DESIGN MANUAL

Pesticide Handling Areas and Biobeds

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The Voluntary Initiative

Developed for the Crop Protection Association and Agricultural Industries Confederation by ADAS. The assistance of the Environment Agency, SEPA, SNIFFER & the Farming Unions is also acknowledged

This is part of the voluntary initiative to minimise the environmental impact of pesticides.

April 2005

1. BACKGROUND

Chemical contamination from agricultural sprayer loading areas has been shown to significantly contribute to water pollution. Most sprayer loading areas have developed conveniently alongside the on-site water supply and chemical store. Recent research investigating sprayer practices in the UK and Europe have shown the effectiveness of simple Biobed treatment systems, in which new loading areas have been created, or existing areas improved. Research has shown that water discharging to the environment from these new treatment systems contains significantly less pesticide than when left untreated. Reductions in pesticide concentrations of typically 10,000 –100,000 fold have been achieved.

The information contained in this document will allow potential users to select a suitable type of sprayer loading area for their own particular farming or spraying business. It then assists in the preparation of the specification, construction and use for such an area, guiding the user on management principles for efficient operation of the area and final disposal of any discharge.

How much will it cost?

It will involve some expense but the main focus is to recommend a cost-effective solution for each type of farming or spray contractor enterprise. Guidance costs are given at the end of this document in Section 6.

2. WHAT PRINCIPLES ARE INVOLVED?

Basically 3 concepts:

1. An area on which the sprayer stands which collects all spilt or drained liquids. This may include rainfall.
2. Storage and a Biobed system to handle all these collected liquids
3. Distribution system for treated liquids from the Biobed

The overriding principle is one of containment, as below:

- Provide a discrete area for the sprayer and operator to safely work on
- Limit any rainfall or other waters falling onto that area
- Collect all liquids falling on the area
- Direct all liquids to a designated Biobed system

After treatment apply discharge to land in a controlled manner

2.1 What is a Biobed?

This is normally a pit in the ground containing a mixture of straw, soil and compost, which is turfed over. In Sweden more than 1,000 such Biobeds are in use, most sited directly below the sprayer loading area. In the UK, recent research has studied Biobed systems where the mixture has been included within an impervious liner. The liner was connected to a drain permitting through flow drainage to a disposal system. In addition, the research included a site with a lined pit containing friable loamy soil with turf over.

The systems are outlined in Figures 2.1 and 2.2 highlighting the main difference as

1. An **OFFSET** system where all liquids are intercepted, then directed to a Biobed (Figure 2.1). This may also be termed an indirect system
2. A **DRIVE-OVER** system where all liquids fall direct onto a Biobed (Figure 2.2).

2.2 What proportions are in the mix?

Either

A mixture by volume of 50% straw, 25% topsoil and 25% peat-free compost, turfed over.

Or

A soil area developed to be “biologically” active, i.e. free from compaction, showing good rooting with a good ecosystem, turfed over. No field, mole or pipe drains should be present.

Thus a Biobed can be interpreted as either one of the above. Where soil is selected for either system it is likely that enhanced performance will come from the selection of light or medium loamy soils. Clay soils may be difficult to manipulate within any mixing required and may mitigate against predictable drainage.

Certain differences exist with the management of the various types of Biobeds; this will be made clear in later sections.

2.3 What are the system choices?

The major decision lies between what the intention is on the handling area:

If the intention is to **handle and mix pesticides ONLY**, then drainage from the area may be direct to soil, if deemed to be in a non-vulnerable location with regard to groundwaters and surface waters. No liner or pre disposal holding tank is necessary, although this is still recommended. See Regulatory Note below.

Where the intention is to **handle and mix pesticides, AND washdown** of the sprayer / vehicle prior to liquid disposal then all discharges must be contained. They may then be:

A collected and held, prior to bioremediation treatment, with disposal to an area of land which may require a Groundwater Authorisation or a consented discharge.

B collected and held, prior to disposal through an authorised waste disposal contractor.

C collected and held, prior to chemical treatment, with disposal to an area of land under a Groundwater Authorisation or to a consented discharge.

B & C above generally involve considerable cost, particularly where intensive sprayer use is practised or where large volumes of water enter the system. The bioremediation system A offers a practical simple system at lower cost.

Component parts of OFFSET and DRIVE OVER systems are depicted in the following diagrams. Selection of an appropriate system is then governed by its intended use.

Biobeds and Regulation

Both EA and SEPA recognise that lined Biobeds offer significant environmental benefits over current practice. However the current regulatory situation is complex with several new, changing and overlapping pieces of legislation affecting their use. Arrangements also differ between Scotland and England/Wales.

The Environment Agency in England and Wales have agreed that lined Biobeds do not require a Groundwater Authorisation provided they are installed and operated correctly. Water from the Biobed can be used for irrigation and sprayer washing without need for Groundwater Authorisation.. Under the new Agricultural Waste Regulations (expected late 2005) the EA is proposing that lined Biobeds will be considered a waste recovery operation and made exempt from the regulations. This would mean that lined Biobeds would not need to be licensed but would need to be registered with the EA. It is planned that the registration will be free and can be conducted on line.

Before building a Biobed in Scotland a farmer must first check with SEPA., whilst farmers in Northern Ireland should seek advice from Environment and Heritage Service.

Given the uncertainty over the regulatory situation, it is strongly recommended that only Lined Biobeds are built. Unlined Biobeds are acceptable if used for liquid from handling and mixing areas, unlined Biobeds being used to treat spray washings must have a Groundwater Authorisation .

Installing a lined Biobed gives greater flexibility for use as well as being less problematic with future regulatory changes.

Figure 2.1. Typical system schematic of an OFFSET system - Liquids intercepted to a Biobed.

This diagram assumes that sprayer washdown will take place and that a site survey determines that a liner will be necessary.

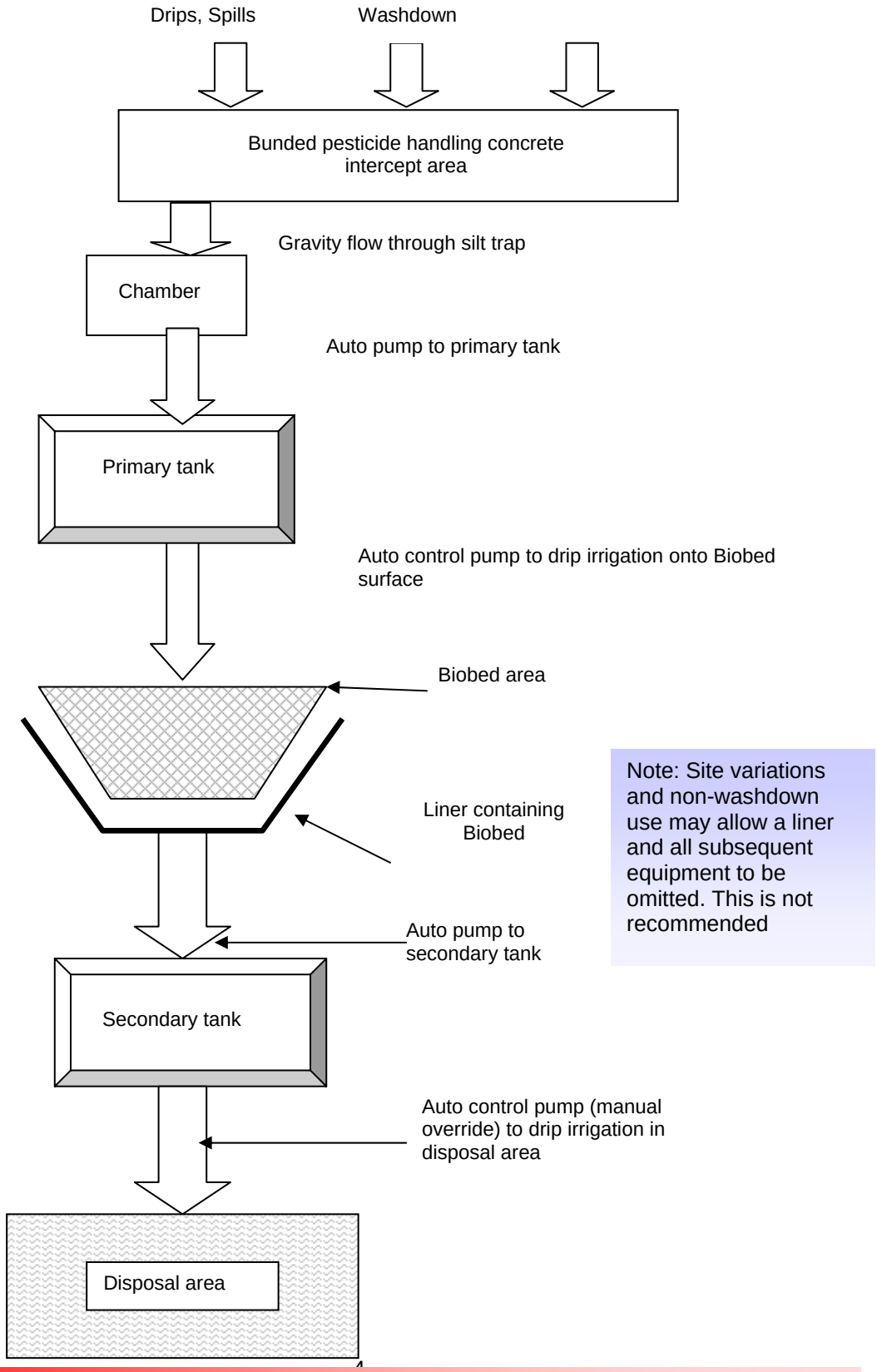
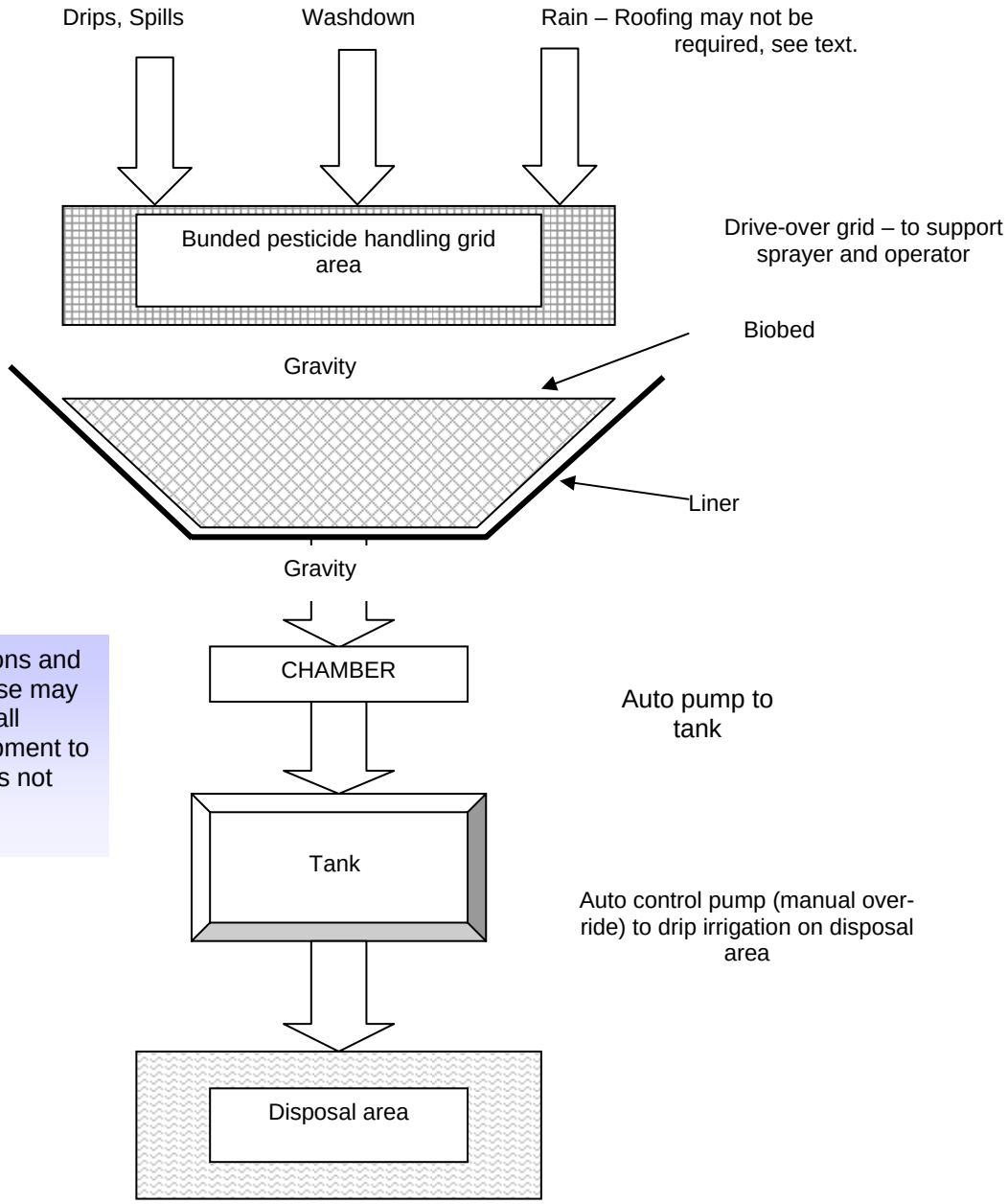


Figure 2.2. Typical system schematic of DRIVE OVER system – liquids fall directly onto Biobed, a "Direct" system.

This diagram assumes that sprayer washdown will take place and that a site survey determines that a liner will be necessary.



Note: Site variations and non-washdown use may allow a liner and all subsequent equipment to be omitted. This is not recommended

3. PLANNING A SYSTEM

3.1 Sprayer loading area

1.1.1 Size

The size must be adequate to contain all liquids that drop from the sprayer and allow the operator to work freely in all pesticide mixing, loading and water filling operations. Routine servicing of the sprayer vehicle/ machinery could take place on the same area. Allowances, from currently available equipment and work routines suggest the following typical sizes:

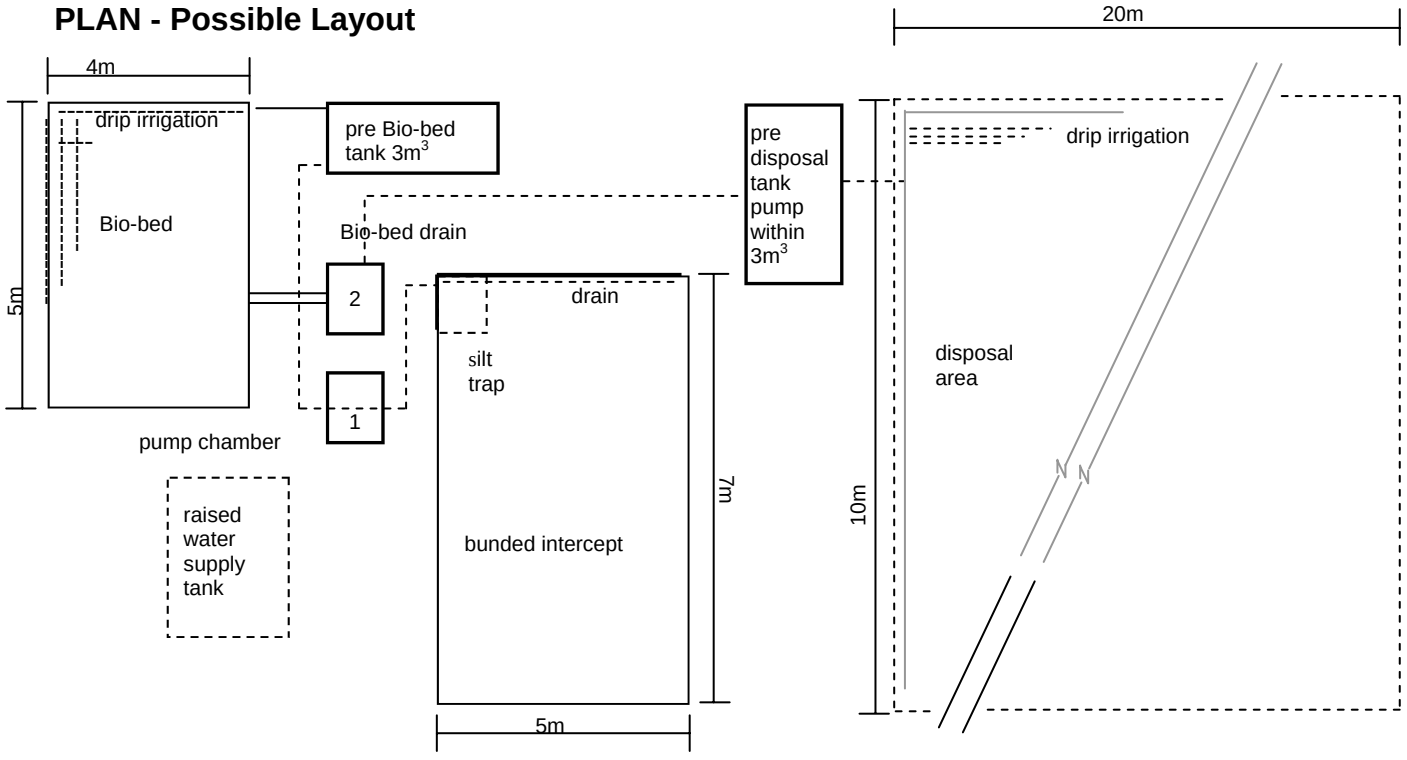
Sprayer Type	Overall Length (m)	Overall Width (m)
Self propelled sprayer	7	5
Trailer	7	5
Mounted	4	5

Size is a compromise between containment of contamination, rainfall limitation and freedom to work safely. It will not allow for full boom unfolding but could allow for some unstowage of individual booms for improved access. Size must be related to current and anticipated future equipment.

In addition, it is likely that for offset systems, some transfer chambers and tanks would need to be sited nearby. This implies an overall area close to or within any "yard" of about 60 m^2 (see Figure 3.1). The final discharge system will occupy an area of land close-by, the final size of which depends on a number of individual site factors. For initial consideration purposes it may be around 60-200 m^2.

OFFSET SYSTEM **Figure 3.1**

PLAN - Possible Layout



3.1.2 Loading area - Surface type and water limitation

As an offset system this is likely to be concrete but a steel drive-over grid with a direct system. All areas must restrict surface water entering the area, or leaving it. The only possible route for liquid once on the area must be through the Biobed system. The simplest method for containment is a small bund. This is recommended to be not less than 100mm high, with width allowing reasonable vehicle run-on comfort at 250-300 mm. This size ensures the operator is certain when the whole vehicle is on the pad and prevents casual driving of other vehicles over the pad.

A concrete area will need a slope in a convenient drainage direction of not less than 1: 100 to a silt trap and pump chamber as necessary.

A steel drive-over grid necessary above a Biobed or soil/grass area must provide safe, direct access for the vehicle and to permit the operator to work around the sprayer. The operator support area should include a mesh size to allow safe foot movement without any tendency to block with debris; mud etc. 100 x 40 mm has been satisfactory. Its design must support the gross weight of the vehicle (fully filled with spray mix). If the Biobed is unlined this may require foundations within the centre of the Biobed. Where the Biobed is to be lined then end and side foundations must be provided to support the grid base. The possibility of the vehicle leaving the grid at an angle should be considered within any design.

Research from other countries suggests that there is a need to top up a Biobed annually with fresh Biobed mix. Therefore where a grid is used this should include easily removable sections to permit this. These sections are likely to require mechanical aids to removal, e.g. hooks or eyes for loader forks etc.

Where a **DRIVE OVER** turfed over soil Biobed is to be used it is recommended that a steel drive-over grid or steel wheel channels are installed to support the vehicle weight. This will prevent repeated traffic compacting the soil, decreasing its infiltration capacity and thus reducing its effectiveness.

3.1.3 Is roofing worthwhile?

Not really. Once the size, shape and site location aspects of each business are considered a roof can become very expensive. If an existing building allows a loading area to be covered this can be beneficial. However there is a need to ensure that the Biobed area is managed at a reasonable moisture input to maintain both bioactivity and flow through the system.

Simple systems of roofing such as polytunnels or simple handling area covers have been considered but a compromise of size and structure required soon suggests costs outweighing other issues.

Some benefit could be obtained by limiting the input of rainfall through during the winter period by providing some form of temporary cover, such as in the style of a cricket pitch cover, directing rainfall away from the Biobed area.

3.1.4 Offset system, liquid transfer from the concrete area to the Biobed

For control purposes a buffer tank may be beneficial. This should be sited as close to the handling area as possible. To save the need for a pump, gravity should be maximised at this point. The tank should be sized to the local site rainfall statistics, especially the expected rainfall intensity values. Note that 1 mm of rainfall on a 1 m^2 area of good quality concrete produces 1 litre of runoff water. Thus peak rainfall intensity values of 25 – 40 mm per 24 hour period must be considered. This “buffer” or primary tank is therefore unlikely to be less than 1.5m^3 in volume.

Where a drive-over grid is used then gravity ensures all liquids enter the Biobed or turfed soil area. The drive-over grid also reduces the total amount of direct rainfall entering the system and avoids the need for any initial buffer tank storage.

In all other situations, unless natural slopes can permit gravity transfer then a pump will be needed. Simple types of single phase submersible centrifugal pumps (up to 6 m head, approx. 200 watt motors) controlled by an integral float switch, with correct circuit protection, have been used successfully. All electrical equipment must be installed to current required electrical safety standards. 110 volt pump options are also available.

Pipework suitable for transfer up to about 30m distance may be needed and with minimal lift this can be kept to 32 mm diameter (25 mm ID).

3.1.5 Distribution of collected liquid over the Biobed

Drip irrigation pipes placed on the surface of either system have been effective. Drip emitters spaced at 25-40 cm and with the pipes a similar distance apart should give good distribution. Surface installation attracts small animals and some vermin problems have been found with thin walled drip "tape" systems. Burial of the tape may only be practical on the turfed soil system due to the need to annually top up the straw based Biobed systems. "Hard" hose drip systems may overcome the pest problems but would be more expensive. Though not capable of high pressures the submersible pumps (mentioned above) have dealt with the system pressures adequately in the drip systems used.

Distribution could be effective with a small sprinkler system but this poses potential challenges with drift and grass kill. Working pressures within the pipe system will need to be higher and more expensive pumps used. The drip system appears to maintain turf growth well on the soil based system.

3.2 Biobed sizing

The developing science of Biobed technology suggests that activity is most effective with Biobeds 0.8-1.0 m deep. A surface area of 5m x 4 m was used in the UK farm scale research which was linked to a concrete intercept area of 35 m^2. Essentially this suggests a ratio of 1 m^2 loading area to 0.6 m^2 Biobed.

Whilst two years study did not identify problems with this ratio, there could be benefit in using a 1:1 ratio between the loading area and the Biobed. The Biobed is suggested as being included within a lined pit, excavated to minimise soil movement, i.e. with side slopes of 30-35^0 dependent on soil type. It may be possible to include the Biobed material in an above ground tank with suitable contained drainage but this will definitely need pumped transfer.

3.3 Should the Biobed be lined?

An artificial liner will be required where washdown of the sprayer equipment is included. This ensures that all liquids are retained before being discharged via a designated disposal option. The liner material of a type suitable for small reservoirs should suffice. This is likely to be not less than 1.5mm thick and should be installed over a recommended geotextile mat and/or 25 mm sand blinding. The liner will require a bonded outlet point to convey all liquid from the Biobed to the final distribution system. This unrestricted through flow of liquid is vital to ensure that the Biobed or turfed soil area is not waterlogged, where it could turn lead to anaerobic conditions and thus become ineffective.

In the case of a site being just a handling and mixing area then a liner may not be required. With washdown facilities included, this aspect will need careful consideration with the local Environment Agency office, with respect to Groundwater Regulations at each site.

3.4 Biobed mix

Successful breakdown of pesticide residues has been achieved with a mixture by volume of 50% straw (wheat or barley), 25% soil and 25% peat-free compost. For guidance on mixing see later section on constructional details.

Soil selection is critical to both ease of mixing and in Biobed performance.

Heavy clays, with poor drainage characteristics should be avoided. Loamy soils, which afford easy mixing and predictable drainage in situ and with low compaction potential, are more suitable.

There is a benefit in covering the Biobed area with turf. This ensures that there is good rooting activity and probably assists in moisture management, through evapotranspiration of water to the atmosphere. The turf does not need to be of high quality, turves from any established pasture field appear to function well.

3.5 Water outflow from Biobed areas

It is most likely that at the outfall from the Biobed a pump will be necessary to either distribute the water to the designated disposal area directly or to a buffer tank. A similar type of pump as used in the initial transfer is satisfactory for this operation.

With satisfactory treatment by the Biobed area this water should have a very low or undetectable pesticide content. However, it will need to be managed during distribution onto land. To meet this requirement, a buffer tank may be necessary to allow managed applications linked to local rainfall and soil conditions. This tank is again unlikely to be less than 1.5 m^3.

The distribution of the water can again be by drip irrigation or sprinkler system. The scheme would normally apply in the order of 2-4 mm per 24 hours, dependant on a number of local site factors. The precise specification for the drip irrigation will depend on the soil type and the size of the disposal area allocated. Hard hose drip irrigation would again be preferred, unless burial of the tape type could be adopted. This could remain undisturbed for several years.

The location of this final distribution area will need to be discussed with the local Environment Agency office *and an Authorisation under the Groundwater Regulations obtained*.

4. CONSTRUCTIONAL DETAIL

4.1 Site selection

A general review of the yard and local area should be made. A simple site review questionnaire is available in appendix 1. This will allow an independent review to be made of the whole area and pesticide handling, mixing washdown procedures, thus guiding site selection and further planning.

The proximity of the on-site chemical store and water supply will influence the location of the sprayer loading area. The intention is thus to handle and open all chemical containers over the DRIVE OVER or OFFSET area. Therefore this area should be close to, but separate from, the store bund. The water supply filling pipe connected to the sprayer should maintain the coupling well inside the BUNDED handling area.

The loading area should not be close to any existing yard “flash flood” routes or contain roof rainwater outlets. Whilst the area will be bunded this might not suffice if the general site is incorrect. As stated earlier the prospect of roofing the area implies high cost. Such a structure would need to ensure access above the sprayer and include some side cladding. The minimisation of the handling area and limitation of other yard water is likely to be a better and more cost-effective option than roofing the entire area.

The site should not intersect any common yard traffic routes. Contamination of wheels can lead to pollution elsewhere. Thus both the position of the area and the bund should preclude any casual use as a short cut or as a parking area. Its provision and siting should promote a “spraying use only” attitude amongst all involved.

Local watercourses and drains will also influence the site selection. The whole approach to an area being developed is to ensure pesticide contaminated water is handled discreetly from all other waters. This is easier if some distance from potentially vulnerable sites can be provided to limit accidental functions. It is suggested that any disposal area should be at a distance of greater than 10m from any open watercourse.

The site should be close to a single phase electrical supply, with earth leakage protection installed to the appropriate electrical standard.

Savings in design can be made if gravity can be used for liquids transfer. Bear in mind that initial silt traps and possibly storage tanks can be set into the ground (at 1.5 m depth), thus site levels & falls and distances must be determined accurately if the need for any pump is to be avoided.

Close proximity to public access routes, e.g. footpaths is to be avoided. Whilst the aim is to lessen risk through the final discharge of any liquid, the handling area can be heavily contaminated and inadvertent use should be discouraged at all times.

4.2 Specifications

OFFSET systems have a common layout and component parts. Inclusion of a straw based biomix or soil in the biobed is one of personal preference.

DRIVE OVER systems limit the number of pumps or chambers necessary. The overall area of any grid may be larger to cover supports over any foundation walls.

4.2.1 OFFSET to Biobed

SPRAYER STANDING AREA WHERE HANDLING AND MIXING WILL TAKE PLACE.

New system – concrete (see Figure 4.1)

Remove existing topsoil. Excavate as necessary to allow for the following construction:-

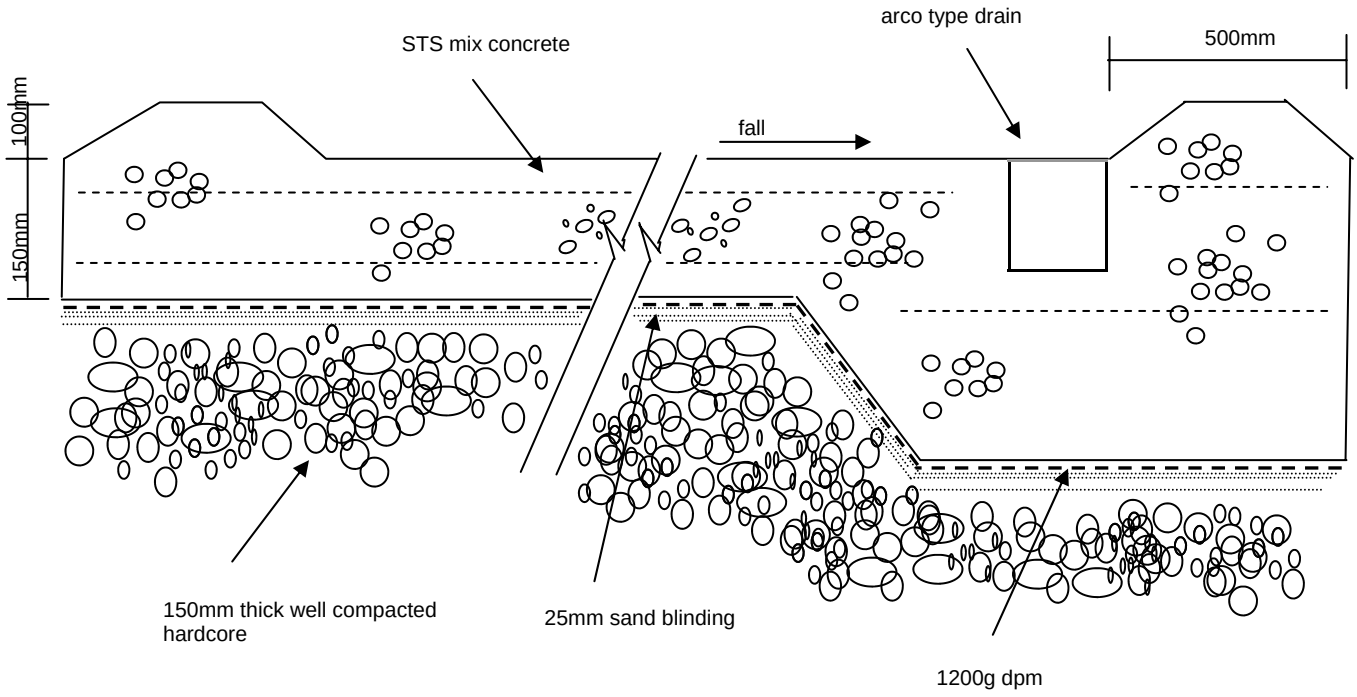
150 mm thick ST5 mix concrete with 2 layers mesh reinforcement pattern A252, with minimum cover of 40mm, on 1200g damp proof membrane, on a 25 mm sand blinding, on a 150 mm thick well compacted hardcore. Slab to be laid to falls of not less than 1 : 100. Slab to have a raised bund edge of minimum 300 mm x 100 mm. All as shown in Figure 4.1.

Install 100mm x 100 mm deep Arco type drain, installed with manufacturers instructions, taken to trapped gully with a 50 mm diameter concentric rib reinforced PVC-U connection to a silt trap. Silt trap, with removable cover to provide 250 mm capacity below inlet pipe.

INDIRECT SYSTEM

Figure 4.1

Section through concrete pesticide handling and mixing intercept area



Existing concrete area – modified to form handling and mixing area

Inspect concrete to ensure surface free from damage, pitting and cracks. Check fall is adequate as above. If not a new area may be required. If no drain available to be intercepted, cut concrete suiting the fall to accept 100mm x 100 mm deep Arco type drain, installed with manufacturers instructions, taken to trapped gully with a 50 mm diameter concentric rib reinforced PVC-U connection to a silt trap. Silt trap, with removable cover to provide 250 mm capacity below inlet pipe.

Prepare surface at size edge to provide a key to accept raised bund edge of minimum 300 mm x 100 mm. This may need existing surface roughened including bonding agents or similar to accept concrete mix.

Pumped transfer

Excavate and install chamber to act as intermediate impervious reservoir for pump installation. Nominal size 0.75 m x 0.75 m x 0.75 m.

Provide 50 mm concentric rib connection from silt trap to chamber. Install submersible pump, including float switch control. Provide and install suitable electrical supply to pump. Pump likely to have nominal capacity = 50 l/min @ 6.5m head. (approx. 200 w motor). Float switch nominally affords 0.25m depth in tank between on /off cycles, i.e. approx. 3 minute run time and meets most expected rainfall intensities on the intercept sizes suggested.

Buffer Storage

Discharge from any good quality concrete area will produce 1 litre of water for every 1 mm of rainfall, which falls on one square metre. Thus in order to manage the moisture content of the Biobed it may be beneficial to hold an amount of the liquid from the handling and mixing area in a buffer storage tank. It is a relatively frequent occurrence to have 25 mm of rain within 24 hours, thus almost 1 m^3 may be collected. This tank will hold all spills; drainage etc so it would be prudent to ensure its volume is approx. 1.5 m^3 for most arable areas, e.g. rainfall up to 750 mm per annum.

Precise constructional details for the installation of this tank will vary with design. Where a pump is needed for transfer the tank could be above ground. Frost proofing must be taken into account with this option. Where a below ground tank is selected guidance must be taken from the suppliers regarding the bedding of the tank within the soil.

Liquid Transfer to Biobed

It is important to distribute the liquid evenly over the Biobed. The Biobed surface area is not large and above ground small sprinklers may still provide excessive wetted areas. Drip irrigation has been used successfully. This has a low pressure demand (nominally 7 m head). Emitters from this pipe have a flow of 1.6-2 l/h and may be spaced at 0.25-0.4 m with pipes spaced a similar distance apart. Hard hose systems are preferred for reasons stated earlier and should give a longer life, which counters their higher cost.

The submersible pump as used in the initial pumped transfer can be used here. The control of this pump should be by time and tank level control. With a drip irrigation outline as above approx. 4 mm liquid can be applied within 15 minutes. Thus it is relatively easy to manage the water flow within the Biobed taking account of average and peak rainfall occurrences. Pressure head characteristics of these submersible pumps vary but those used within the UK research projects have supplied the drip tape adequately.

Other sprinkler types of irrigation may be used but care should be taken to avoid drift and overlapping or non-Biobed areas. Sprinkler systems will require a higher pressure system and this could challenge the pump selection to accommodate this.

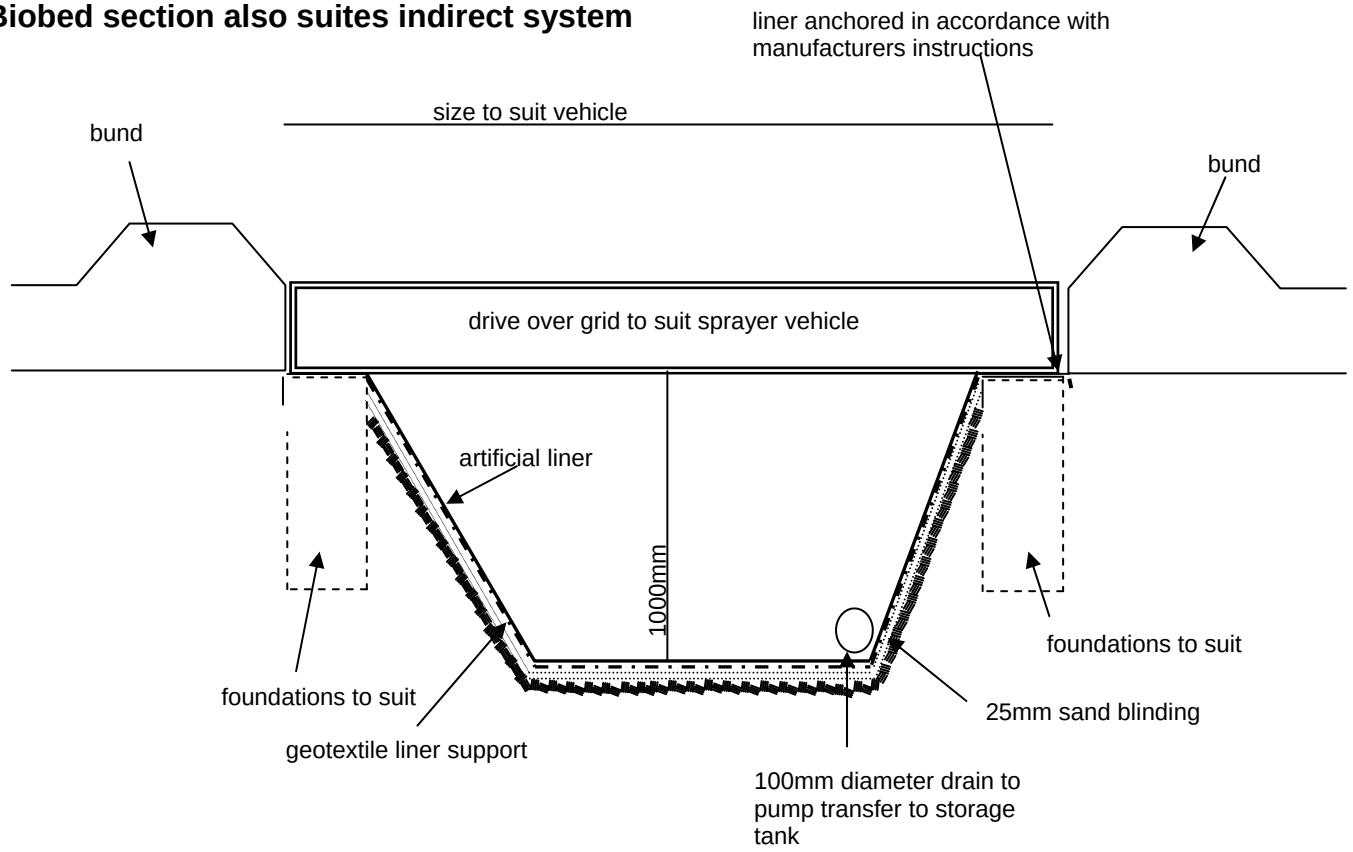
Biobed construction

A pit must be excavated to contain the Biobed mix. This could be a shape to suit any tank or lining system, so long as the effective depth of the Biobed is 0.8-1.0m. Where a liner is used an outlet drain is needed at the base to ensure unrestricted water through flow. All liner manufacturers recommendations for installation must be followed. Successful Biobed operation has been found with soil side slopes of $30\text{-}35^0$ blinded with 25mm sand. Over this a geotextile membrane of 190 grams per square metre an artificial liner was installed. The liner must be anchored securely to the soil surface in line with manufacturers instructions. The liner is likely to be 1.5 mm thick and of a synthetic material. 100 mm drain is then bonded to the liner at the low point compatible with site layout. (See Figure 4.2 - suited to direct and offset systems) A coarse filter should be installed over the drain intake to prevent the biomix material clogging the pipe. This is likely to be approx. 4 mm square mesh. Dependent on constructional plans and timing this liner may need filling with water (blocking the drain temporarily) to hold it in place until the biomix material is prepared.

DRIVE OVER SYSTEM

Figure 4.2

Drive over grid cover Biobed section
Biobed section also suites indirect system



Biobed Mix

This has been prepared successfully by layering the ingredients on a concrete yard area and then handling the material with a telehandler and manure fork (or similar machine). Small amounts may be handled manually with manure forks. A mixture, by volume, of 50% straw, 25% soil and 25% peat-free compost should be prepared. There appears to be little requirement for overlong mixing so long as the resultant mix can be left for some 5-8 weeks prior to loading in the Biobed pit. By this time the composting operation has begun and the mix is likely to be effective at retaining and degrading pesticide residues.

Loading of the material into the pit should leave the surface slightly humped to allow for subsidence prior to establishing the drip irrigation and use.

Turfing over the mix requires only pasture type turf. Reasonable care should be taken to ensure the turves butt well and that some moisture is added to encourage successful establishment. The turves root relatively easily into the Biobed mix.

Drip irrigation installation can then progress laying the pipes over the turf as per manufacturers instructions.

Liquid Transfer from Biobed

A second chamber similar to the initial intercept chamber is required. Unless the site has a particularly beneficial slope it is likely that pumped transfer is required. Excavate and install a chamber to act as intermediate impervious reservoir for pump installation. (Similar to section on liquid transfer to Biobed) Chamber size, nominally 0.75 m x 0.75 m x 0.75 m. Connect from Biobed liner to this chamber by 100 mm PVC-U connection.

Provide and install suitable electrical supply to pump. Install pump identical to handling and mixing area transfer above.

Buffer storage

Whilst it would be possible to pump directly to a disposal area this is considered unlikely without a degree of interim storage. This could be a small chamber as for the initial collection from the loading area. However a greater degree of control may be useful due to rainfall variations and soil type / moisture content. Therefore a similar holding capacity to the initial handling and mixing area storage tank (minimum 1.5m^3), dependent on rainfall is suggested. Installation requirements are similar.

Irrigation of final discharge water to disposal area

For similar reasons as before drip irrigation is proposed. Soil type will determine the spacing of both emitters and pipes. Light soils will require closer spacings, progressively wider spacing on heavier soils to a probable maximum of 0.5m being likely. A system should be installed to apply 2-4 mm at a time. Where a spacing as 0.5 x 0.5m is possible with emitter flow as before such an application would be possible within 30 minutes.

It is possible to bury the drip irrigation some 50 mm below the soil surface which would control surface evaporation and minimise any bird / vermin problems.

This pump should be automatically controlled by time with override provided by level control and manual deactivation.

4.2.2 DRIVE OVER Biobed

These systems are simpler in principle as gravity is used to advantage and the containment of liquids is confined to one area only. It is unlikely that any system exists currently to allow modification, therefore a "new" approach may simplify decisions.

Drive-over grid

The purpose of the drive-over grid is to prevent the spray vehicle and other compaction factors affecting the performance of the Biobed and allowing easy vehicle traffic over the area. Therefore the specification for the grid must fully take account of the intended or any future weight of the spray vehicle. Whilst a mounted small sprayer may be in use now it may be prudent to plan for larger vehicles, perhaps on contract spraying. Reference to Section 2.3 will determine whether or not a liner is needed. Where a liner is fitted, to avoid damage to the liner, the grid may need to be supported at the end and sides by foundation works accepting the complete spanning of the Biobed.

Some Scandinavian designs include only channels placed lengthways over the Biobed, which support the vehicle wheels only. The operator thus stands on the Biobed surface. On Health and Safety grounds, when handling chemical containers safely, this is considered undesirable, as a firm footing is required. The Biobed itself, particularly if a straw/soil/compost mix is also not likely to function well if it is continuously compacted by the operators feet.

Many spray vehicles approach any handling area from slightly different routes on occasions. This places a need to specify the design to deal with such variable angle approaches or departures. Such a specification thus allows the operator complete freedom in any working routine.

The surface grid will need to give a sure footing to the operator and allow all liquids to pass vertically though it. A 40 x 100 mm steel mesh over the supporting steel work is recommended. Soil/mud from tyres should easily enter the Biobed area. The grid requires removable sections to allow for the annual topping up of the Biobed material. These sections are likely to require mechanical aids to removal, e.g. hooks or eyes for loader forks etc as unless the sections are very small they will be too heavy for one person to handle.

For end and side foundations, excavate to a firm subsoil base; shutter as necessary and lay a concrete mix ST5 liaising with grid supplier over the anchorage system for the grid.

The drive-over grid should not accept liquids, other than those vertically above it. Therefore a bund, similar to that for the concrete intercept areas, should be installed with a raised bund edge of minimum 300 mm x 100 mm. All as shown in Figure 4.2.

BIOBED CONSTRUCTION

Constructional details are the same as for an offset system.

Biobed Mix

Biobed mixing is the same as for an OFFSET system. As all liquids fall directly through the grid no liquid distribution system is needed.

Liquid Transfer from Biobed

An initial intercept chamber is required. Unless the site has a particularly beneficial slope it is likely that pumped transfer is required. For this excavate and install chamber to act as intermediate impervious reservoir for pump installation. Nominal size 0.75 m x 0.75 m x 0.75 m. Connect from Biobed liner to this chamber by 100 mm PVC-U connection.

Provide and install suitable electrical supply to pump. Install pump identical to handling and mixing area transfer under indirect systems.

Buffer storage

Whilst it would be possible to pump directly to a disposal area this is considered unlikely without a degree of interim storage. This could be a small chamber as for the initial collection from the loading area. However a greater degree of control may be useful due to rainfall variations and soil type / moisture content. Therefore a similar holding capacity to the initial handling and mixing area storage tank (minimum 1.5m^3), dependent on rainfall is suggested. Installation requirements are similar.

Irrigation of final discharge water to disposal area

For similar reasons as with indirect systems drip irrigation is proposed. Soil type will determine the spacing of both emitters and pipes. Light soils will require closer spacings, progressively wider spacing on heavier soils to a probable maximum of 0.5m being likely. In order to plan any frequent irrigation a system should be installed to apply 2-4 mm at a time. Where a spacing as 0.5 x 0.5m is possible with emitter flow as before such an application would be possible within 30 minutes.

It is possible to bury the drip irrigation some 50 mm below the soil surface which would control surface evaporation and minimise any vermin problems.

This pump should be automatically controlled by time with override provided by level control (e.g. float switch) and manual deactivation.

4.2.3 OFFSET to disposal

Concrete draining to sealed tank prior to disposal

Where Biobed systems may not provide a solution to discharge from a handling and mixing area the liquid should be stored in a sealed tank *and disposed of through a waste disposal contractor or via a Groundwater Regulations Authorisation*. There is merit in roofing over the area to limit rainfall and thus the amount of liquid to be disposed of.

The OFFSET system principle and layout for the handling and mixing area is proposed. Constructional and installation detail will be similar up to the primary tank.

This tank requires sizing to be compatible with road tanker disposal and liquids intercepted (rainfall and ex-sprayer use). Such a tank may need to be quite large to deal with all rainfall peak intensities safely. For instance a normal road tanker could accept a pick up, probably between 10 - 20m^3.

For a 7 x 5 m handling and mixing / washdown area and reasonable sprayer use with rainfall 10m^3 may be produced within one month.

Final transfer to road haulage will normally be by the vehicles own pump. If not then selection must take account of loading times required and any delay penalties.

It is essential to park any collection vehicle with its coupling locations on the OFFSET area during transfer. This should control possible leakages etc. during the transfer process. The size and position of all couplings on the vehicle will need to be considered when planning the handling and mixing area.

4.3 Safety

All materials must be selected to suit the intended purpose. All construction and installation work must be carried out within the relevant sections of the Health and Safety at Work Act. All electrical work must follow the appropriate British Standard.

Particular attention should be paid to the exterior nature of all equipment provision and installation having particular due regard to electrical function in close proximity to liquids and operators.

5. SYSTEM MANAGEMENT

5.1 Daily operation

The system as installed should avoid the need for detailed management inputs every day. There will be a need to assess the installation during spraying operations for normal function as well as when periods of high rainfall are experienced.

In addition, outside spraying activities, a weekly observation should include:

Check

- Intercept / grid areas for soil/mud deposits, brush up and transfer to Biobed areas or push through the drive-over grid.
- Silt traps. If blocked, wearing suitable hand and face protection remove any trapped material by hand trowel or small shovel to adjacent Biobed area.
- Liquid depth in all chambers, pump operation
- Drip irrigation function-Biobed area and disposal area, damage/leaks etc.
- Condition of all Biobed vegetative growth.

In periods of high rainfall it may be necessary to manually manage the pumping intervals applying water to both the Biobed and disposal irrigation systems. Experience will guide necessary action relative to soil types, capacities installed and system interaction.

5.2 Annual maintenance

As with any composted material it is anticipated that the biomix material will degrade steadily through each year. Topping up of the biomix material will probably be required annually when approx. 300 mm of fresh biomix may need to be added. This procedure is expected, from Swedish experience, to be necessary each year for 5-7 years. At that time it is beneficial to remove all the biomix material to a safe location where it may composted for a further year to allow further degradation. During that year it is beneficial to turn or mix the compost thus ensuring maximum degradation of any remaining pesticides. *The disposal of this material will be required to comply with the relevant waste regulations.*

The soil / turf mixture life is less well documented. Its life may be indicated by any vegetative growth performance. Final destiny for this material may also be as for the composted material above.

5.3 Cold weather provision

Each site and installation will present different challenges during winter conditions. Most systems will need to remain functional during cold weather to handle natural rainfall entering the system. Installations should limit all surface pipe runs as far as possible. Where they exist they should be insulated to an effective level using proprietary waterproof pipe insulation.

Most systems will be vulnerable where drip irrigation is used over Biobed surfaces. It is suggested that these be covered with a straw layer for insulation purposes.

6. COSTS

Indications of expected costs are given below. Inevitably these will vary depending on site and systems selected as well as whether any part of any system already exists and can be incorporated into the design.

Bunded loading area, with drain and trap – concrete	£ 40-50 per m^2
Small pump chambers	£250 each
Pumps	£60 each
Electrical supply, time switches etc	£350 per site
Liner and membrane 5 x 4 m, nominal Biobed with drain	£800
1.5m^3 plastic water storage tank-double skin	£650-1500
Drive over grid – suited to self propelled 24 m sprayer	£90 per m^2
Drip irrigation – Biobed distribution and disposal area	£300
Roofing area – single span, mono pitch	£20-25 per m^2

These costs, all for proprietary new items, suggest that one new un-roofed offset system using all expected equipment options and two tanks on a new concrete surface could result in expenditure in the range of £3500 -7,000. The drive-over lined Biobed option would require a similar level of expenditure.

Many variables exist with each site, especially where part schemes already exist. Modifications to such schemes, using farm or local construction skills, may mean that in reality the actual expenditure figure may well be considerably lower than this.

Checklist for Potential Biobed Sites

1. Name ……

2. Address ……

Postcode:……...

Tel:…….. Fax:……

Email:……...

3. Type of farm Arable / Mixed (please circle)

4. Typical soil type ……

5. Area of farm ……

6. Area of cropping ……

7. Typical crops grown ……

8. Agronomic advice (ADAS or other) ……

9. Typical number of spray days per spray season ……

10. Typical number of exterior washdown operations ……

11. Type of spray machinery ……

- Spec eg tank size …….. - Boom Width ……...
- S/P Trailed …….. - Mounted ……...
- Weight ……...

12. Is sprayer... Farmer operated / Spray contractor (please circle)

13. Is sprayer just used for pesticides or liquid fertilisers also? ……

14. Any other critical issues - dimensions etc ……

15. Current pesticide handling and wash-down facility. ……

- could it be easily converted by eg. Installation of bund and drain? ……

- Can gradient be used instead of pumps to move water from pad to biobed? ……

16. Short description...

- Size	……	- Materials	……
	……..		……..
- Drainage / Watercourses	……	- Location	……
	……..		……..
- Pressure washing facilities	……	- Power Available?	……
	……..		……..
- Proximity to pesticide store	……	- Is this the only site in use?	……
	……		……
	……..		……

Checklist for Potential Biobed Sites continued...

17. Current waste disposal system / technique ……

18. Footpaths / Neighbours ……

19. Any climatic info for site ie. Rainfall etc. ……

20. List of typical pesticide products used ……

21. Livestock present? ……
- Access routes around farm near any site offered. ……

22. Does sprayer have to cross any watercourses within catchment enrout to and from treatment fields? ……
- Are there always proper bridges? ……
- Are there any fords? ……

23. Does sprayer always travel from mixing area to treatment fields fully loaded with spray mix? ……
- Are there facilities to mix and fill up elsewhere? ……
- If so, how are the pesticide products stored during transport? ……

24. Are headlands sprayed last before exiting fields after application? ……

25. Is full consideration given to any LERAP requirement for specific pesticide products? ……

26. Have you signed up to National Register of Sprayer Operators (NRoSO)? ……

27. Have you signed up to National Sprayer Testing Scheme (NSTS)? ……