995 base of 25% by 2010, 50% by 2013 and 65% by 2020.
  – Equates to c.20 million tonnes of waste by 2020
  – Infrastructure requirement of c.£7 billion ($10 billion) over next 10 years

• **Landfill Allowance Trading Scheme (LATS)**
  – Permit trading scheme between local authorities
  – Failure to achieve diversion or secure sufficient LATS = £150 ($225)/t penalty

• **Landfill Tax**
  – 2007 Budget increased escalator from £3 ($5) to £8 ($12)/yr from 2008.
  – Tax increase from £24 ($36)/t in 2007 to £56 ($85)/t in 2011

• **Energy prices**
  – Crude oil doubled in price during 2007
  – Waste can be alternative fuel
Organic Waste on land – UK Drivers

• Soil organic matter reserves are reaching ‘critically’ low levels
  - annual cultivation of arable soil
  - crop production may not be sustainable in the long term on some soils

- Soil organic matter is Defra’s headline soil quality indicator and maintenance/enhancement is a cross compliance requirement

• EA want to see “Waste producers considering recycling organic materials on land as a fertiliser or to improve soil structure as a first option” (EA, 2007)

• Drive to remove biodegradable waste from landfill
Beneficial effects of organic matter additions

- Plant nutrients
- Enhanced water holding capacity
- Structural stability
- Improved water infiltration
- Carbon storage
- Soil aeration
- Reduced erosion risk
- Acidity amelioration
Standard rules SR2010No4
Mobile plant for landspreading
(land treatment resulting in benefit to agriculture or ecological improvement)

Introductory note

This introductory note does not form part of these standard rules.

When referred to in an environmental permit, these standard rules will allow the operator to operate mobile plant. The mobile plant shall be for land treatment activities on notified agricultural or non-agricultural land in England and Wales resulting in benefit to agriculture or ecological improvement.

The operator is permitted to use the following technology and associated plant necessary for treatment and associated storage:

- plant for the storage and mixing (not for treatment) of permitted wastes listed in tables 2.2A Lists A wastes and 2.2B List B wastes, and
- plant for the spreading of wastes in order to carry out treatment of land.

The activities shall not be carried out within:

- 10 metres of any watercourse;
- 50 metres of any spring or well, or any borehole used to supply water for domestic or food production purposes; and
- Groundwater Source Protection Zone 1.

Any wastes controlled by the Animal By-Products Regulations must be treated and handled in accordance with any requirements imposed by those Regulations.

The operator shall submit a deployment form to the Environment Agency, prior to the activity commencing.

End of Introductory Note

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The Animal By-Products Regulations 2000 (SI No. 2347) and the Animal By-Products (Wales) Regulations 2000 (SI No. 1295, W.127)

Standard rules SR2010No5
Mobile plant for the reclamation, restoration or improvement of land

Introductory note

This introductory note does not form part of these standard rules.

When referred to in an environmental permit, these standard rules will allow the operator to operate mobile plant. The mobile plant shall be for land treatment activities on notified land that has been subject to industrial or other man-made development for reclamation, restoration or improvement in England and Wales resulting in benefit to agriculture or ecological improvement.

The operator is permitted to use the following technology and associated plant necessary for treatment and associated storage:

- plant for the storage and mixing (not for treatment) of permitted wastes listed in tables 2.2 and 2.3, and
- plant for the spreading of wastes in order to carry out treatment of land to create or improve a soil profile.

The activities shall not be carried out within:

- 10 metres of any watercourse;
- 50 metres of any spring or well, or any borehole used to supply water for domestic or food production purposes; and
- Groundwater Source Protection Zone 1.

The operator shall submit a deployment form to the Environment Agency, prior to the activity commencing.

End of Introductory Note
Suitability of ‘waste’ materials for land

- a benefit to agriculture or ecological improvement

Materials need to contain:

• Plant Nutrients e.g. N, P, K, S
• Organic matter
• Lime value
• Low metals
• No hazardous/dangerous substances
Land Benefit – wool carpet
Preliminary Work

Samples analysed for:

• Nutrients etc
• Heavy metals
• Physical Contaminants
• Organic compound contaminants (OCCs)
  - EA agreed analysis depending on waste

• Risk Assessments – dependent on waste
Fertiliser replacement value – plant nutrients
# Total nutrient contents (kg/t fresh weight)

<table>
<thead>
<tr>
<th></th>
<th>Nitrogen (N)</th>
<th>Phosphate (P$_2$O$_5$)</th>
<th>Potash (K$_2$O)</th>
<th>Sulphur (SO$_3$)</th>
<th>Magnesium (MgO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80:20 wool carpet</td>
<td>90</td>
<td>0.5</td>
<td>0.8</td>
<td>30</td>
<td>0.6</td>
</tr>
<tr>
<td>Biosolids – typical cake (25% DM)</td>
<td>7.5</td>
<td>9.0</td>
<td>Trace</td>
<td>6.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Green compost (65% DM)</td>
<td>8.0</td>
<td>3.0</td>
<td>6.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
</tbody>
</table>
Estimated ££ value of Shredded Wool Carpet application (250 kg/ha total N)

<table>
<thead>
<tr>
<th>Fertiliser value</th>
<th>kg/ha</th>
<th>£/ha</th>
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</thead>
<tbody>
<tr>
<td>Total Nitrogen</td>
<td>250</td>
<td>150</td>
</tr>
<tr>
<td>Total phosphate</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total potash</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total sulphate</td>
<td>80</td>
<td>8</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td><strong>£161</strong></td>
</tr>
</tbody>
</table>

= $100

Assuming N = 60 p/kg, P$_2$O$_5$ = 80 p/kg, K$_2$O = 80 p/kg and SO$_3$ = 10 p/kg
Heavy Metals
### Total heavy metals (mg/kg dry matter)

<table>
<thead>
<tr>
<th></th>
<th>Zn</th>
<th>Cu</th>
<th>Cd</th>
<th>Ni</th>
<th>Pb</th>
<th>Cr</th>
<th>Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>80:20 wool carpet</td>
<td>49</td>
<td>2.7</td>
<td>0.01</td>
<td>1.1</td>
<td>4.3</td>
<td>61</td>
<td>0.05</td>
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<tr>
<td>Biosolids</td>
<td>800</td>
<td>570</td>
<td>3.4</td>
<td>60</td>
<td>220</td>
<td>165</td>
<td>2.3</td>
</tr>
<tr>
<td>Green Compost</td>
<td>398</td>
<td>187</td>
<td>1.4</td>
<td>48</td>
<td>187</td>
<td>96</td>
<td>0.9</td>
</tr>
</tbody>
</table>


Environmental/Human Health Risk - OCC
Environmental Risk Assessment - Agriculture

Carpet 250 kg/ha total N
(c. 2.8 t/ha)

30 cm soil @ 1.7 g/cm³ (wet)

Equation 1:

\[
PEC_{soil} = \frac{C_{occ} \times APPL_{Bio}}{DEPTH_{soil} \times RHO_{soil(dry)}}
\]

Where:

- \( PEC_{soil} \) in mg/kg
- \( C_{occ} \) in mg/kg dry weight
- \( APPL_{Bio} \) is the application rate (dry weight) of the Biowaste applied to land (kg/m²)
- \( DEPTH_{soil} \) is the incorporation depth of the Biowaste (m)
- \( RHO_{soil(dry)} \) is the dry bulk density of the soil (kg/m³)

From Gibbs and Chambers 2007
Environmental Risk Assessment – groundwater (250 kg/ha total N)

Equation 2:

\[ PEC_{GW} = PEC_{local\text{--}soil\text{--}porew} = \frac{C_{OCC} \times APPL_{Bio}}{DEPTH_{soil} \times K_{soil\text{--}water} \times 1000} \]

Where:

\[ K_{soil\text{--}water} = (F_{air\text{--}soil} \times K_{air\text{--}water}) + F_{water\text{--}soil} + \left( F_{solid\text{--}soil} \times \frac{K_p_{soil}}{1000} \times RHO_{solid} \right) \]

And:

\[ K_{air\text{--}water} = \frac{HENRY}{R \times TEMP} \]

\[ Kp_{soil} = Foc_{soil} \times K_{OC} \]

From Gibbs and Chambers 2007
Environmental Risk Assessment – human health (‘worst case’)

- Direct ingestion (as soil and via vegetables):
  - most sensitive receptor
  - 0-6 year old female
  - lower 5% tile body weight = 5.9kg
  - upper 95% tile soil ingestion rate = 303 mg/day*

- Exposure via milk:
  - cow ingests 0.438 kg soil/day
  - all OCC consumed converted to milk
  - all milk produced in day consumed by a single 0-6 year old female

* Previous UKWIR report for pathogen transfer = 70 mg/day
Based on analysis and risk assessment, demonstrated that wool rich carpet:

- provides a valuable source of major plant nutrients
- provides a valuable source of organic matter
- has a liming value equivalent to c.1 t/ha ground limestone
- has low levels of heavy metals and organic compound contaminants
Bioassay Trial
Land Restoration
Land Restoration – Jan 2011
Tree Mats
4Recycling Ltd Offer

Nylon
Nylon 6 6
Polypropylene
PET
Wool
Vinyl
4R Carpet Recycling - 2012
4Recycling @ CARE

- Supplies of synthetic based carpet materials
- Joint partnerships with equipment suppliers in to UK and Europe
- Assistance with wool rich carpet recycling