Biosolids recycling - past, present and future

The Past

In the early 19th century, sewage from urban areas was either disposed of directly into rivers and the sea, or solid materials were taken direct to land (as night soil). Thereafter, sewage networks were developed along with basic wastewater treatment systems that returned effluent to watercourses, whilst raw sludge was taken to land or disposed of at sea.

By the early 20th century, the increasing number and the extent of sewage networks with more efficient wastewater treatment technologies resulted in increased quantities of sludge production. Activated treatment processes (developed 100 years ago) were used to reduce the fermentability (odour) and microbiological load of these sludges. However, they still contained high levels of industrial contaminants (particularly heavy metals) from trade effluent entering sewer networks, which were only brought under control from around 1950 onwards. Various Acts (including *Public Health, Rivers, Control of Pollution,* and *Water*) helped to encourage the use of new technologies and improve the impact of wastewater treatment processes and sludge production on the environment.

In 1986, the European Sludge Directive (EU, 1986) was introduced and was followed in 1989 by the UK "Sludge (Use in Agriculture) Regulations" (SI, 1989), which set out statutory requirements for the use of sludge on agricultural land, including controls on heavy metal and nutrient additions to soil.

In 1998, sludge dispersal to sea was banned in the EU, thereby increasing reliance on agricultural land for biosolids recycling; the only other realistic (alternative) outlet was incineration. At this time, the ADAS "Safe Sludge Matrix" (ADAS, 2001) was agreed to strengthen reassurance in the food chain that microbiological risks were unlikely to pose a threat to human and animal health.

A typical process flow diagram from wastewater collection to the generation and treatment of sludge, and resulting biosolids products for agricultural recycling is illustrated in Figure 1.

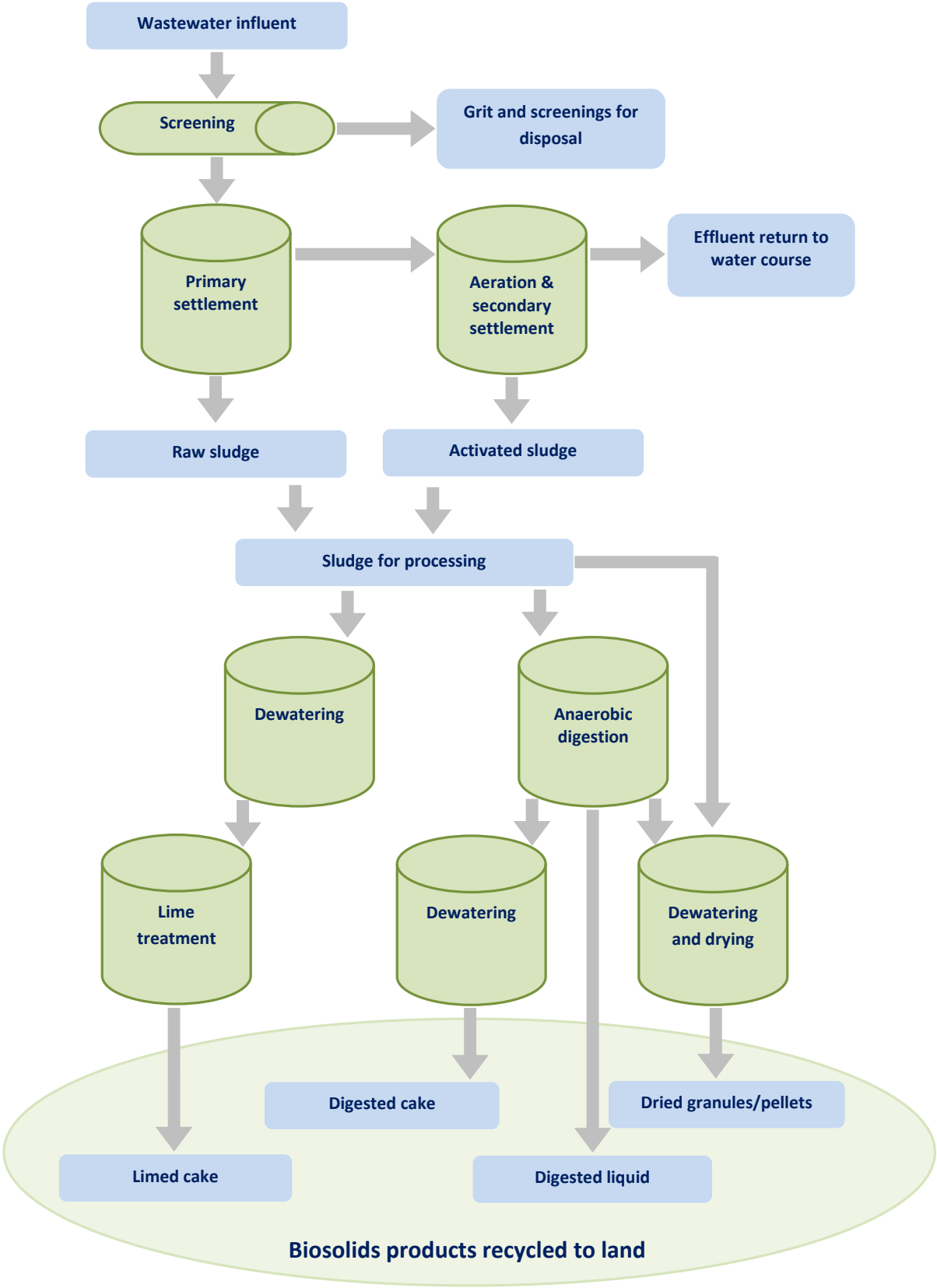

Figure 1. **A typical process flow from wastewater influent to biosolids products**

The Present

The beginning of the 21st century has seen the continued development of both wastewater and sludge treatment technologies that have continually increased the amount of biosolids produced and led to the increased adoption of advanced digestion processes with energy (biogas) generation in specialised sludge treatment centres. Most sludge is treated by mesophilic anaerobic digestion (AD), where sludge is retained for specific time periods, at temperatures typically ranging from 35 to 45°C. Thermophilic anaerobic digestion, which reaches temperature of >55°C for a shorter period, is also used but to a much lesser extent. Thermal hydrolysis (high temperature and pressure) processes are increasingly being used ahead of AD to improve digestion, increase the release of biogas and reduce microbiological loads. The treatment of sludge with lime, which reduces microbiological loadings by increasing pH (releasing ammonia gas) and temperature, is gradually being replaced by advanced digestion processes (excepting at small or remote sites). Incineration only tends to be used where land availability is limited, and long haulage distances make agricultural recycling impractical.

Industrial contaminants (including heavy metals) have continued to reduce in sewer effluent and biosolids due to stringent trade effluent controls, and a reduction in heavy industries in the UK.

In the UK, around 1.5 million tonnes (dry solids) of untreated sludge is produced annually. After treatment this reduces to about 1.1 million tonnes of which *c.*78% (*c.*860,000 tonnes of dry solids) is recycled to agricultural land (2016), Figure 2. This equates to around 3.6 million tonnes on a fresh weight basis. Over 150,000 hectares of agricultural land receives biosolids annually, with the majority applied to arable land.

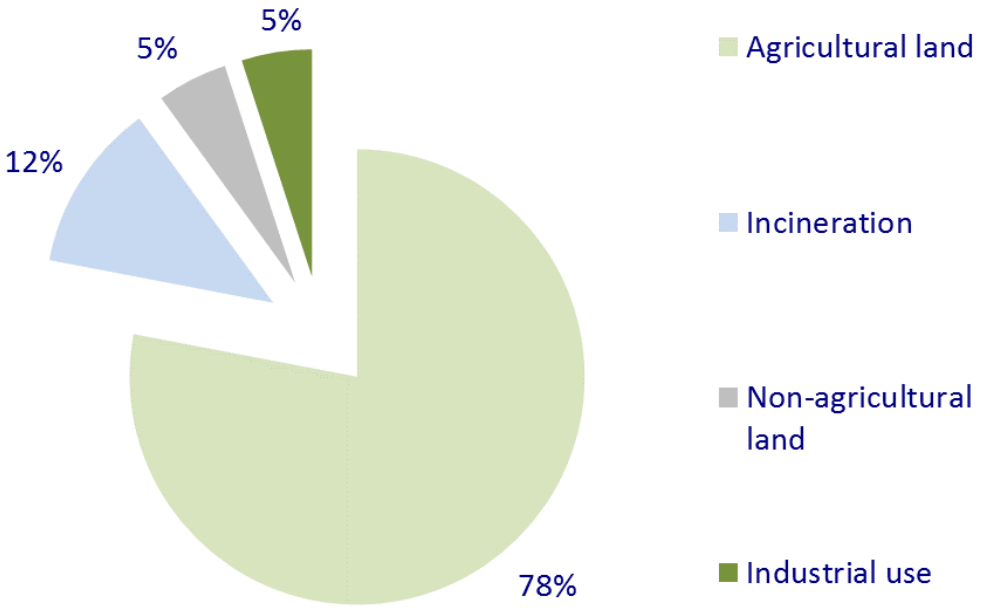

Figure 2. Sludge destination routes (UK, 2016).

The Future

Increased sewerage network connections and the growing UK population will lead to increasing amounts of raw sludge for treatment over the next 20 years. Whilst future business plans vary between water companies (depending on regional circumstances) they generally involve a move away from lime treatment towards advanced digestion with energy recovery at large specialised sludge treatment centres.

The increased focus on improving river and ground water quality in response to the Nitrate and Water Framework Directives, will lead to an increased requirement for phosphate precipitation from wastewater treatment into biosolids products, which in turn will increase their nutrient value to farmers.