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Measures for decreaseding negative impact of sludge capitalizaton

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Abstract. There are few operators of purification stations that presently have options for the capitalization of sludge. Over 90% of the resulting sludge is stocked in the purification stations and the lack of interest in finding beneficial solutions for the administration of sludge are especially due to additional inquiring costs, as well as technical and administrative difficulties encountered in determining new methods of sludge removal, along with the poor quality of this product. The current report is focused on measures for reducing and/or eliminating the negative impact by adopting new solution of sludge capitalization: adequate storage, energy recovery, rebuilding of degraded terrains, reforestation, and/or utilization of mud in agriculture.
Key Words: used water, agriculture, storage, energy, water purification, impact, sludge, mud.

Introduction. Many stations of purifications are equipped with low quality and inefficiency machinery, producing low quality effluents, much below official standards of evacuation. Although some stations have methods and equipment for the treatment of sludge, almost half are no longer running. Over 70% of the mud produced is dehydrated and deposited on separate sites (Ministerul Mediului şi Schimbărilor Climatice 2014).

The use in agriculture is considered one of the most durable options of sludge administration. The UE legislation supports this preference for agriculture, given that the quality standard for mud fulfills certain requirements, and its use is controlled and monitored to prevent negative consequence for human health and environment.

Material and Method. According to Romanian standards of used waters purification, NTPA011, 70-90% of biological oxygen use must be removed – CBO, 75% for COD and 90% for TSS. For advanced treatments, tertiary, by nitrification, a total of 70-80% of containing nitrogen and 80% of phosphorous can be removed efficiently.

The measures suggested for the prevention, reduction, and improvement of negative effects on the surrounding environment vary based on available options for sludge capitalization. These options are (Bercu 2011):

- agriculture;
- reforestation;
- rebuilding of resulting deteriorated lands;
- stocking;
- energy recovery;
- new alternative solutions of sludge capitalization.

For each of the above options, the present report outlines necessary measures to reduce and possibly completely eliminate the negative effects on the surrounding environment.

Results and Discussion

The use of sludge in agriculture. Measures for diminishing the negative impact on the surrounding environment for sludge use in agriculture are presented in the following paragraphs (Ministerul Mediului şi Schimbărilor climatice 2011).

- The development of a marketing strategy that is general and concentrated. The staffs who deal with the marketing of sludge should also deal with general marketing activities, in particular the establishment of contact with independent farmers and other potential users of sludge. Their specific and individual needs should be addressed. If sludge use is accepted, the marketing staff could also be involved in the sampling of soil, analysis coordination, tracking the demand and supply of sludge, providing all necessary technical advice on the use of sludge, including agronomic and regulatory, and providing quality control services during the process. More marketing activities should include the production and distribution of promotional items, research literature, workshops, public meetings and other public relations exercises to increase public awareness and acceptance of reusability of sludge in agriculture (Rusu & Avram 2009).
- The need for sludge storage for times when spreading on the ground is not appropriate/accessible. The sludge can be spread on agricultural land only during specific periods of the crop season, requiring storage for the remainder of the year. Storage units (platforms/drying beds) must be designed and constructed to prevent tank overfilling and accidental dumping on soil. Naturally, unauthorized personnel should be prohibited from entering the storage area.
- The optimization of timing for the sludge application on agricultural land. It is recommended to avoid spreading during very hot-weather periods of year, in order to eliminate the production of unpleasant smells.
- Considerations such as resulting traffic congestion, odor and accidental spillage of sludge are crucial in determining the type and size of sludge transport vehicles. All shipments of sludge will be properly isolated to avoid olfactory pollution.
- Avoiding use of heavy machinery on wet soils, especially clay soils, as this may cause damage to the soil and reduce crop yields.
- The reduction of tire pressure to avoid soil compaction. The tractor must be fitted with a compressor to allow periodic adjustments of tire pressure to maximize traction and minimize compaction, and inflation of tire for driving on roads; low pressure tires can be mounted, by contrast.
- The adequate training and supervision of field staff to ensure capability of accurate diagnosis of ground conditions.
- The program for sludge spreading must be done according to the type of soil considered. For example, on sandy soils, the sludge must be spread during periods of wet-weather due to more efficient water drainage. Also they can be accessed in the winter when sludge spreading on heavy soils is not accessible.
- The prohibition of sludge spreading on lands located less than 10 meters from water sources or streams.
- The prohibition of sludge spreading on lands located less than 50 meters from groundwater abstraction wells.
- Transport routes should be chosen such that public inconvenience is minimally.
- The restriction of public access immediately following the spreading of sludge.
- The delivery of sludge is strictly prohibited for use on:
  - lands used for grazing;
  - lands used for growing shrubs;
  - lands used for growing vegetables;
  - lands used for fruit trees, during harvest and minimum 10 months before harvest.

Spreading of sludge on some surfaces may cause negative reactions from neighboring population, particularly relating to odor. Therefore, several measures are mandatory:

- spreading of only well-treated sludge;
- avoiding, wherever possible, sludge spreading on lands located near residential and other sensitive areas;
- prohibiting sludge spreading by application methods with high trajectory. High altitudes may cause the release of sludge aerosols' that may travel over large distances;

- land cultivation as soon as possible after sludge application. If raw sludge is left on the surface, especially during hot-weather, may cause unpleasant odors that can persist for several days.

The use of sludge for reforestation. Similarly to the option outline above, sludge use for reforestation requires develop a marketing strategy that includes promotional materials, workshops, advertising, public debates, and other similar options (Bercu 2011).

- the regimen of sludge application and frequency chosen must consider type of soil and fluctuations of water volume in soil content;
- the prohibition of sludge spreading for minimum 3 months prior to planting of trees;
- the prohibition of public access for a minimum of 3 months post sludge spreading;
- establishment of a "cushion" land strip of approximately 20 m between the access roads to forests and areas of sludge spreading; there would be absent sludge spreading on the land strips;
- adequate marking of reforestation areas where sludge spreading is occurring;
- the level of toxic substances in sludge should not exceed that of utilization in agriculture;
- application of sludge on soils with high groundwater should be avoided because of the high risk of leakage and, implicitly, erosion (high value of the coefficient of storm water drainage on the ground) and the possible pollution of tree roots. For the same reasons, it is prohibited to spread sludge on wetlands.

For this option too, the type and size of machines, and the methods used for spreading sludge are chosen according to type of cultures and soil. The transport methods and routes are as well chosen to minimize the negative impact for human factor (Rusu & Avram 2009).

Use of sludge for rebuilding of degraded lands. The use of sludge to improve soil and restoring vegetation for the purpose of restoring lands or protecting soil from erosion must be done in consideration with previous uses of the area under consideration. For industrial areas, the vegetation soil may be absent or if present, it bears the consequences of previous activities performed on it. Several of the options outlined above also apply to the recommendation of sludge use for rebuilding of degraded lands (Rusu & Teodorof 2009):

- consulting with other organizations regarding exclusion areas, restrictions and other similar important considerations;
- operational control, including choice of area and coordination and analyses of obtained samples, transport routes, client needs, etc;
- the development of an adequate and efficient marketing strategy (visits and experiments performed on the area, workshops, publishing of informative bulletins and other promotional and consulting material).

Before applying sludge on degraded land, various environmental authorities and other relevant interest groups should be consulted to ensure awareness of any restrictions that may be placed on transport routes and prevention of conflicts with the population living along the river. The consultation would have to establish:

- if the targeted lands are in an exclusion or at risk area where sludge spreading may be limited or not possible;
- adequate transport routes for sludge, in order to prevent to the best of ability worsening of traffic (bridges with weight restrictions, construction zones, narrow roads and other similar considerations);
- proposed method of delivery, storage and application of sludge does not conflict with the local waste management and environmental policies;
- the local interest groups would be informed and updated regarding details of sludge spreading activities on the targeted degraded lands.

A particular problem when restoring degraded lands is the possible pollution of nearby water courses. In this respect, an important measure to avoid a negative impact

on surface water bodies is the free sludge application on lands with slopes less than 15 degrees. On good condition lands that are sloped at anywhere between 15 and 25 degrees, the frequency of application should be reduced to allow for proper drainage. For slopes exceeding 25 degrees, the sludge should be applied only after careful consideration of sludge retention level for each surface considered. Sludge should not be applied to areas suffering from prolonged waterlogging or minimal soil infiltration capacity (Rusu & Avram 2009)

To control any surface leakage that may occur, the slope length can be modified by including ditches or areas used for planting at various annual intervals. Ideally, the restoration would result in slightly contoured slopes to assist drainage and reduce gathering of sludge in wet areas. Even shallow slopes can cause leaks during wet periods if the soil cannot absorb water fast enough. Mild land cultivation before applying sludge increases soil infiltration capacity in susceptible areas and is especially recommended for cases when liquid sludge is used. The already existing vegetation is also very effective in reducing leakage. High frequency application of mud cake and mud products can improve many of the structural problems of abandoned or destroyed lands, increasing infiltration rates and moisture retention, as well as encouraging the growth of lush vegetation while reducing the risk of flooding. Another important measure is to ban the spreading of sludge in the vicinity of groundwater abstraction fronts, especially if the land on which the application is performed, lies upstream of the frontage in the direction of groundwater flows.

Sludge storage situation. There are two options for sludge disposal by landfill (Stoicescu 2011):

- mono-discharging when the deposit is only used for mud;
- co-draining when sewage is discharged into the municipal waste disposal pits.

For situations requiring a sludge deposit, the following measures should be considered:

- selection of storage areas that is safe in terms of the risk of surface- and groundwater contamination. The warehouse design must comply with the law in terms of constructive solutions;
- safety distances consistent with applicable law must be established and implemented to various locations, such as residential areas, public roads, dams rivers etc. It is important that the selected site is not located in a floodplain. Also, the land should not be of great value in terms of agriculture;
- choosing an optimal location in terms of transport distances.

Sludge storage in already established landfills is economically desirable. As a measure adopted by the Romanian legislation, the solids content of the sludge must be at least 35%. In addition, the method for sludge storage chosen must prevent creating further or new instability, which may hamper safety of activities and free traffic in the area. In general, depending on the working practice, the sludge must be deposited at the work surface base. Above it, dry or compact residues should be scattered. Measures relating to the transport and storage of sludge in municipal waste pits are similar to those adopted for agriculture.

The use of sludge for energy recovery. Interest in recycling/energy recovery from sludge is increasing because it is seen as a new source of renewable energy (Gligor 2011).

Solids in the slurry have a heat capacity similar to brown coal and as such can be used to produce energy by:

- strict specifications for sludge incineration; the energy recovered can be used to pre-dry the sludge and generated electricity;
- co-incineration with municipal solid waste; the energy can be recovered for heating and additional energy;
- co-combustion in the context of energy-intensive industrial processes, such as cement plants, thermal-power plant and electrical-power plants for which the sludge is a partial replacement of fossil fuels;

- the incineration process generates emissions in the air, soil and water mainly in the area surrounding the incineration plan or landfill where ash is discharged.

Hence, the following measures outlined aim to diminish negative environmental consequences:

- control of substance content in sludge about to be incinerated;
- treatment of flue gas and water resulting from incineration to reduce emissions of pollutants. Flue gas treatment will be achieved with filters and scrubbers;
- insurance of phosphorus sludge content below 1% so as not to affect the product quality when sludge is used to produce cement (Rusu 2008).

New solutions of sludge capitalization. New solutions of sludge capitalization include a range of alternative and innovative recovery means of sludge or incinerator ash, as well as recovery of valuable resources. The most viable solution is the use of incinerator ash as a constituent of construction materials (structural elements and aggregates). Ash and slag resulting from processes of incineration and sludge co-incineration, respectively, will be used to manufacture building materials in compliance with the legislation. Many of the new processing options involve thermal energy, chemicals and waste streams to be treated before safe disposal. Currently, measures to reduce or eliminate the negative impact differ based on type of process (the flue gases resulting from the process), resulting debris, for example. However, these measures are among general environmental protection measures adopted for industrial activities (Gligor 2011).

In Figure 1 is shown the current route sludge from wastewater treatment plant Urican and Danutoni- Jiu Valley.

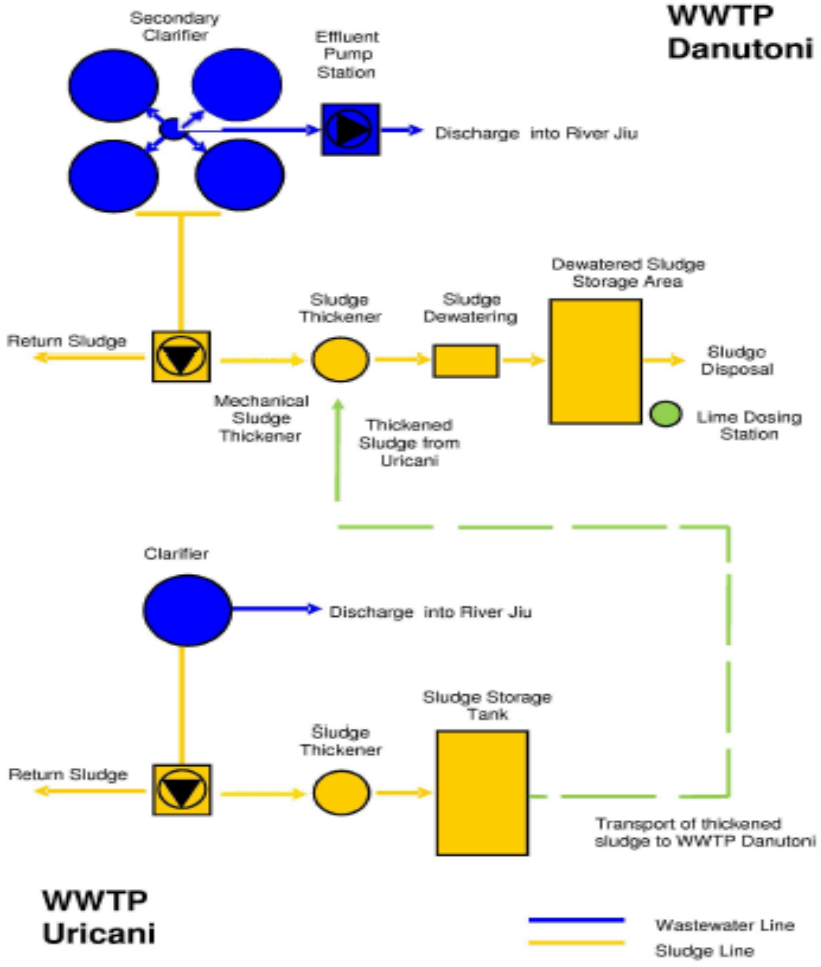

Figure 1. Current route sludge from WWTP Urican and Danutoni.

Conclusions. Of all options of sludge capitalization, the use of sludge in agriculture is the most plausible technically, financially, logistically and institutionally, and therefore this option was given special attention in strategy development.

In comparison, the other options for use or disposal of sludge are relatively simple from the perspective of both institutional and operational involvement, as well as for the operator of purification station; this simplicity relates to having one requiring: the transport of sludge towards a tertiary party that will assume full responsibility for its administration.

These facilities involve the use of sludge in combustion (cement production), composting sludge along with solid wastes or its disposal in solid waste landfills.

Dumping sludge in landfills is an option less accepted as EU legislation restricts progressive organic waste disposal. Therefore, the proposed strategy includes the evaluation of criteria and restrictions involved in sludge management; suggested schemes highlight the progressive introduction of sludge use in agriculture, along with incineration, co-incineration, where land conditions do not allow its exclusive use in agriculture. At the same time, there is strong support for abandoning the practice of storing sludge in landfills.

Regardless of chosen option, several general measures are required to reduce the negative environmental impact, which is essentially an environmental management policy based on the use of sludge:

- the application of best available techniques in process streams from the production sectors, industrial and economic, to reduce the quantities of pollutants resulting from production processes;

- the adoption of laws that contain effective enforcement measures related to non-compliance with the limit values of chemical industrial wastewater disposed into municipal sewage systems;

- the industrial sewer discharges must be strictly controlled as per agreements for the disposal of effluent present in NTPA 002/2005. This will lead to significant reductions in the concentrations of metals and other contaminants in sludge. Alterations within industrial activity and the use of chemicals will also help to reduce the level of contaminants.

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