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THE ORGANIZATION OF WASTE MANAGEMENT
AT THE FIRST TECHNOLOGICAL LEVEL

The waste management of resident's area - an integral organizational and technological spatial oriented system, a component of the functional and planning structure of the city. The town-planning organization of waste management is aimed at improving the ecological condition and improving the comfort and quality of life of the inhabitants. The model of consistency of the approval of the project decision of design of the of primary collection points at the pre-design stages has been proposed in conditions of reconstruction or new building. The technological and planning constraints and the impact and morphological structure of the constructed waste in the places of their nascence which have locate in the zone of influence of the primary collection point in this model has been included.

The method of calculation of waste management is divided into three technological levels according to the organizational model of waste management. The method of calculation of waste management have at each level of system the object of research - it the territory which limited by the zone of influence of the urban environment elements as the subject of research:

I   level   - research of primary collection points;

II level   - sorting or reloading stations;

III level   - enterprises for recycling or of household waste

This article will consider the organization of sanitary cleaning at the first technological level.

Keywords: waste management; resident's area; primary collection points; waste collection points; household waste; equipment; planning module; functional; working; transit; influence zone of waste management.

The organization of waste management at the first technological level performed sequentially for residential areas in conditions of reconstruction or existing buildings and includes the following stages:

• analysis of areas for town planning of residential area, natural and sanitary-hygienic conditions;

• placement of primary collection points in the conditions of existing buildings in accordance with the town planning of residential area, natural-climatic and sanitary-hygienic restrictions;

• calculation of household waste of primary collection points;

• determination of the area of the primary collection points for household waste and they improvement and landscaping

The local analysis of the territory is required at the first stage for:

• town planning indicators: the number of permanent residents, the area of the neighborhood, the housing stock, the regulatory of housing, the average number of storeys of residential houses, the normative indicator of the amount of household waste and their morphological composition;

• analysis of the territory for town planning restrictions functional and planning structure of the territory, analysis of the location of housing and local analysis of the road network;

• according of natural conditions: temperature and humidity, directions of dominant winds, landscape;

• the norm of sanitary-hygienic requirements in accordance with the technological requirements of picking way of household waste of primary collection points.

The locations of the primary collection point determine in the second stage according to town planning conditions and restrictions

• the restriction zone of the primary collection point in accordance with the normal requirements is defined by pedestrian accessibility 100 meters from the primary collection point to the entrance to the house;

• the equipment for primary collection points should be placed at a distance from window constructions, (Table 1 [DBN B.2.2-12: 2019]), according to sanitary and hygienic norms and accordance with the technological or organizational-technological method of organization of waste management;

• the area of the working zone of the garbage truck to provide is necessary and the function of removal household waste from the residential area in accordance with the accepted method of removal for the primary collection point should be satisfy;

• the transit zone of the garbage truck should be limited on the adjacent territory of the resident area: the functional-planning organization of the transit movement of the garbage truck on the territory of the neighborhood can be carried out only on the main driveway or residential streets and to exclude the transit movement of the garbage truck on the adjacent territory of residential blocks. Fig. 1 and Figs. 2.
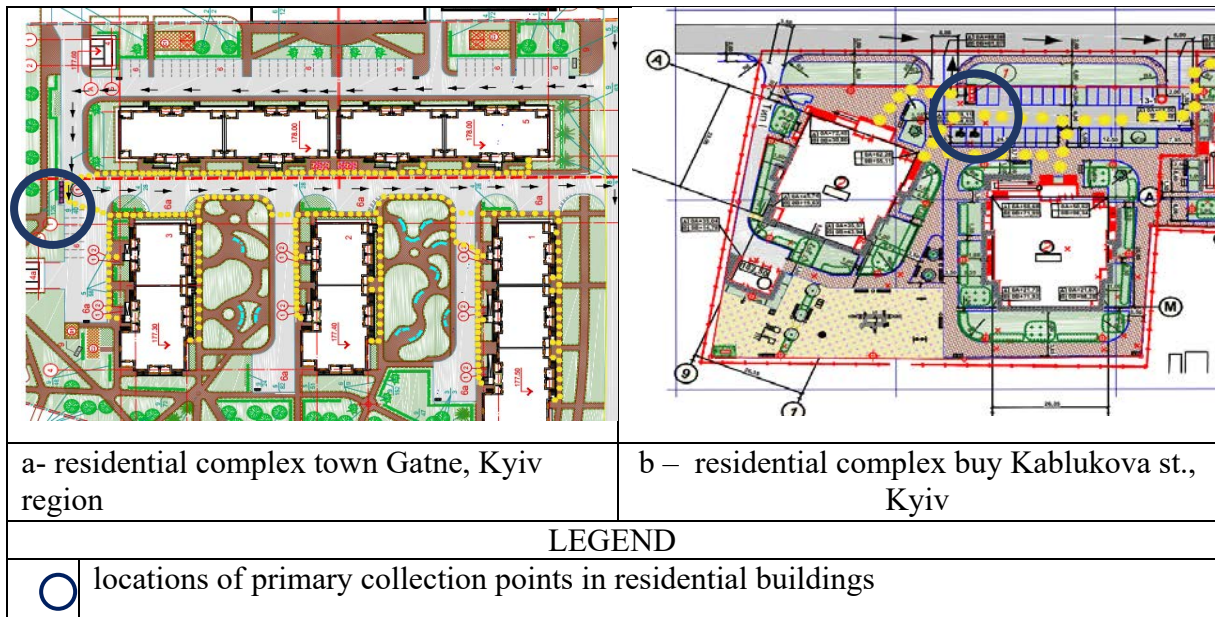
a- residential complex town Gatne, Kyiv region	b – residential complex buy Kablukova st., Kyiv
LEGEND	
◯ locations of primary collection points in residential buildings	

Fig. 1. The examples of placement of primary collection points in residential areas

a- functional scheme of organizational and technological (mechanical) removal with the location of primary collection points on the territory	b- functional scheme of technological removal with the location of primary collection points on the territory
1-resident building; 2- parking for temporary storage of vehicles; 3- place for physical training; 4 - a place for rest of the population; 5 - place for games of school and preschool children; 6 - street and road network (streets and driveways, turning areas); 7 - economic site for the collection of household waste	
LEGEND	

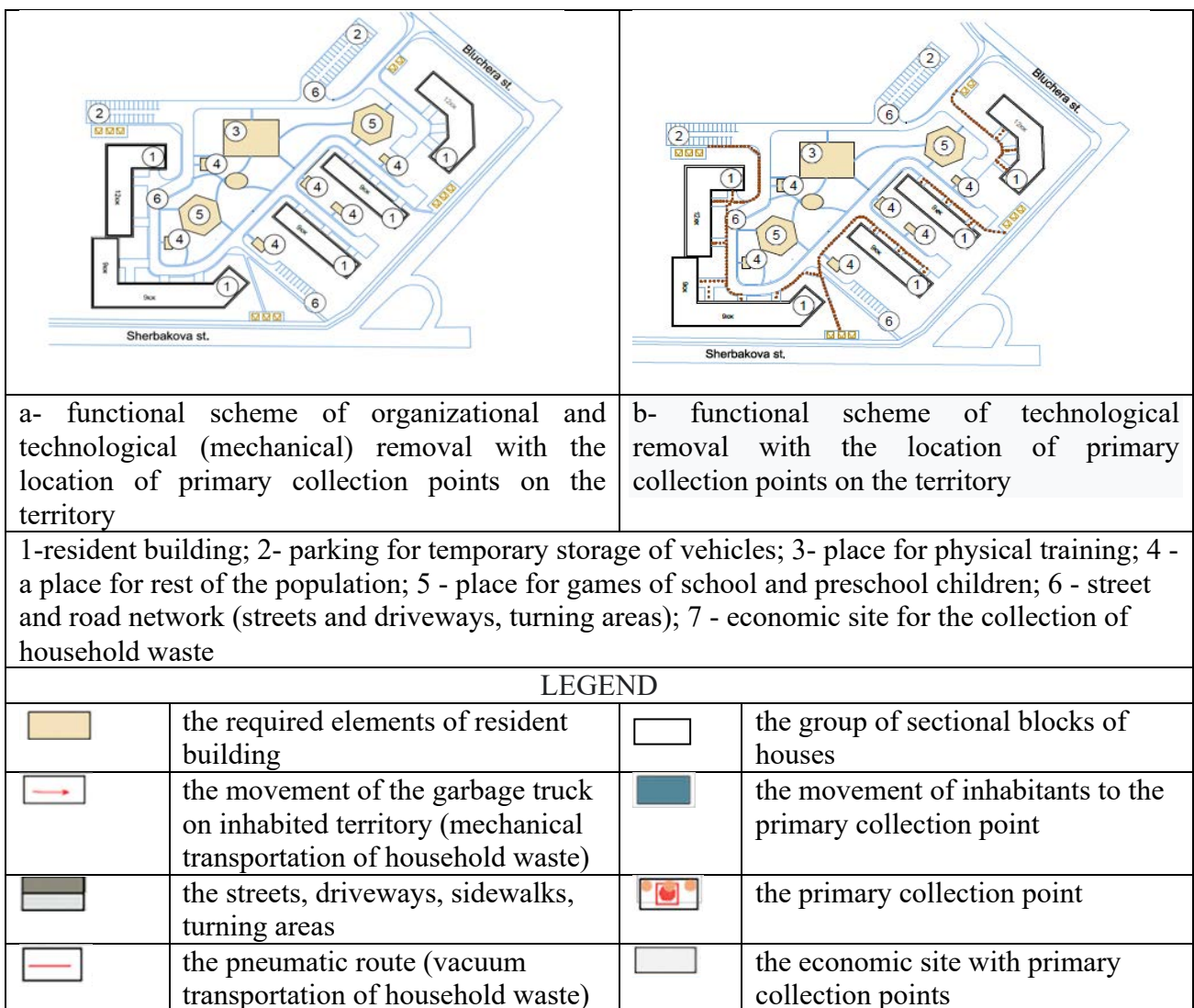|			
▭	the required elements of resident building	▭	the group of sectional blocks of houses
▭→	the movement of the garbage truck on inhabited territory (mechanical transportation of household waste)	▭	the movement of inhabitants to the primary collection point
▭	the streets, driveways, sidewalks, turning areas	▭	the primary collection point
▭	the pneumatic route (vacuum transportation of household waste)	▭	the economic site with primary collection points

Fig. 2. The layout of the primary collection points in the residential area

The volumetric of household waste for the primary collection points is determine in the third stage according to town planning conditions and restrictions

The calculation of the volume of household waste and their morphological composition is limited by area of influence of the primary collection point. The influence zone of primary collection points for residential area includes all residential units and inhabitant within the zone of influence. This zone can include all town-planning objects also because of extra task.

The volume of household waste which were formed of influence zone of primary collection points is calculated by the formula

$$V = \frac{V_n \times N}{365}$$

where in:

V - daily volume of household waste which were formed of influence zone of primary collection point in the residential area;

V_n - the annual rate of household waste formed per unit of account (resident) is expressed in m³, table 1 [DBN B.2.2-12: 2019];

N - the number of people which living in a residential area;

365   - the number of days on the year

Table 1.

The rate of formation of solid household reviews [DBN B.2.2-12: 2019]

The object of household waste generation	Unit of account	The annual unit of solid waste generation per unit of account	
		kilogram	m³
On average by population, taking into account the organization and institutions of pendulum migration	one inhabitant	300-350	1,8-2,5
The garbage from the improved coverage of road and square	one m² of area	3-15	0,005-0,025
The garden entrances	one m² of area	-	0,008
Note: the norms for the provision of household waste disposal services for settlements of resort value it is necessary to increase by 30-50%.			

The volume of household waste of the primary collection point is taken into account the coefficient of uneven accumulation (daily and seasonal unevenness). The uneven accumulation it is 25% more than the usual daily volume and this coefficient takes from research accordingly

$$V_{pcp} = V + (V \times 25\%)$$

where in:

V -daily volume of household waste for the territory in the influence zone formed;

V_{pcp} -daily volume of household waste of the primary collection point in the influence zone formed;

The morphological composition of the household waste for their region of Ukraine as a whole are similar, and approved of local government, see Fig. 3.

The state rules of collection of household waste it is to use process of sorting. The morphological composition of the household waste should to take into consideration for calculate the capacity of containers corresponding to the fractions of waste.
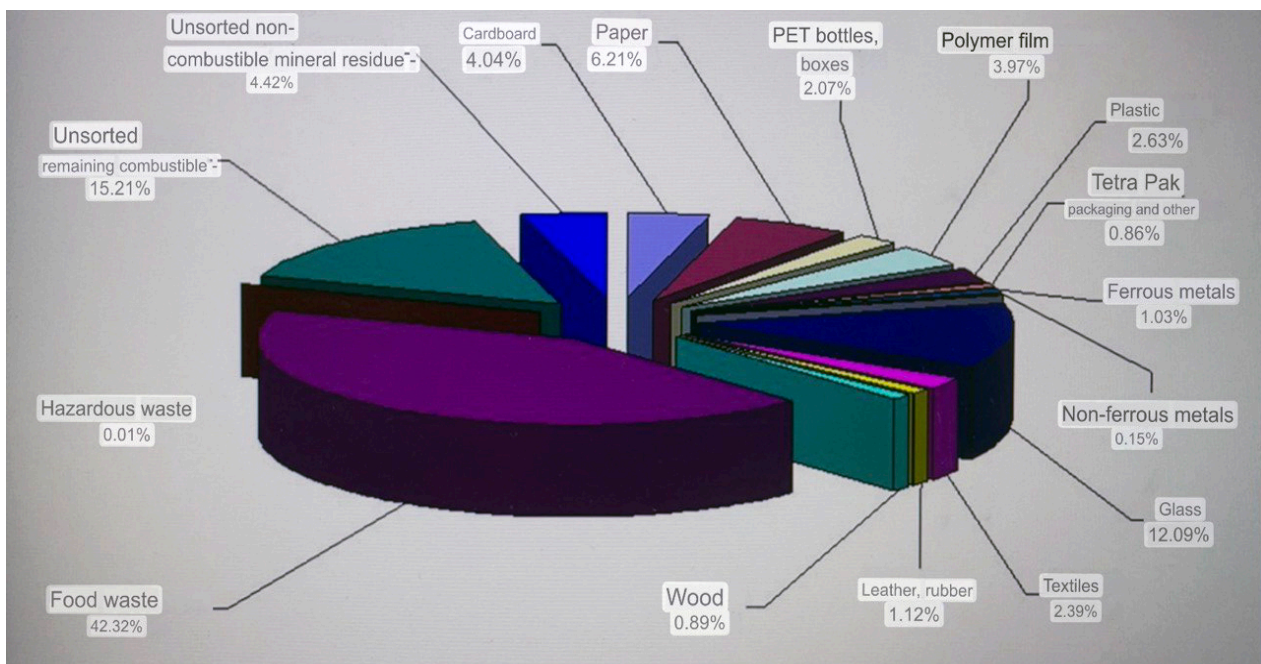

Fig. 3. Morphological composition of constructed residential waste
multi-storey buildings, Kyiv []
[Technical report. Project research "Scheme of waste management of Kyiv 2011" initial data for design. Appendix 1 to Volume 1. Book 1. Part 1. Research and Design Institute of Municipal Economy].

The module of the primary collection point, his area and the final location on the territory is determine in the fourth stage
The functional-planning organization of the primary collection point includes four zones: functional, working, transit and zone of influence.

The functional zone – satisfies the function of household waste accumulation.
The area required for the equipment of the primary collection point and the area in accordance with the anthropometric indicators of the person (inhabitant of the residential area) as well the area as improvement of the primary collection point according to the method of solid household waste is necessary to meet the need for solid accumulation of solid waste.

The capacity and area of the equipment depends on the method of household waste collection, which is determined at the second technological level of the city sanitation system.

There are three methods of collection for sanitary cleaning of the territory: ground, underground and vacuum

The area of the required territory of the primary collection point is accepted in accordance with:

$V_{ппз}$ - the daily volume of household waste of the primary collection point according to table 2 [DBN B.2.2-12: 2019].

Table 2.

Area and location of the site of separate collection of household waste in the residential area [DBN B.2.2-12: 2019].

Waste collection method	Planning module area, m2				The distance from the windows of residential and public buildings, m
	Planning module (1		Planning module (2		
	0,4 m³	1,1 m³	0,8 m³	2,2 m³	
Land-based	7,5	10,0	11,0	16,0	20
Underground, vacuum	3,5		5,5		They are defined by technical conditions

Note 1. The method of removal: land-based, underground or vacuum (pneumatic) influences the location and area of the collection points.

Note 2. The planning module of the underground and vacuum method can increase the volume of household waste accumulation to 5-10 m³, respectively, if this does not contradict the technical conditions.

Note 3. The distance from the collection points of household waste to physical culture grounds, playgrounds for children and recreation of adults should be taken at least 20 m. The pedestrian accessibility of the waste collection points should be taken as no more than 100 m. The area of the ground waste collection points is indicated taking into account landscaping.

Note 4. Household waste collection points for the ground method are designed in accordance with the requirements of DSTU-NB B.2.2-7. Underground and vacuum collection points are designed in accordance with urban planning and technical conditions.

Note 5. When blocking planning modules for a larger number of equipment with the addition of each of the next planning module, the area of the sum of the blocks decreases from 2 m² to 5 m², depending on the type of module and the method of blocking.

Note 6. The waste collection points must be equipped to receive hazardous waste (chemical current sources, household batteries, etc.).

Note 7. The waste collection points in residential areas should not be located on the leeward side, not in drafts, but with ensuring the norms of aeration of the territory. It is allowed to place a waste collection points for public service institutions a special task agreed with local authorities.

Note 8. Large-sized household waste collection points (furniture, household appliances, construction waste, etc.) should be placed on the farm territory in communal quarters or communal storage areas.

When cooperating planning modules for three, five or more containers for the accumulation of household waste, the functional area of the primary collection point is reduced around 2 m² to 5 m² depending on the method of blocking, see Note 5, Table 2 [DBN B.2.2-12: 2019].

The area of the working zone of the primary collection point is necessary for the technological operation. Since the technological operation of the primary collection point is the process of removing household waste - loading it into the garbage truck, the area of the working area is characterized by the size of the area necessary for the operation of the garbage truck, see Fig. 4, a; b - working area of the garbage truck with side or rear loading:

$$S_w = S_f + S_{t.o.}$$

where in:

$S_{t.o.}$ -the area required for technological operation;

$S_{f.}$ - square, functional area;

S_w - square of working area.

The area required for the technological operation depends on the dimensions of the garbage truck and the area for loading household waste. Garbage trucks are divided by type, structural differences and dimensions, so the area of the working area can be different according to the characteristics of the garbage truck.

According to the organizational-technological method (land-based and underground methods), the movement of small-sized garbage trucks-electric cars is allowed on the territory of the quarter, the movement of large-sized garbage trucks is possible only on the road network of the city, therefore. The working zone in the organizational-technological method is considered within the limits of the first technological level of the waste management system.

According to the technological method (stationary and mobile vacuum removal system), the movement of large-sized garbage trucks is allowed only on the road network of the city, therefore. The working zone in the technological method of the waste management system is not considered.

$$S_{t.o} = S_{g.t} + S_{l.w}$$

where in:

$S_{t.o.}$ -- the area required for technological operation;

$S_{g.t.}$ - the area necessary for stopping the garbage truck-electric vehicle;

$S_{l.w.}$ - the area necessary for loading work.

The area required for an electric garbage truck is equal to the product of its length times its width. The area of the area for loading works is equal to the sum of

the area for loading, the area of the container and the anthropometric indicators of a person during the technological operation.
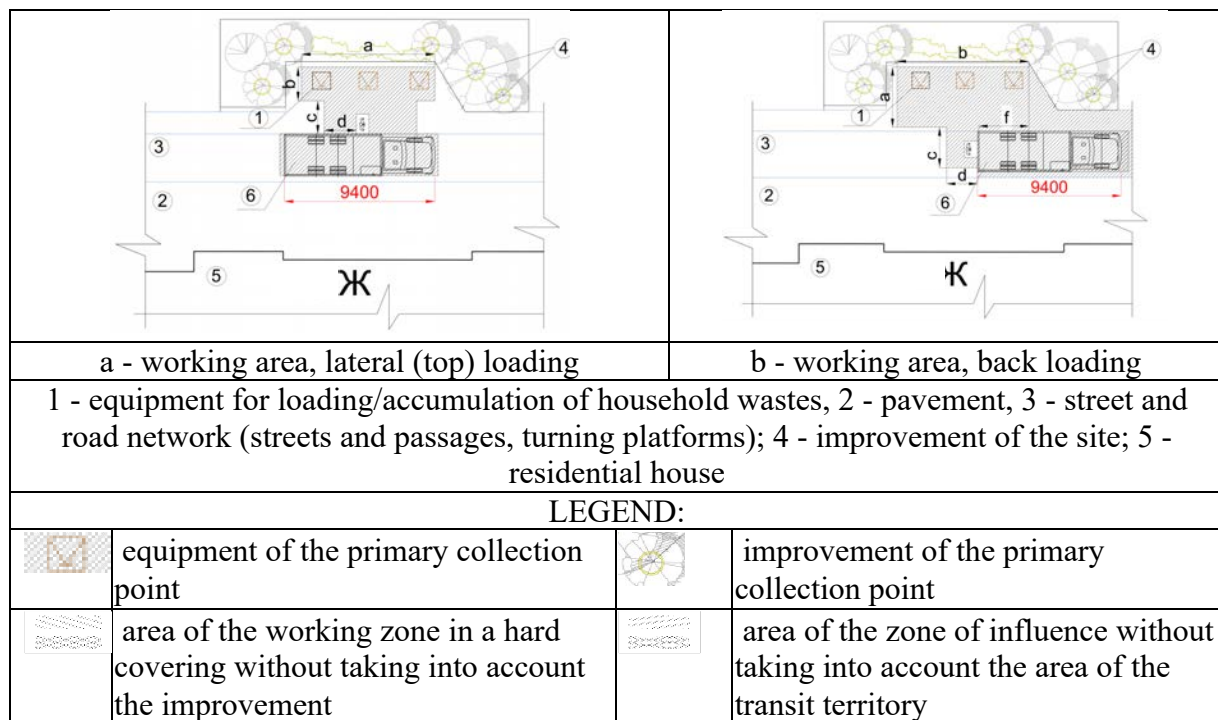
a - working area, lateral (top) loading	b - working area, back loading
1 - equipment for loading/accumulation of household wastes, 2 - pavement, 3 - street and road network (streets and passages, turning platforms); 4 - improvement of the site; 5 - residential house	
LEGEND:	
equipment of the primary collection point	improvement of the primary collection point
area of the working zone in a hard covering without taking into account the improvement	area of the zone of influence without taking into account the area of the transit territory

Fig. 4, a; b - working area of the garbage truck with side or rear loading

The area of the transit zone of the primary collection point includes the sum of the working zone, the transit area of the garbage truck-electric vehicle and its turning area (Fig. 5, a; b).

$$S_{tr} = S_w + S_{\text{tr.m}} + S_{turn.g.t.}$$

where in:

S_{tr} -- the area of the transit zone;

S_{w} - square of working area;

$S_{\text{tr.m}}$ - the area necessary for the transit movement of the garbage truck-electric vehicle;

$S_{\text{turng.t.}}$ - the area necessary for turn of the garbage truck-electric vehicle.

The area required for the transit traffic of the garbage truck is determined locally depending on the location of the primary collection points and urban planning conditions, requirements and restrictions. The area for a turn-turn of a garbage truck-electric vehicle is determined depending on the dimensions and maneuverability of the vehicle, urban planning conditions and restrictions.
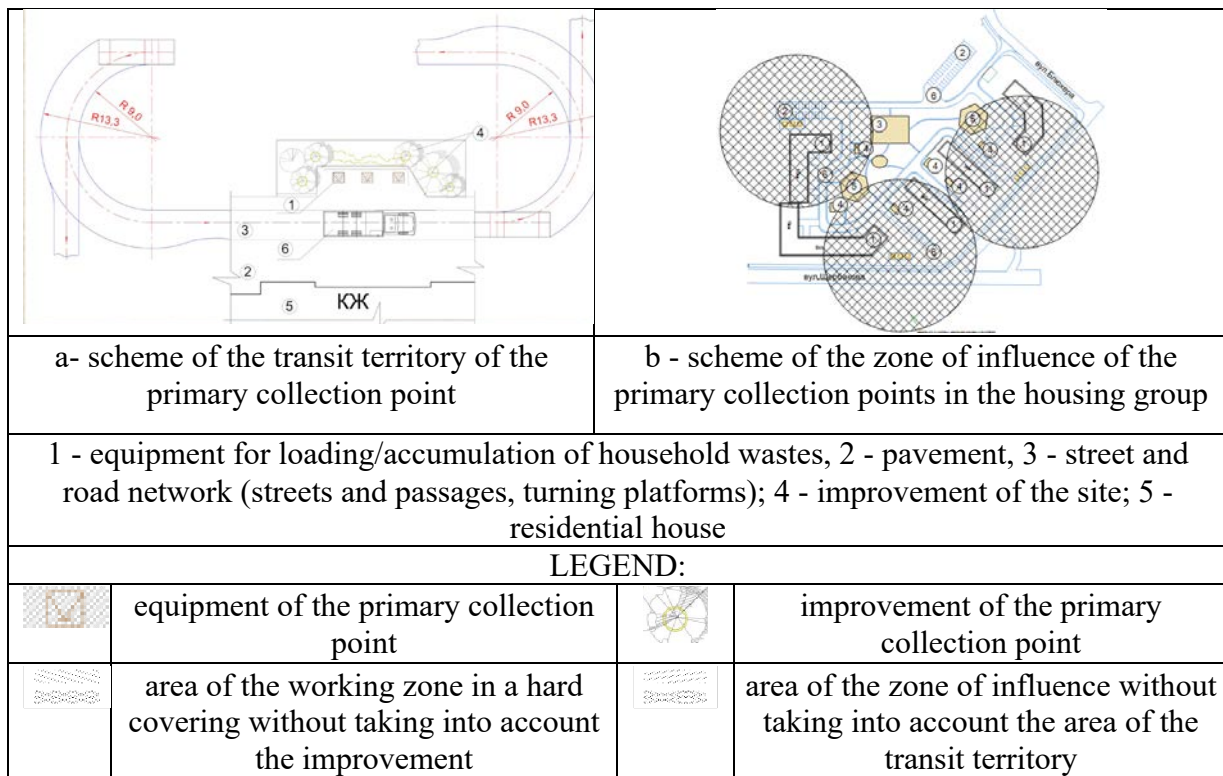
a- scheme of the transit territory of the primary collection point	b - scheme of the zone of influence of the primary collection points in the housing group
1 - equipment for loading/accumulation of household wastes, 2 - pavement, 3 - street and road network (streets and passages, turning platforms); 4 - improvement of the site; 5 - residential house	
LEGEND:	
equipment of the primary collection point	improvement of the primary collection point
area of the working zone in a hard covering without taking into account the improvement	area of the zone of influence without taking into account the area of the transit territory

Fig. 5, a; b- The schematic representation of the zones of the primary collection point

The number of garbage trucks, the periodicity of removal, the productivity of the garbage truck, etc., is determined by the "Rules on the organization of collection, transportation, processing and disposal of solid household waste approved"

The area of the influence zone for the residential area consists of the territory served by the primary collection point and is limited by the maximum pedestrian accessibility from the entrance to the house to the primary collection point.

Standard walking distance to the primary collection point is 100 meters (see Fig. 5, b). Provided that the non-linearity coefficient satisfies the normative value and we take k =1.5, it is possible to determine the area of the influence zone based on the formula for the area of a circle:

$$S_{\text{inf.}} = \frac{\pi R^2}{k}$$

where in:

$S_{\text{inf.}}$ -the area of the influence zone;

k - the non-linearity coefficient;

R - the radius of pedestrian accessibility to the primary collection point is 100 meters.

If the zone of influence includes a residential area, as well as the territory of household services or the territory of non-neighborhood significance, then the area of the zone of influence of the primary collection point can be determined based on the formula for the area of a circle or based on the formula for the area of a sector of a circle, i.e. without the territory that is not included in the service area of the primary collection point.

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ОРГАНІЗАЦІЯ САНІТАРНОГО ОЧИЩЕННЯ НА ПЕРШОМУ ТЕХНОЛОГІЧНОМУ РІВНІ

Санітарне очищення житлової території - це цілісна організаційно-технологічна просторово орієнтована система, складова функціонально-планувальної структури міста, містобудівна організація якої спрямована на підвищення екологічного стану та покращення комфорту та якості життєдіяльності населення. Запропоновано послідовність (модель) ухвалення проектного рішення щодо організації системи збору та розташування первинних пунктів на предпроектних стадіях розроблення містобудівної документації в умовах реконструкції або нового будівництва з врахуванням об'єму та морфологічної структури побутових відходів в місцях їх утворення, що розміщенні в зоні впливу первинного пункту збору, технологічних та планувальних обмежень.

Метод розрахунку системи санітарного очищення розподіляється на три технологічні рівні згідно з організаційною моделлю санітарного очищення та мають на кожному рівні системи об'єкт дослідження - територію, обмежену зоною впливу містобудівного елемента предмета дослідження:

I рівень   -   дослідження первинних пунктів збору;
II рівень   -   станції сортування або перезавантаження;
III рівень   -   підприємства з утилізації, переробки або захоронення побутових відходів.

Ключові слова: санітарне очищення міста; житлові території; первинні пункти збору; пункти збору відходів; побутові відходи; обладнання; планувальний модуль; функціональна; робоча; транзитна зона; зона впливу санітарного очищення.

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