NATIONAL AVIATION UNIVERSITY
FACULTY OF ENVIRONMENTAL SAFETY, ENGINEERING AND TECHNOLOGIES
DEPARTMENT OF ENVIRONMENTAL SCIENCES

The first (Bachelor) Level
The field of Study: 10 «Natural Sciences»
Specialty: 101 «Ecology»
Educational and Professional Program: «Ecology and Environmental Protection»
Semester 4
Training Course: «WASTE UTILIZATION & RECUPERATION»

TEST PAPER № 1

1. What ought to be understood under "waste"?
2. What methods of medical waste treatment do you know?
3. Where and when radioactive waste is produced?
4. What're the methods of landfill gas utilization?
5. To determine the total capacity of the municipal solid waste landfill.

Initial data:

- term of exploitation of the landfill (T, years) according to Table 1;
- specific rate of waste generation per person per year, W_1, m^3/year; average – 1,2 m^3/year;
- the rate of annual increase of the specific norm of waste (U,%); U=1,8%;
- citizens at the time of landfills engineering, N_1, people;
- expected specific population of the city in T years, N_2, people;

Table 1

T, years	N_1, 10^3, people	N_2, 10^3, people	$H_{oriented}$, m	K_1	K_2
20	350	500	20	4,0	1,2

Determination of the specific rate of waste generation W_2, m^3 per person per year in T years:

$$W_2 = W_1(1+\frac{U}{100})^T,$$

Calculation of total landfill capacity, E, m^3:

$$E = \frac{W_1 + W_2}{2} \bullet \frac{N_1 + N_2}{2} \bullet \frac{K_2}{K_1} \bullet T,$$

where N_1 - citizens at the time of landfills engineering;
N_2 - citizens at the time of landfills putting into exploitation and in T years;
K_1 - coefficient of municipal solid waste reduction (sealing) for all the time T (Table 1);
K_2 - coefficient of isolated layer of soil (Table 1);
T - period of operation of the landfill, years.

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TEST PAPER № 2

1. Can you name the main reasons of industrial waste generation?
2. Hazardous composition of electronic waste.
3. What's nuclear waste recycling?
4. Waste management in Ukraine.
5. To determine of the municipal solid waste landfill square.

Initial data:

- the high of the waste hill, $H_{oriented}$, m – 35;
- landfill capacity, E, m^3 – 7188 $\cdot 10^3$

The basis of the landfill is taken as a rectangle, and the shape of the hill - in the form of a cut pyramid.

Due to pyramid volume ($V = S\frac{H}{3}$) we determine its base (square of solid municipal waste storage area) S_1, m^2:

$$S_1 = \frac{3V}{H} = \frac{3E}{H_{oriented}},$$

Around the waste storage area there should be a free space for movement and operation of transport, mechanisms, service personnel and service roads. Therefore, the required area for the landfill (S_2) must be larger than the storage area (S_1) for the placement of the auxiliary zone (S_3) (S_3=0,6 ha) and service roads (coefficient 1,1).

$$S_2 = 1{,}1S_1 + S_3.$$

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TEST PAPER № 3

1. Chemical composition of industrial waste.
2. Analyze the main steps of electronic waste recycling chain.
3. How can satellites be protected from debris?
4. What're the types of organic waste? Waste reduction and recycling.
5. To calculate the parameters of waste pit (at municipal solid waste landfill).

Initial data:

- square of solid municipal waste storage area, m^2; $S_1=718.8\ 10^3$
- height, m; $H_{hill} =362316 \cdot 10^3$
- coefficient of isolated layer of soil $K_2=1.18$

Practice shows that the soil for isolated intermediate layers and in the future for the upper layer, when the landfill service life is exhausted, is economically advantageous to be harvested from the pit for the basis of the waste storage site.

$$V = \frac{1}{3}(S_{lower} + S_{upper} + \sqrt{S_{lower} S_{upper}})H$$

where S_{lower}, S_{upper} – square of lower and upper foundation of landfill, m^2; H – height, m.
Therefore, the total landfill capacity, E_{hill}, m^3 is calculated by the formula:

$$E_{hill} = \frac{1}{3}(S_1 + S_{upper} + \sqrt{S_1 S_{upper}})H_{hill}$$

Square of the upper foundation of "hill" is shape of quadrate. $S_{upper} =40 \cdot 40\ m^2$.
Then we determine the necessary volume of soil V_{soil}, m^3.

$$V_{soil} = E_{hill}\left(1 - \frac{1}{K_2}\right)$$

Depth of waste pit H_{pit}, m is equal to:

$$H_{pit} = 1{,}1\frac{V_{soil}}{S_1}$$

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TEST PAPER № 4

1. What's the impact of the industrial waste on the environment and human health?
2. What refers to space debris? Categories of space debris.
3. Describe the main criteria to choose a method of medical waste recycling.
4. What can you do to reduce paper pollution and waste?
5. To determine the total capacity of the municipal solid waste landfill.

Initial data:

- term of exploitation of the landfill (T, years) according to Table 1;
- specific rate of waste generation per person per year, W_1, m^3/year; average – 1,2 m^3/year;
- the rate of annual increase of the specific norm of waste (U,%); U=1,8%;
- citizens at the time of landfills engineering, N_1, people;
- expected specific population of the city in T years, N_2, people;

Table 1

T, years	N_1, 10^3, people	N_2, 10^3, people	$H_{oriented}$, m	K_1	K_2
25	280	450	25	4,0	1,2

Determination of the specific rate of waste generation W_2, m^3 per person per year in T years:

$$W_2 = W_1(1+\frac{U}{100})^T,$$

Calculation of total landfill capacity, E, m^3:

$$E = \frac{W_1 + W_2}{2} \bullet \frac{N_1 + N_2}{2} \bullet \frac{K_2}{K_1} \bullet T,$$

where N_1 - citizens at the time of landfills engineering;
N_2 - citizens at the time of landfills putting into exploitation and in T years;
K_1 - coefficient of municipal solid waste reduction (sealing) for all the time T (Table 1);
K_2 - coefficient of isolated layer of soil (Table 1);
T - period of operation of the landfill, years.

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TEST PAPER № 5

1. Municipal solid waste disposal methods.
2. What is radioactive waste, their types and characteristic?
3. Measures to reduce "space debris population".
4. What's the tendency of paper recycling in Europe and Ukraine?
5. To determine of the municipal solid waste landfill square.

Initial data:

- the high of the waste hill, $H_{oriented}$, m – 30;
- landfill capacity, E, m^3 – $5400 \cdot 10^3$.

The basis of the landfill is taken as a rectangle, and the shape of the hill - in the form of a cut pyramid.

Due to pyramid volume ($V = S\frac{H}{3}$) we determine its base (square of solid municipal waste storage area) S_1, m^2:

$$S_1 = \frac{3V}{H} = \frac{3E}{H_{oriented}},$$

Around the waste storage area there should be a free space for movement and operation of transport, mechanisms, service personnel and service roads. Therefore, the required area for the landfill (S_2) must be larger than the storage area (S_1) for the placement of the auxiliary zone (S_3) (S_3=0,6 ha) and service roads (coefficient 1,1).

$$S_2 = 1{,}1S_1 + S_3.$$

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TEST PAPER № 6

1. What is medical waste? What types of waste must be included to this category?
2. What methods, devices and technologies can you propose to protect water quality from industrial waste?
3. Can you name the advantages of household solid waste composting?
4. Environmental effects of paper waste.
5. To determine the total capacity of the municipal solid waste landfill.

Initial data:

- term of exploitation of the landfill (T, years) according to Table 1;
- specific rate of waste generation per person per year, W_1, m^3/year; average – 1,2 m^3/year;
- the rate of annual increase of the specific norm of waste (U,%); U=1,8%;
- citizens at the time of landfills engineering, N_1, people;
- expected specific population of the city in T years, N_2, people;

Table 1

T, years	N_1, 10^3, people	N_2, 10^3, people	$H_{oriented}$, m	K_1	K_2
20	1300	2000	40	4,5	1,18

Determination of the specific rate of waste generation W_2, m^3 per person per year in T years:

$$W_2 = W_1(1+\frac{U}{100})^T,$$

Calculation of total landfill capacity, E, m^3:

$$E = \frac{W_1 + W_2}{2} \bullet \frac{N_1 + N_2}{2} \bullet \frac{K_2}{K_1} \bullet T,$$

where N_1 - citizens at the time of landfills engineering;
N_2 - citizens at the time of landfills putting into exploitation and in T years;
K_1 - coefficient of municipal solid waste reduction (sealing) for all the time T (Table 1);
K_2 - coefficient of isolated layer of soil (Table 1);
T - period of operation of the landfill, years.

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TEST PAPER № 7

1. What do you know about hazardous waste management?
2. What can you do for reducing municipal solid waste?
3. Thermal methods of medical waste disposal.
4. Impact of organic waste on the environment.
5. To determine the total capacity of the municipal solid waste landfill.

Initial data:

- term of exploitation of the landfill (T, years) according to Table 1;
- specific rate of waste generation per person per year, W_1, m^3/year; average – 1,2 m^3/year;
- the rate of annual increase of the specific norm of waste (U,%); U=1,8%;
- citizens at the time of landfills engineering, N_1, people;
- expected specific population of the city in T years, N_2, people;

Table 1

T, years	N_1, 10^3, people	N_2, 10^3, people	$H_{oriented}$, m	K_1	K_2
18	800	1100	30	4,0	1,18

Determination of the specific rate of waste generation W_2, m^3 per person per year in T years:

$$W_2 = W_1(1+\frac{U}{100})^T,$$

Calculation of total landfill capacity, E, m^3:

$$E = \frac{W_1 + W_2}{2} \bullet \frac{N_1 + N_2}{2} \bullet \frac{K_2}{K_1} \bullet T,$$

where N_1 - citizens at the time of landfills engineering;
N_2 - citizens at the time of landfills putting into exploitation and in T years;
K_1 - coefficient of municipal solid waste reduction (sealing) for all the time T (Table 1);
K_2 - coefficient of isolated layer of soil (Table 1);
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TEST PAPER № 8

1. What's the difference between the term "hazardous" and "toxic" substances. To name characteristics of hazardous materials, defined by U.A. Environmental Protection Agency.
2. What are technologies of domestic waste processing do you know?
3. What types of medical waste do you know?
4. To characterize the process of paper recycling.
5. To calculate the volume of biogas production at Pidgirtsi (Obukhiv distric) solid waste landfill, taking into account the fact that on MSW landfill will be accumulated waste of all residents of the capital.

Initial data:
Object of research – Kyiv city (population- 2927227 citizens=2,9 mln)
Subject of research - Pidgirtsi solid domestic waste landfill.
n - rate of annual amount of accumulated waste, m^3/person=1,4.

The amount of biogas and the intensity of its release are calculated by the formula:

$$Q_{bg} = \frac{0.5 \times Q_{an} \times \rho \times q_{bg}}{1000}, \ m^3$$

where Q_{an} - annual amount of accumulated waste, which must be transported to landfill, m^3;
ρ - waste density, kg/ m^3;
q_{bg} - intensity of gas release during waste degradation process, m^3/t;
0,5 – const.

Annual amount of MSW, which must be transported to landfill is determined due to formula:

$$Q_{an} - n \times N, \ m^3/year$$

where n - rate of annual amount of accumulated waste, m^3/person;

N- amount of population.

The density of waste is adopted a value 250-300 kg/ m^3. Specific rate of gas release during waste degradation process is adopted on a value q_{bg} =200-400 m^3/t.

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TEST PAPER № 9

1. What's the municipal solid waste? Analyze the stages of waste management.
2. What is radioactive waste and what types do you know?
3. Significance of electronic waste recycling.
4. What's the composition & physical properties of landfill gas?
5. To calculate the volume of biogas production at Pidgirtsi (Obukhiv distric) solid waste landfill, taking into account the fact that on MSW landfill will be accumulated waste of 30% residents of the capital;

Initial data:
Object of research – Kyiv city (population- 2927227 citizens=2,9 mln)
Subject of research - Pidgirtsi solid domestic waste landfill.
n - rate of annual amount of accumulated waste, m^3/person=1,4.

The amount of biogas and the intensity of its release are calculated by the formula:

$$Q_{bg} = \frac{0.5 \times Q_{an} \times \rho \times q_{bg}}{1000}, \ m^3$$

where Q_{an} - annual amount of accumulated waste, which must be transported to landfill, m^3;
ρ - waste density, kg/ m^3;
q_{bg} - intensity of gas release during waste degradation process, m^3/t;
0,5 – const.

Annual amount of MSW, which must be transported to landfill is determined due to formula:

$$Q_{an} - n \times N, \ m^3/year$$

where n - rate of annual amount of accumulated waste, m^3/person;

N- amount of population.

The density of waste is adopted a value 250-300 kg/ m^3. Specific rate of gas release during waste degradation process is adopted on a value q_{bg} =200-400 m^3/t.

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TEST PAPER № 10

1. What can you propose for the domestic waste reduction?
2. What steps must be included to space debris management?
3. What hazardous and toxic substances are included in composition of electronic waste?
4. What's the composting of organic waste? What are the indicators of good compost?
5. To calculate the parameters of waste pit (at municipal solid waste landfill).

Initial data:

- square of solid municipal waste storage area, m^2; $S_1=718.8\cdot10^3$
- height, m; $H_{hill}=362316\cdot10^3$
- coefficient of isolated layer of soil $K_2=1.18$

Practice shows that the soil for isolated intermediate layers and in the future for the upper layer, when the landfill service life is exhausted, is economically advantageous to be harvested from the pit for the basis of the waste storage site.

$$V = \frac{1}{3}(S_{lower} + S_{upper} + \sqrt{S_{lower} S_{upper}})H$$

where S_{lower}, S_{upper} – square of lower and upper foundation of landfill, m^2; H – height, m.
Therefore, the total landfill capacity, E_{hill}, m^3 is calculated by the formula:

$$E_{hill} = \frac{1}{3}(S_1 + S_{upper} + \sqrt{S_1 S_{upper}})H_{hill}$$

Square of the upper foundation of "hill" is shape of quadrate. $S_{upper}=40\cdot40$ m^2.
Then we determine the necessary volume of soil V_{soil}, m^3.

$$V_{soil} = E_{hill}\left(1 - \frac{1}{K_2}\right)$$

Depth of waste pit H_{pit}, m is equal to:

$$H_{pit} = 1{,}1\frac{V_{soil}}{S_1}$$

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TEST PAPER № 11

1. Impact of organic waste on the environment.
2. What steps must be included to space debris management?
3. What types of medical waste do you know?
4. Significance of electronic waste recycling.
5. To calculate the parameters of waste pit (at municipal solid waste landfill).

Initial data:

- square of solid municipal waste storage area, m^2; $S_1=718.8\cdot10^3$
- height, m; $H_{hill}=362316\cdot10^3$
- coefficient of isolated layer of soil $K_2=1.18$

Practice shows that the soil for isolated intermediate layers and in the future for the upper layer, when the landfill service life is exhausted, is economically advantageous to be harvested from the pit for the basis of the waste storage site.

$$V = \frac{1}{3}(S_{lower} + S_{upper} + \sqrt{S_{lower} S_{upper}})H$$

where S_{lower}, S_{upper} – square of lower and upper foundation of landfill, m^2; H – height, m.
Therefore, the total landfill capacity, E_{hill}, m^3 is calculated by the formula:

$$E_{hill} = \frac{1}{3}(S_1 + S_{upper} + \sqrt{S_1 S_{upper}})H_{hill}$$

Square of the upper foundation of "hill" is shape of quadrate. $S_{upper}=40\cdot40$ m^2.
Then we determine the necessary volume of soil V_{soil}, m^3.

$$V_{soil} = E_{hill}\left(1 - \frac{1}{K_2}\right)$$

Depth of waste pit H_{pit}, m is equal to:

$$H_{pit} = 1{,}1\frac{V_{soil}}{S_1}$$

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