DRAFT –
INTERIM SLUDGE SOLUTIONS
(June 2013)

Introduction

Sludge originates from the process of treatment of waste water. Under *Urban Waste Water Treatment Directive 91/271/EEC,* sludge is defined as treated or untreated sludge residue, coming from wastewater treatment plants. The progressive implementation of the UWWTD in all Member States, the increase of connection rate and upgrading of treatment level to tertiary treatment results in increasing quantities of sewage sludge for which final disposal is required.

Croatia is facing the same challenges. According the *Implementation Plan for water utility directive,* the deadline for the implementation of the requirements of the directive is 2023. for all agglomerations > 2.000 P.E. with transitional periods 2018. and 2020. Croatia has defined 294 agglomerations larger than 2.000 P.E.

Croatia has started to develop an exhaustive *project pipeline* for the construction of WWTP's most of which will require assistance through EU co-financing. One of prerequisites for EU funding is the development of an adequate solution for sludge management and disposal.

In June 2012. Hrvatske Vode contracted the study "The technical – economic study "Treatment and disposal of waste and waste sludge generated by treatment of wastewater from public sewerage systems of towns and municipalities in Croatian counties" (further as Study) to a consortium led by WYG International Limited UK. This study is underway and the final document is expected in the beginning of 2014. The study will provide for the development of the strategic outlines for sludge treatment and disposal and provide for the basis of a regulatory framework (bylaws) to regulate sludge management and disposal in Croatia.

In the meantime, for Projects under the Programming Period 2007-2013 and beginning of 2014-2020 interim solutions are required. This Document aims to provide for interim sludge management and disposal solutions which are reliable at any time and have a sound legal and technical background i.e. they are coherent with energy, resource, water and waste EU and national policies.

Legal basis

The existing European legislation related to sludge treatment, disposal and recycling focuses principally on the use of sludge in agriculture. For the moment, other uses or disposal routes for sludge generally fall under more general laws on waste and water management.

Directives most relevant to sludge management are the following:

I. **The Council Directive 86/278/EEC on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture.** The Directive sets minimum quality standards for the soil and sludge used in agriculture, and defines monitoring requirements when sludge is used on agricultural land. The directive defines limit values for heavy metals in sewage sludge and for soil when sewage

sludge is used on land and maximum annual heavy metals loads through the application of sewage sludge.

The sludge directive is in a process to be amended and various studies have been carried out to evaluate the effect of changes. The changes will probably include stricter limit values for heavy metals, the inclusion of limit values for organic pollutants and pathogens.

II. **Directive 2008/98/EC on waste (Waste Framework Directive)** sets the basic concepts and definitions related to waste management, such as definitions of waste, recycling, recovery. It explains when waste ceases to be waste and becomes a secondary raw material (so called end-of-waste criteria), and how to distinguish between waste and by-products. In addition, this Directive provides the definition for the term "waste" (where waste means any substance or object which the holder discards or intends or is required to discard) including a clarification of the distinction between waste and non-waste. A list of the different type of waste is provided by the Commission Decision 2001/118/EC which amends Decision 2000/532/EC. Directives specific to certain wastes (e.g. sludge) are applied additionally to the Waste Framework Directive.

III. **The Council Directive of 21 May 1991 concerning urban waste water treatment (91/271/EEC), known as the Urban Waste Water Treatment Directive,** is aimed at protecting the environment from the adverse effects of waste water discharges. This Directive sets minimum sewage treatment standards to be achieved in stages by the end of 2005, and provides for advanced waste water treatment for the removal of nitrogen and phosphorus from sensitive areas. The Directive 91/271/EEC supports the use of sewage sludge in article 14: "*sludge arising from waste water treatment shall be re-used whenever appropriate. Disposal routs shall minimise the adverse effects on the environment.*" The same article specifies that the disposal of sludge from urban waste water treatment plants is subject to general rules, registration or authorisation. In addition, this Directive introduces detailed monitoring requirements and requires Member States to submit reports every two years on their waste water treatment and sludge disposal activities.

IV. **The Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources, known as the Nitrates Directive,** requires identification by Member States of Nitrates Vulnerable Zones (NVZ). These zones are defined as areas where water quality has or will exceed EC drinking water standard in terms of nitrates concentration (defined in Directive 75/440/EEC concerning the quality required of surface water intended for the abstraction of drinking water in Member States).

In addition to these Directives the Commission decision of 12 February 2001 amending Decision 98/488/EC establishing the ecological criteria for the award of the Community Eco-label to soil improvers, specifies that these products may not contain sewage sludge.

Some other Directives related to waste management have also implications on sludge management. The Directive on the landfill of waste 1999/31/EC will contribute to making disposal of sludge to landfill more difficult, as this Directive aims at reducing the quantity of biodegradable waste going to landfills, and prohibits the landfilling of both liquid and untreated wastes. In addition, Directive on the Incineration of Waste 2000/76/EC sets limit values for emissions of pollutants to air due to waste incineration.

National legal basis

The table below gives an overview of the Strategies, Plans, Programmes, lows and corresponding bylaws regulating the sludge management policy in Croatia.

Table 1: Overview of the legislation regulating sludge management policy in Croatia

ZAKONI	PODZAKONSKI AKTI	STRATEGIJE	PLANOVI
Zakon o zaštiti okoliša (NN 110/07) Zakon o otpadu (NN 178/04, 111/06, 60/08, 87/09)[1]	Pravilnik o gospodarenju muljem iz uređaja za pročišćavanje otpadnih voda kada se mulj koristi u poljoprivredi (NN 38/08)	Strategija gospodarenja otpadom Republike Hrvatske (NN 130/05)	Plan gospodarenja otpadom u Republici Hrvatskoj za razdoblje 2007. – 2015. godina (NN 85/07, 126/10, 31/11)
	Pravilnik o gospodarenju otpadom (NN 23/07)		
	Uredba o kategorijama, vrstama i klasifikaciji otpada s katalogom otpada i listom opasnog otpada (NN 50/05, 39/09)		Planovi gospodarenja otpadom koje trebaju donijeti općine, gradovi, županije
	Pravilnik o načinima i uvjetima odlaganja otpada, kategorijama i uvjetima rada za odlagališta otpada (NN 117/07)		
	Pravilnik o načinima i uvjetima termičke obrade otpada (NN 45/07)		
Zakon o vodama (NN 153/09, 56/13)	Pravilnik o graničnim vrijednostima emisija otpadnih voda (NN 87/10)	Strategija upravljanja vodama (NN 91/08)	Plan provedbe vodnokomunalnih direktiva (studeni 2010)
	Pravilnik o uvjetima za utvrđivanje zona sanitarne zaštite izvorišta (NN 66/11)		
Zakon o poljoprivredi (NN 66/01, 83/02)	Pravilnik o zaštiti poljoprivrednog zemljišta od onečišćenja (NN 32/10)		Akcijski program (NN 15/13)
	Pravilnik o sadržaju akcijskog programa zaštite voda od onečišćenja uzrokovanog nitratima poljoprivrednog podrijetla (NN 7/13)		
Zakon o zaštiti zraka (NN 60/08)	Uredba o graničnim vrijednostima onečišćujućih tvari u zraku (NN 133/05)		

Interim Sludge Solutions

The treatment and disposal of sludge is an inseparable element of waste water treatment. Hence the development of a waste water treatment solution must include a solution for the treatment and disposal of the generated sludge and the costs of sludge treatment and disposal are an inherent cost of the treatment of waste water.
The choice of the adequate sludge disposal solution and location depends on several factors including but not limited to: quality and quantity of sludge produced at WWTP, regulatory aspects, local conditions as well as investment and operation and maintenance costs.
In countries with a longer tradition of waste water treatment a number of outlets are applied for the sludge including the use in agriculture and thermal treatments. In Croatia these sludge outlets are currently practically unavailable and have yet to be developed. Until such outlets

[1] Waste Act (OG 178/04, 111/06, 60/08, 87/09) is in the process of being changed to approximate the new Waste Framework Directive.

have been developed, either for individual plants or in a regional set-up, solutions are required on a plant-by-plant basis and be developed through the Feasibility studies. This applies to:

Projects under the Programming Period 2007-2013

Projects under the Programming Period 2014-2020

Containing:
- Sufficient explanation for Sludge disposal way in CF Grant application
- Cost calculation (including rebuilding measures, if necessary)
- Eligible disposal ways as given further in this document
- No changes to technologies or processes for waste water treatment

The following sludge treatment and disposal options are in compliance with the EU and the national legislative framework:

1. Landfilling of processed sludge, either in special areas or solid waste disposal sites
2. Composting with the organic fraction of municipal solid waste or livestock waste
3. Use in agriculture and forestry
4. Energy recovery
5. *[Optional]* Treatment by (Regional) Waste Management Centres
6. Temporary Storage and Treatment (Reed beds)
7. Other solutions legally compliant (e.g. use in construction material, isolation material etc.)

1. Landfilling of processed sludge, either in special areas or solid waste disposal sites

In most countries the disposal of sludge to landfills is progressively reduced in accordance with the requirements of the Directive on the landfill of waste (1999/31/EEC) which requires the reduction of biodegradable waste going to landfills and prohibits the landfilling of both liquid wastes and untreated wastes.

The *Plan for Waste Management in Croatia for the period 2007-2015 (OG 85/07)* envisages the possibility for disposal of stabilized sludge on sanitary landfills. However, this option should take into consideration following main disadvantages:

- actual availability of sanitary landfills,
- reachability of sanitary landfills,
- the EU and Croatian strategy to phase out this kind of sludge disposal method.

The *Ordinance on the terms and conditions of waste disposal, categories and working conditions for landfills (OG 117/07)* in fact forbids the sludge disposal on landfills because:

i. the acceptance of, inter alia, waste if it mass of biodegradable components exceeds 35% of total weight is forbidden (biologically stabilized sludge always contains more than 35% of biodegradable matter)[2].
ii. for waste disposal on landfills of non-hazardous waste the limit value for total organic carbon (TOC) is maximum 5% of dry matter weight (which is always the case with stabilized sludge)[3].

In addition, sludge to be disposed on landfill should be in line with criteria given in Article 6 of the Ordinance (it should be characterized as non-hazardous waste).

[2] T.B.Splitaler, Sept 2011, Poreč Sewerage and Waste Water Treatment Plants – Treatment, Reuse and recovery of sludge - Feasibility study
[3] Vouk and co., 2011

It can be concluded that the disposal of biologically stabilized sludge on landfills in Croatia is in fact not allowed under the current regulations.
Only if sludge is additionally treated (e.g. thermal treatment with ash as final product) it is possible to comply with limitations given in the Ordinance.

2. Use in agriculture and forestry

The advantages of the use of sludge in agriculture are:

- application of artificial fertilizers is reduced,
- Reduced production costs,
- soil fertility and structure improvement,
- Optimum humidity maintenance, permeability improvements,
- Enrichment with organic matter,
- Recirculation of globally exhausted phosphorus compounds,
- Reduction of erosion potential,
- State-owned land can be used etc.

A long term sustainable use of sludge in agriculture is also promoted by EUREAU[4]:

- Sludge should be managed as a resource (e.g. phosphorous and other nutrients and as a soil improver) which is in line with current EU thinking embodied in various policies as in EU 2020 flagship on the efficient use of resources;
- Sustainable use of sewage sludge calls for increased biogas production. This is in line with EU Energy targets for EU 2020;
- Within the Waste policy, "end-of-waste" status is an opportunity for composed sludge to be recognized as useful fertilizer;

However, on national level, application of sludge on agricultural land should be examined having in mind certain limitations (*Ordinance on management of sewage sludge when used in agriculture (OG 38/08), Rulebook on protection of agricultural land from contaminants (OG 32/10), Rulebook on good agricultural praxis when using fertilizers (OG 56/08)).* The major constraint thereto is prescribed by Article 8 of the Ordinance OG 38/08 stating that the maximum of 1, 66 Mg of treated sludge is permitted. However, this Ordinance does not state any threshold for the case sludge has been composted.

On the other hand it is of note that the use of sludge in agriculture is decreasing across the EU and several countries and regions have implied bans on the use of sludge in agriculture mainly due to the unforeseeable risks of the introduction of metals, inorganic pollutants, pathogens and other chemical compounds (medicines) in the soil. The public concerns on the use of sludge and the potential impact on food quality play an important role.

3. Composting with organic portion of municipal solid waste or livestock waste

[4] EUREAU Position paper on how the revision of the Fertiliser regulation should promote sustainable use of sludge n agriculture, 21 March 2012. The arguments of EUREAU refer to the UWWTD where use in agriculture is promoted and the Waste Framework Directive where it comes to waste as a resource.

Composting is well known and proven treatment system for stabilisation and pathogen reduction. It requires a bulking agent (straw, wood products, organic fraction of municipal waste, etc.).
The selection of final disposal of the compost requires consideration. Potential outlets are:

- *Application on agricultural land*
- *Recultivation (green areas and Parks)*
  The suitability of treated sludge for soil conditioning purposes for green areas and parks is limited and has only subsidiary effect.
- *Remediation (Mining Tailing Dams and polluted/contaminated sites)*
  According Waste Management Strategy priority contaminated locations are determined. Compost is acceptable for remediation purposes.
- *Rehabilitation (Landfill)*
  Natural topsoil for cover and rehabilitation works on dumpsites and/or future sanitary landfills can be replaced by biodegradable waste and sludge components.
- *Hydro Seeding*
  This is one of the several methods used for slope protection against water, wind and frost erosion, but it has limited applicability in agriculture due to the limitation of 1,66 Mg DS/ha as well as geo-morphological characterization (karstic area). A potential can be seen in the use for erosion prevention and protection in road and slope greening along highways.

The following aspects should be considered:

- Acceptance by public (NIMBY effect)/reputation problem of the product,
- national legislative framework on limitations for land application,
- high investment/operation costs,
- transportation cost (in case of decentralised solution),
- IPPC Permit (for rehabilitation of industrial/contaminated sites), …

4. Energy recovery

The organic compounds in sludge represent a substantial energy potential.

Energy from sludge can be (partly) recovered at the WWTP by digesting the raw sludge and generating biogas. The energy can be used to (partly) cover the energy requirements of the WWTP. The remaining sludge is considerably lower in organic content and the caloric value is reduced making the sludge unsuitable for thermal recovery of energy.

I. Biogas production

Biogas production (either onsite or off-site) is proven technology however, it is weighted by high investment and O&M cost and thus only applied in large WWTP's. If sludge is treated off-site the transportation cost would substantially add to the costs of treatment.
Costs of such solutions (construction, operation and maintenance) would be more affordable for the plants with higher capacities or by considering regional concept (one centralized biogas plant for fewer smaller WWTPs).
The remaining digestate must be dewatered and requires post-treatment (for instance composting). Due to the digestion the caloric value is low. Final disposal can be to land or alternatively requires further thermal treatment.

II. **Thermal treatment**

Thermal treatment for energy recovery has a potential in thermal power plants and cement kilns often requiring prior drying of the sludge. In Croatia co-firing of sludge might be possible in the coal fired Plomin power plant and in cement kilns. No municipal waste incineration plants exist allowing the co-incineration of sludge with municipal waste.

The potential of co-firing sludge in the Plomin power plant and in cement kilns need to be evaluated on regional or national level and in co-operation with the respective owners/operators.

5. [*Optional*][5] Treatment by Regional Waste Management Centres

For the establishment of waste management in Croatia, Waste management Strategy and Plan for 2007-2015 envision the construction of regional and county waste management centres. The applied technology would be a form of Mechanical Biological Treatment (MBT) and to produce refuse-derived fuel (RDF) or necessary recultivation material for the final closure of the enclosed sanitary landfill (according landfill directive – closure and aftercare).

6. Temporary Storage and Treatment

In the absence of National Strategy, and in duly justified cases where compliance with applicable national legislation can't be achieved in line with former solutions, temporary solutions are required. Following options can be applicable:

I. Reed bed technology offers opportunities for the storage of sludge for a period of 5 years or more depending on the design capacity.

Reed beds should be considered due to the following advantages:

- Reed beds can easily be installed,
- Capital cost and operation and maintenance costs are low,
- Safe disposal of sludge for several years of operation,
- No-regret measure,
- Can be located next to the WWTP,
- If there is no possibility on site, for the remote location transportation costs have to be calculated accordingly,
- Foreseen duration of the process is 6-10 years. Sludge after treatment on drying beds is ready for land application (agricultural or non-agricultural use), use as a replacement material or final disposal in incineration plant.

Technical design of the reed bed itself should be open for contractors design (Yellow book) and should take into consideration operation experiences of filling and emptying (excavation).

II. Temporary storage (disposal) specifically for sludge which can be excavated later for further treatment once such treatment is available.

[5] This option should also be examined in Feasibility study from techno – economic point of view. However, if this option has been regarded as most feasible, the State authorities for water and for waste management are holding the right to decide on it as a final solution.