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CALCULATION OF NECESSARY LANDFILL AREA AND ANALYSIS OF DEPOSITION BY LAYERS FOR THE NEWLY SELECTED LOCATION FOR THE COMMUNAL SOLID WASTE LANDFILL

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Abstract

In this work the possibility for deposition the solid communal waste in Stip, in new location is investigated. There are several analysis and calculations done, on the ground of the available maps, in order to determinate if the appropriate location is suitable for building the communal landfill. There are cross sections of the landfill done, on the Topographic map, where all the hills and depressions of the area can be noticed, and also the zone of fulfillment can be noticed. There is a special deposition space calculated, needed for the dumping ground, with calculating capacity for compact communal waste and capacity of the covering material and the needed landfill space is calculated. There are analyses done for deposition in layers. At the end, the summary of the possible influences of the living environment is given, and there are measures for prevention of the unwanted consequences from the accompaniments' near the projected landfill area.

Key words: deposition, communal waste, landfill, environment, prevention

Introduction

With the urban plan of the town of Stip is foreseen the new location for communal landfill in the locality called TrestenaSkala, about 4 km from the town of Stip or 2 km of ring road Skopje - Strumica. This location was confirmed with the elaborate for protection of the living environment. It is made available for the sanitary inspectors and the Ministry of Health and by a decision of the City Council of Stip, the General Urban Plan for the city Stip was adopted. With that the public corporation Isar has received a new location for the disposal of waste. When choosing a location the project was not made, in fact there was no calculations done for the necessary dumping ground space and there are no analysis done for depositing the waste in layers to determine whether the chosen location would be suitable for disposal in the next 20 to 30 years. Therefore this paper is prepared in which the necessary results are obtained.

Determination of required landfill space

To determine the body size of the forcommunal landfill there are some calculations done, shown in Table 1. First, data is taken from the municipality for the number of residents in the town of Stip. Because of the population increasing the waste increases also and the annually population growth is calculated using the formula:

$$Sb = Sp(1+\frac{Kp}{100})^n$$

Sb is planned population
Sp is the current number of residents (46,457)

Kp is the ratio of population growth for 1 year. Expressed in% (takes 1,0%)
n - planned period expressed in number of years (it takes $1 \leq n \leq 25$)

Then to determine the required dumping ground space it is going through the following actions:

- Determination of volume of compressed waste

$$Wo = Q / \rho \quad (m^3)$$

Wo is the volume of compressed waste
ρ = 300 kg / m^3 (thickness of waste is 200 kg / m, and the waste should becompressed 1.5 times so its density after the thickening it would be increased to 300 kg/m^3).

- Determination of volume of the covering material

$$Wp = 0.25 * Wo(m^3)$$

- Calculating needed landfill space

$$Wd = Wo + Wp + Wind\ (m^3)$$

Wd-needed landfill space
Wo-thick volume of communal waste
Wp- volume of covering material
Wind-volume industrial waste

- The annual quantity of communal solid waste is calculated by the following formula:

$$Qo = Sb * q * 365\ (kg / year)$$

Qo is an annual amount of municipal solid waste
q = 1-3 kg / day / capita (takes 1 kg / day / capita)

The industrial waste data is taken for 8.800m3 a year.
All calculations are shown in Table 1.

Table 1 Calculations.

Year	Number of years	Sb- planned population	Q(kg/year) for q=1	Wo(m^3)	Wp(m^3)	Wind(m^3)	Wd(m^3) amount	W(m^3) by years
2011	1	46457	16956805	56523	14131	8800	79453	79453
2012	2	46922	17126530	57088	14272	8800	80161	159614
2013	3	47391	17297715	57659	14415	8800	80874	240487
2014	4	47865	17470725	58236	14559	8800	81595	322082
2015	5	48344	17645560	58819	14705	8800	82323	404405
2016	6	48827	17821855	59406	14852	8800	83058	487463
2017	7	49315	17999975	60000	15000	8800	83800	571263
2018	8	49809	18180285	60601	15150	8800	84551	655814
2019	9	50307	18362055	61207	15302	8800	85309	741123
2020	10	50810	18545650	61819	15455	8800	86074	827196
2021	11	51318	18731070	62437	15609	8800	86846	914042
2022	12	51831	18918315	63061	15765	8800	87626	1001669
2023	13	52349	19107385	63691	15923	8800	88414	1090083
2024	14	52873	19298645	64329	16082	8800	89211	1179294
2025	15	53402	19491730	64972	16243	8800	90016	1269309
2026	16	53936	19686640	65622	16406	8800	90828	1360137
2027	17	54475	19883375	66278	16569	8800	91647	1451784
2028	18	55020	20082300	66941	16735	8800	92476	1544261
2029	19	55570	20283050	67610	16903	8800	93313	1637573
2030	20	56126	20485990	68287	17072	8800	94158	1731732
2031	21	56687	20690755	68969	17242	8800	95011	1826743
2032	22	57254	20897710	69659	17415	8800	95874	1922617
2033	23	57826	21106490	70355	17589	8800	96744	2019361
2034	24	58404	21317460	71058	17765	8800	97623	2116983
2035	25	58989	21530985	71770	17942	8800	98512	2215496

So after 25 years total waste along with the necessary covering material would be 2.215.496 m^3.

Analysis of disposal by layers

To determine the volume of landfill space where the waste will be disposed, first of all we should make longitudinal and cross sections of the landfill body, on the topographic map and then to determine the surface after elevations. Based on cross sections made at a scale 1:2500 the following lengths and areas shown in Table 2 were obtained.

Table 2 Lengths and areas from the topographic map[6]

	Metersa. sea level	Profil B-B Length (m)	ProfilC-C Length (m)	ProfilD-D Length (m)	Area (m^2) by elevation
Elevation	260	18	88	138	33.315
Elevation	270	65	140	275	75.795
Elevation	280	150	325	510	130.132
Elevation	290	225	475	710	195.198

The table shows that the lowest elevation from which we will start the deposit is 260 meters above sea level. At this elevation the ground should be smooth and its surface according to the table will be 33,315 m^2.

Landfill will be conducted in four layers from a 2.5 m, and the surface will gradually increase every 2.5 meters until reaching up to 270 meters above sea level elevation. On the surface elevation reaches 75,795 m^2 and continues to deposit the same in four layers from a 2.5 m until reaching up to 280 meters above sea level elevation, where surface disposal is increased up to 130.132 m^2. On the surface this may be extended until the deposit elevation reaches 290 meters above sea level with a surface of 195,198 m^2. At this elevation the deposit cannot continue because the ground does not allow it. The determination of the surface layers of each 2.5 meters is calculated in cubic capacity of the layers shown in Table 3. The collection of all cubic layers from elevation 260-290 is obtained a figure of 3,004,482 m^3. The Table 2 shows that the need cubic for a disposal for a period of 25 years (for how many the landfill is foreseen) is 2.215.496 m^3. So for this period of 25 years goes to elevation 286 meters above sea level In Table 3 we can see that these 2.215.496 m^3 of waste can accommodate up to 287.5 meters above sea level elevation and there will be completed and the deposit will be put final covering layer.

Table 3Calculating the cubic capacity of the landfill.

Bottom height (m)	Layers (m)	Upper height (m)	Area (m2)	Volume (m3)	Elevation(m)	Total(m^3)
260	2.5	262.5	33315	83.287	260-262.5	83.287
262.5	2.5	265	43935	109.837	260-265	193.125
265	2.5	267.5	54555	136.387	260-267.5	329.512
267.5	2.5	270	67175	167.937	260-270	497.450
270	2.5	272.5	75795	189.487	260-272.5	686.937
272.5	2.5	275	89379	223.447	260-275	910.385
275	2.5	277.5	10296.	257.410	260-277.5	1.167.795
277.5	2.5	280	116548	291.370	260-280	1.459.165
280	2.5	282.5	130132	325.330	260-282.5	1.784.495
282.5	2.5	285	146398	365.996	260-285	2.150.491
285	2.5	287.5	162665	406.662	260-287.5	2.557.153
287.5	2.5	290	178931	447.328	260-290	3.004.482

Conclusion

Analyzing the above presented data and the relevant details of the maps, the foreseen location is considered suitable for the construction of a landfill for the next 25 years. Its construction and normal working are expected to fundamentally solve the problem of solid waste from the town of Strip.

Positive sides for building the landfill are the following:

- Located on state land;
- Located on the waterproof ground;
- Is located on a sufficient distance from populated areas ;
- Located in an area that hasn't have natural resources, cultural and historical monuments or plant and animal species;
- Located in a location with favorable hydro-geological conditions;

- Located in an area with favorable climatic characteristics;
- Positive attitude of the local inhabitants.

Current practice is - collected waste to be disposed in certain locations without taking special measures, except occasionally covering with building rubble what forms huge dumping grounds, beds of pollution of the environment. The most serious consequences of this are:

- The spreading of contagious diseases by rats, flies and other insects that live on garbage dumps;
- Pollution of groundwater, surface water and atmospheric waters;
- Bad smell and pollution of the surrounding air, especially from burning trash;
- Danger of explosion;
- Pollution of the surrounding areas with waste that the wind brings etc.

With the construction of a new municipal landfill all of these negative consequences will be eliminated.
In order to reduce or eliminate potential environmental impacts during the construction and operational phases of the proposed landfill, it is necessary the following measures to be taken:

- Constantly covering the daily material with thickness of 20-30 cm, to prevent spreading of infectious diseases;
- Construction of a suitable facility in the vicinity of the landfill for treatment of the leaking water;
- Installation of a system for the extraction of gas storage;
- Fencing the landfill and its locking to prevent free access to the landfill;
- Final closing followed by fixing the location when maximum capacity is reached;
- Timely cleaning of the ditches used for acceptance of rain water to prevent their clogging and flooding the landfill;
- Continuous monitoring;
- Permanent sanitary hygienic reviews of staff.

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