Peculiarities of the technological process of the dung mass utilization at the former poultry factory “Snezhnaya”

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1. Object of study
The enterprise of the poultry farm “Snezhnaya” was put into operation in 1981. The production capacity was 1 million birds of average annual livestock per year. The company produced poultry meat for consumption in the Murmansk Region. At present, the poultry farm has been eliminated, but the dung storage remains a source of environmental pollution.

2. Material and research methods
The dung storage of “Poultry Farm “Snezhnaya” JSC was put into operation in 1983 and was intended for receiving and storing the dung of the poultry farm. Since 2004, it has not accepted dung. The approximate amount of dung is currently 560 thousand tons. The dung storage was built in the valley of the Zemlyanoy brook by construction of a fence (dam) along the entire perimeter. The beginning of the Zemlyanoy brook is located 100 metres from the dam. For many years, right up to the closure of the enterprise, the melting snow overwhelmed the dung storage of the “Poultry Farm “Snezhnaya”, which led to the dam breaking and the ingress of sewage and dung into the Kola River - the source of drinking water supply. Currently, at the highest level of water in the dung storage (after rains), the sewage is discharged through the pipe through the dam body to the valley of the Zemlyanoy brook, the waters of which flow into the Kola River. Thus, even now the dung storage is a source of water pollution in the Kola River.

To assess environmental risks on the territory of the dung storage, the following samplings were taken: water sampling from surface watercourses (rivers, streams), water reservoirs (ponds, lakes, storage ponds), dung storage; sampling of groundwater from wells; soil sampling; air sampling.

All chemical and analytical studies were carried out in laboratories with state licenses.

3. Research results
According to the results of laboratory studies, in the waters of the Zemlyanoy brook, MPCs for water of water bodies of fishery importance are exceeded for nitrite nitrogen, ammonium ion, phosphates.
To assess the quality of water from the Zemlyanoy brook, an index of water pollution by WPI was used (a conditional complex indicator of water quality that takes into account the most common pollutants). The results of determining the WPI are shown in table 1.

**Table 1. The value of the pollution index of the studied water**

| Indicators      | Unit of measurement | Sampling of water from the Zemlyanoy brook | MPC   | Ratio of concentration to MPC | WPI  |
|-----------------|---------------------|------------------------------------------|-------|------------------------------|------|
| Nitrite nitrogen| mg/l                | 1.4                                      | 0.02  | 70                           | 25.57|
| Phosphates      | mg/l                | 0.44                                     | 0.20  | 2.2                          |      |
| Ammonium ion    | mg/l                | 1.8                                      | 0.40  | 4.5                          |      |

From the results it can be seen that, in terms of the chemical indicators of the quality of the water, the Zemlyanoy brook is extremely dirty - the 7th grade of water quality.

According to the results of the study of the liquid phase of the dung storage on the basis of physical and chemical, sanitary and hygienic indicators, it can be seen that a very high concentration of ammonium ion is observed in the sampling. This indicates the processes of decomposition of organic matter without air access under water (Table 2). A very high COD value indicates a large amount of undecomposed organic matter.

**Table 2. Physical and chemical and sanitary and hygienic indicators in the sampling of the liquid phase of the dung storage**

| Indicators          | Unit of measurement | Sampling of dung storage | Normative documentation on test methods          |
|---------------------|---------------------|--------------------------|-------------------------------------------------|
| Nitrate nitrogen    | mg/l                | 0.6                      | GOST 33045-2014 mD                              |
| Ammonium ion        | mg/l                | 142.5                    | GOST 33045-2014 mA                              |
| BOD₅                | mgO₂/l              | 5.0                      | PND F 14.1:2:3:4.123-97                         |
| COD                 | mgO₂/l              | 495.0                    | PND F 14.1:2:4 100-97                           |
| Dry residue         | mg/l                | 1090.0                   | PND F 14.1:2:4 261-10                           |
| Hydrogen indicator  | pH                  | 7.9                      | PND F 14.1:2:3.4.121.97                         |

The analysis of the materials obtained showed that the dung storage facility of the liquidated “Poultry Farm “Snezhnaya” was a significant source of environmental pollution, a source of influence on public health. Ecological risks are associated with soil pollution by microorganisms, surface waters by chemical substances and microorganisms, and atmospheric air - by biogas released from the dung storage. In emergency situations, when the storage pond overflows with water and discharges it into the valley of the Zemlyanoy brook through an overflow pipe, the discharged waters flow into the Kola river and are a source of pollution of drinking water. Therefore, it is necessary to reclaim the dung storage site, the complete elimination of dung and sewage from the storage pond, fencing of the dam and soil reclamation are planned.
Taking into account all the input parameters, a dung mass disposal complex is proposed, which includes five blocks (Figure 1): the first block (dredger complete) is a unit for collection and transportation of dung, the second is a dehydration unit, the third is a filtrate cleaning unit, the fourth is a composting unit, the fifth is the compost storage unit.

The dehydration, the leachate treatment, the composting units are located indoors. For disposal of the dung, it is planned to pump the dung mass with a volume of 300 m$^3$/day with slurry pumps daily to the building of the dung disposal complex.

The dung mass from the dung storage site is pumped through pumps to the decontamination pit, and then to the dewatering unit.

Dehydrated droppings are delivered to the storage, native microflora is also delivered there, enzymes are mixed with sediment in the storage for a faster composting process.

The finished compost is discharged onto the conveyor by an auger-type mixer when the tunnel exit is open. Further, the compost on a belt conveyor is reloaded into burts at concreted areas with drainage near the complex building. Drainage flows come through the gravity pipeline into the intermediate pit.

When the need for dilution of the dung disappears, the filtrate will be delivered to the biological treatment unit for cleaning. The equipment layout is presented in figure 2.
The leachate treatment unit includes stages [1-9]:
- electrocoagulation. It provides effective removal of organic matter and other related contaminants due to anodic oxidation and cathodic recovery with the formation of insoluble in water compounds precipitated in settling tanks;
- sewage neutralization. It is carried out by solutions of hydrochloric acid or sodium hydroxide, sewage neutralization occurs automatically to MPC norms. For the preparation of acid and alkaline solutions used cleaned to the standards of MPC of the fish farm and disinfected filtrate;
- mechanical treatment (primary settling tanks with thin-layer modules). The stage is used for deposition of insoluble and partially colloidal contaminants. Primary settling tanks for mechanical purification of sewage are a preliminary stage before biological treatment. In mechanical sewage treatment, the effect of reducing of suspended solids is 40-60%, which also leads to a decrease in the BOD value by 20-40% [1-9];
- biological treatment (bioreactors with anaerobic zone and aerobic treatment zone). In the anaerobic zone the destruction of hard-oxidized organic matter on the bio-carrier occurs by immobilized and free-floating microorganisms. Then the sewage is cleaned in the aerobic zone (aeration tanks). Under the action of nitrification - oxidation of ammonium nitrogen salts to nitrous acid salts (nitrites), with further oxidation of nitrate by bacteria to salts of nitric acid (nitrates). Nitrification process is the final stage of mineralization of nitrogen-containing organic contaminants. The presence of nitrates in treated sewage is one of the indicators of the degree of their complete purification. Nitrates accumulate a reserve of oxygen, which can be used to oxidize organic nitrogen-free substances. The bound oxygen segregates from nitrites and nitrates under the action of denitrifying bacteria and the second time is consumed for oxidation of organic matter. The process of denitrification is accompanied by the release of free nitrogen and nitrogen oxide into the atmosphere in gaseous form. A trophic chain forms, It is represented by biocenosis of microorganisms, the final link of which is predatory forms, eating living and dying bacterial cells, assimilating and splitting organic compounds at the beginning of the chain [1-9];
- deposition of sludge in secondary settling tanks;
- tertiary treatment (filters of mechanical and sorption treatment);
- disinfection (ultraviolet radiation) of the purified filtrate (water) from viruses, bacteria, protozoans.

After the release of the dung storage facility from the dung mass, the lands are reclaimed.

Conclusion
Currently, the dung storage of the liquidated Open Society “Poultry Farm “Snezhnaya” of the Murmans’k Region” is a source of anthropogenic pollution in the adjacent territory. Reclamation of the dung storage site is justified by:
- pollution of atmospheric air in the decomposition of dung under a layer of water;
- biological pollution of the soil of the adjacent territory;
- chemical pollution of the soils adjacent to the dung storage area;
- water pollution in the Zemlyanoy brook and the Kola River, where the drinking water intake is located;
- contamination of groundwaters in the valley of the Zemlyanoy brook;
- impact on public health when the water phase is discharged from the dung storage facility in emergency situations;
- the impact on public health when pollutants are emitted into the air.

Thus, the dung storage, as a source of pollution, causes significant damage to the environment and public health. There is a danger of the spread of infectious diseases by water, associated with the water coming from the dung storage. Soils pollution in the adjacent territory removes land from economic use.

In order to minimize or completely eliminate environmental risks, it is necessary to carry out the reclamation of the dung storage site in the dung storage territory. This is an environmental protection
measure, in which the complete elimination of dung and sewage from the dung storage pond, enclosing dam and soil reclamation are being planned.

The formation of the chemical composition of groundwater is currently due to a complex of factors - the close level of groundwater in the valley of the Zemlyanoy brook, the infiltration of water from the dung storage into the groundwater, and the chemical composition of sewage. Liquidation of the dung storage site eliminates sources of groundwater pollution. In addition, the source of pollution of surface waters - the Zemlyanoy brook and the Kola River is eliminated.

After reclamation of the dung storage site, the impact on the soil cover will be minimized. The integrity of the soil cover and its natural state will be restored, as a result of cutting, storing and subsequent application of a fertile layer on the surface to be reclaimed.

With the reclamation of the dung storage, the natural habitat of plants and animals is restored, and the distribution area of plants and animals increases. In this connection, the restoration of the natural habitats of animals, and, accordingly, restoration within ecosystem links, including food chains occurs.

Thus, the source of impact on flora and fauna will be eliminated and additional favorable conditions created for the development of the ecosystem.

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