Residential land surveying for sustainable communities

Olga Leptyukhova[1*] and *Egor* Firov[1]

[1]Moscow State University of Civil Engineering, Yaroslavskoe highway, 26, 129337, Moscow, Russia

Abstract. This research focused on the analysis of land surveying practices and the development of an optimized urban planning approach. The analysis included studying foreign and domestic experiences, scientific publications, and regulatory and technical documentation. The findings led to the identification of different types of land surveying, their strengths and weaknesses, and the main tasks involved. The researchers proposed a classification of five types of land surveying for residential areas. Using a theoretical model, input parameters such as development type, planning structure elements, and existing plot shapes were considered to propose optimizing measures. A block diagram of the optimized urban planning approach to land surveying was developed, which took into account the formation of land plots in residential districts and micro-districts, as well as functional processes and urban planning considerations. An experiment was conducted to test the proposed optimization tool for forming land plot boundaries under multi-apartment residential buildings in Moscow region. The results showed that the proposed mechanism effectively established boundaries and formed functional zones based on principles of compactness and a conflict-free urban environment.

1 Introduction

One of the actual tasks in urban planning is to ensure the rights and legitimate interests of citizens to a safe and comfortable neighbourhood space of apartment buildings, the boundaries of which should be established taking into account all functional processes occurring on the territory.

In accordance with the Order of the Government of the Russian Federation from 31.10.2022 №3268-r "On approval of the Strategy of development of the construction industry and housing and communal services of the Russian Federation for the period up to 2030 with a forecast up to 2035g" the objectives of the strategy is to improve the comfort and quality of the urban environment, increase the efficiency of land use.

With the change of socio-economic formation and the emergence of private property there was a need to establish a connection between the rights and obligations of the owner of the capital construction object and the territory on which it is located, there was a need for land surveying.

* Corresponding author: kanz@mgsu.ru

For owners of real estate objects the issue of land plot formation under apartment buildings is important because it creates prerequisites for development and preservation of comfortable and favourable courtyard environment.

Land surveying is the basis for rational use of space between buildings and creates a "zone of responsibility" for owners: a prerequisite for more responsible and careful treatment of property.

The issues of the legal nature of land surveying and their aspects were considered in the publications: Savvina L.Ya "Cadastral registration of land plots under apartment buildings as a guarantee of reducing the risk of conflicts over the use of such territories"; Zinarchin G.F "Putting land plots under apartment buildings on the state cadastral registration"; Frelich A.N., Korneev V.I., Makurina M.E "Legal aspects of the process of land surveying of built-up areas". [1-3]

The question of correct execution of land surveying of built-up urban territories for the purpose of intra-quarter planning was considered in the publications: Arzhnikov A.E., Veretennikova K.V. "Problems of land surveying of built-up territories and why should land surveying be systematic?"; Goryunova O.I. "Formation of land plots under apartment buildings in the existing building on the example of ZATO Zheleznogorsk"; Darchinyan I.D "Land surveying on the lands of built-up territories"; Mamontova S.A., Mugako A.D "Formation of land plots under apartment buildings in the existing building on the example of ZATO Zheleznogorsk", Mugako A.D. "Formation of a land plot under an apartment building"; Nikonova P.N. "Land surveying and the image (cropping) of the city (one of many aspects)"; Sorokina E. I "Procedure of land plot land surveying under an apartment building"; Zagitov B. A "Formation of land plots under apartment buildings by approval of the scheme of location of the land plot on the cadastral plan of the territory"; Shoikova S. I "Technology of land plot formation under apartment residential buildings". [4-11]

The issues of land surveying were also considered in foreign scientific literature: Armen A. Alchian "Property Rights"; Antti Tuure, H. Emre Ilgin "Space Efficiency in Finnish Mid-Rise Timber Apartment Buildings"; Radenka Cvetić "Right of apartment/condominium owners on the land on which the building is located in the context of conversion of the right of use into the right of ownership on the construction land"; Sloboda Midorović, Radenka Cvetić "Co-ownership of apartment owners with regard to the land on which the building is built"; Anna Bielska, Agnieszka Wendland, Maciej Delnicki "Possibilities for the Development of Building Plots with an Unfavourable Structure in the Context of Spatial Justice: A Case Study of Poland." [12-16]

The present article is a continuation of the study [17] and includes a recommendation on optimisation of the procedure of surveying residential elements of the planning structure.

The object of the study is residential elements of the planning structure (quarter/microdistrict) as a basis for the formation of land plots, on the example of the Moscow region.

Hypothesis of the study - optimisation of the urban planning approach to the land surveying of the quarter territory will allow to ensure the integrated functional use of the land plots territory, based on the principles of compactness and conflict-free urban environment.

2 Materials and Methods

The boundaries of the study are residential formations bounded by red lines - blocks or neighbourhoods built up with residential houses, in the absence of zones with special conditions of territories. The study was conducted in three stages.

At the first stage the analysis of open reference and information online resources containing information about the boundaries of residential elements of the planning structure and real estate objects located within their boundaries was carried out.

Domestic experience of land surveying was analysed for the territory of the Moscow region using the Public cadastral map of Rosreestr [18] and approved land surveying projects.

The analysis of foreign experience was carried out using data from the online reference and information resource of the national mapping agency of the Czech Republic - Geoprohlížeč, online reference and information resource of the land surveying body of Sweden - LantmŠteriet, online reference and information resource of the city of Vienna containing a digital map of the city of Vienna - Stadt Wien. [19-21]

The analysis of foreign and domestic practice of urban planning and land management allowed us to determine the types of land surveying and to propose a classification of five types of land surveying of residential elements of the planning structure: "land surveying on the pavement", "land surveying with adjacent territory", "continuous land surveying", "combined land surveying", "with the establishment of public easement" (Fig. 1).

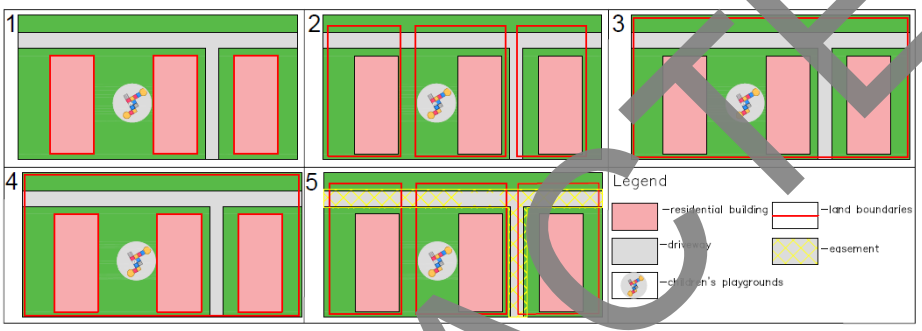

Fig. 1. Classification of types of residential elements of the planning structure: 1. "along the pavement", 2. "with adjacent territory", 3. "continuous", 4. "combined surveying", 5. "with the establishment of an easement".

In general, approaches to land surveying abroad and in Russia are based on the types of land surveying 1-3; the 4th type is found exclusively in foreign experience and the 5th type is inherent exclusively in domestic land surveying practice. Each of the considered types of land surveying of residential elements of the planning structure has strengths and weaknesses.

At the second stage we analysed the main regulatory and legal documentation that regulates and regulates the procedure of land surveying:

- Land Code of the Russian Federation dated 25.10.2001 No. 136-FZ;
- Town-planning Code of the Russian Federation from 29.12.2004 No. 190-FZ;
- Order of the Ministry of Construction of Russia from 07.03 2019 No. 153/pr "On approval of methodological recommendations for carrying out works on the formation of land plots on which apartment buildings are located";
- SP 42.13330.2016 "SNiP 2.07.01-89* Urban Planning. Planning and development of urban and rural settlements";
- SP 476.1325800.2020 "Territories of urban and rural settlements. Rules of planning, development and improvement of residential neighbourhoods";
- Resolution of the Government of the Moscow Region dated 17.08.2015 No. 713/30 "On Approval of Urban Planning Design Standards of the Moscow Region" (hereinafter - Regional Urban Planning Design Standards, RNGP);
- Resolution of the Government of the Moscow Region of 17.08.2018 No. 542/29 "On Approval of the Regulations on the Procedure for Decision-Making on Approval of the Territory Planning Project and the Territory Land Survey Project in the Moscow Region" [22-28].

Based on the analysis of the above regulatory and legal documentation, the composition of the elements of the organisation of the territory of the residential quarter, microdistrict was determined:

- residential quarter: car parks for motor transport, ground garages with a capacity of not more than 500 m/m; transformer substations, boilers, central heating stations, central heating stations, VNS-3 lift, boiler houses; sports grounds; shops of food and industrial goods, catering outlets; dry cleaners and laundries, hairdressing salons; pharmacy establishments, outpatient and polyclinic organisations, dispensaries, medical centres; pre-school educational organisations;
- residential microdistrict: car parks, garages; gas regulator stations, support and amplification stations, CNS, boiler houses; physical training and recreation complexes, flat structures; shopping centres, cafes, bars, canteens, cookeries; ateliers, repair shops, public toilets; post offices, bank branches; pharmacy establishments.

At the third stage, the urban planning characteristics of the identified practices of residential elements of the planning structure on the territory of the Moscow region were determined (the area and shape of the land plot, the composition of elements of territory organisation within the boundaries of the land plot). A comparative analysis of the calculation of the area of land plots on the basis of regional norms of town-planning design and on the basis of the order of the Ministry of the Russian Federation for Land Policy, Construction and Housing and Communal Services from 26.08.1998 №59 "On approval of methodological guidelines for calculating the normative size of plots in condominiums" was also carried out [29].

As a result of the analysis of urban planning characteristics of the formed land plots under residential buildings, determination of the areas of land plots on the basis of the RNGP, the problems were revealed, namely: in the current practice there is no complete surveying of the internal space of the formed in the Soviet time residential quarters and neighbourhoods and they remain spotted with "unallocated state property", which leads to stagnation and degradation of the internal space. Also the formed land plots may have broken borders, interlocations, wedges and unjustified geometric shape, and already existing formed land plots under apartment buildings do not take into account the ongoing functional processes on the territory and the composition of elements of the territory organisation.

3 Results and Discussion

As a result of the analysis of foreign and domestic experience of residential elements of the planning structure land surveying, urban planning characteristics of the types of land surveying used in domestic practice, taking into account the identified advantages and disadvantages of each type of land surveying, a flowchart of optimisation of the calculation and graphic part of the design of land surveying of residential districts and neighbourhoods was developed.

The flowchart shows the sequence of design and graphic work on territory boundary surveying (Fig. 2).

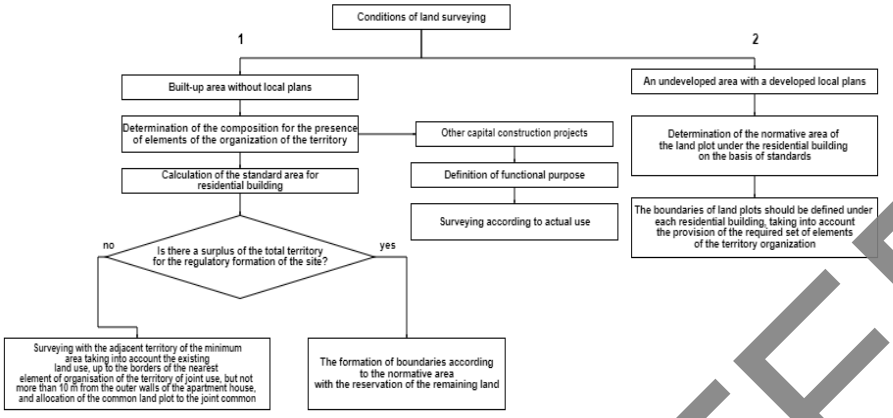

Fig.2 Flowchart for optimising the survey procedure

At first it is necessary to define the conditions for land surveying: land surveying of already built-up residential areas or land surveying of areas that are just to be built up. In practice, built-up territories are Soviet-era neighbourhoods that do not meet the requirements of modern norms for territory planning and have never had a territory planning project. For undeveloped territories, planning documentation is prepared (a planning project and a land rezoning project) in accordance with the requirements of current legislation.
The first algorithmic design is related to the land use planning of a built-up area without local plans.

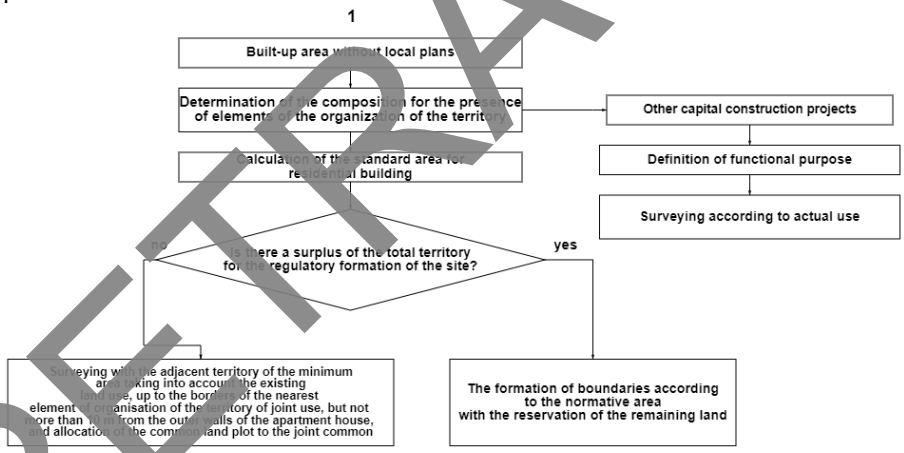

Fig. 3 Algorithm fragment of the of the built-up area

As a rule, there is no planning documentation for the case of land rezoning of a built-up area, so it is necessary to perform a preliminary field or cartographic survey of the territory SO, in order to carry out land rezoning it is necessary to determine the composition of the elements of the territory organisation, the list of which includes apartment buildings and other capital construction objects, including pre-school educational organisations and general education organisations, as well as elements of landscaping: playgrounds (children's playgrounds, sports grounds and sports grounds).

At the next stage, after analysing the composition and location of the elements of territory organisation, the area under each apartment building in a block or microdistrict is calculated based on the normative indicators adopted in the RNGP. Multi-apartment residential

buildings are the main types of functional use of the territory forming the residential development of a block (microdistrict).

After calculating the size of land plots under apartment buildings it is necessary to determine whether there is a deficit of territory to accommodate all normative elements of territory organisation: pavements and entrances to the entrance groups of buildings, green areas with adult recreation areas and children's playgrounds, places for storage of motor transport and others.

In case of revealed estimated surplus of territory and possibility to place normative elements of territory organisation on land plots of estimated area, formation of a land plot under each apartment house is made according to the found area according to the normative of regional town-planning norms, overnormative territory is allocated to the reserve of a municipality for possibility of formation of an independent land plot.

In case the deficit of the territory within the boundaries of the quarter/microdistrict is revealed, the surveying under the apartment house is carried out by the method of surveying with the adjacent territory of the minimum area taking into account the existing land use, up to the borders of the nearest element of organisation of the territory of joint use, but not more than 10 m from the outer walls of the apartment house, and allocation of the common land plot to the joint common use of houses in proportion to the living area of the houses located inside the element of the planning structure.

Restrictions related to the distance of no more than 10 m from the external walls of the apartment building are caused by sanitary gaps according to p. 7.5, SP 42.13330.2016 "SNiP 2.07.01-89* Urban Planning. Planning and development of urban and rural settlements".

The location of the common land plot may depend on the planning organisation of development in the quarter: closed volumetric and spatial complexes or group composition complexes (Fig. 4, Fig. 5).

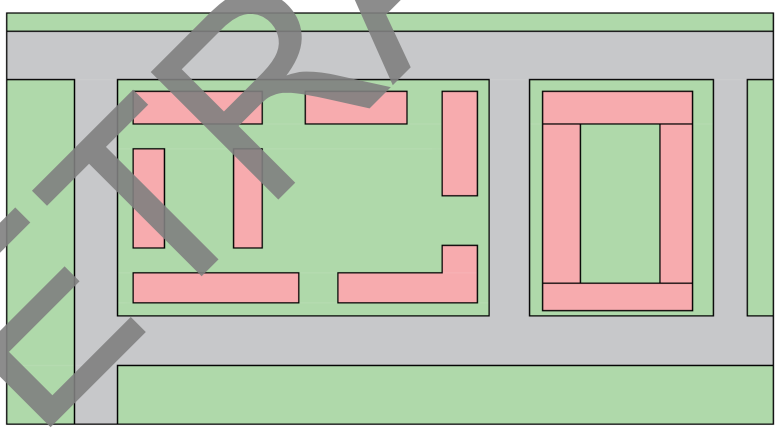

Fig.4 Closed volume-spatial composite complexes

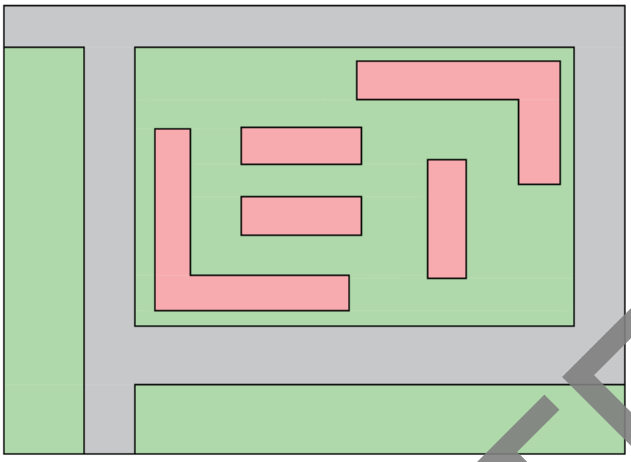

Fig.5 Group volume-spatial composite complexes

The formation of land plots for other capital construction facilities in the neighbourhood/microdistrict is based on the normative indicators of the need for territory depending on the functional purpose of the facility in accordance with Annex D of SP 42.13330.2016 "SNiP 2.07.01-89* Urban Planning. Planning and development of urban and rural settlements".

The second algorithmic design is related to the land use planning of an undeveloped area on the basis of the developed territory planning project (Fig. 6).

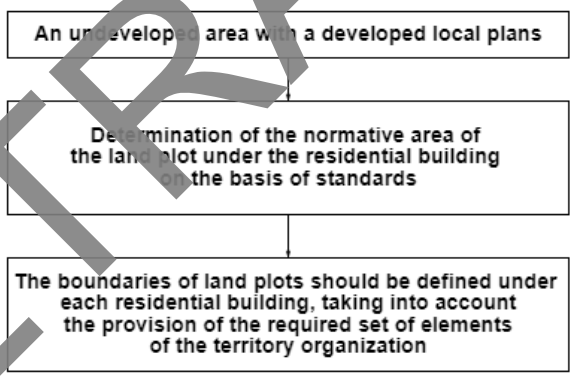

Fig.6 Algorithm fragment for non-built-up area

For the undeveloped area, the normative land plots for multi-apartment residential buildings are calculated on the basis of the current RNGP. The formation of land plots under multi-apartment residential buildings should be carried out by the type of land rezoning "from adjacent territories".

In this case it is advisable to design the territory planning taking into account the autonomous provision of each residential building with a normative set of elements of territory organisation on the basis of SP 476.1325800.2020 "Territories of urban and rural settlements. Rules of planning, development and landscaping of residential neighbourhoods", so, for example, according to p.7.26 "Private adjacent territory includes the following mandatory elements: approaches and entrances to the entrance groups of buildings, territories

of green areas with recreation areas for adults and children's playgrounds". elements of territory organisation.

4 Application example

Let's study the example of land surveying of the 8th microdistrict in the city of Mytishchi, Moscow region.

Fig.7 The boundaries of the microdistrict in question

1. First of all, define the conditions of land rezoning - Built-up area without local plans.
2. Define the structure of the territory organization and present it in Table 1.

Table 1. Definition of the elements on the territory under consideration

Assignment of objects	**Composition of facilities within the boundaries of the residential neighborhood**
Storage facilities for individual motor vehicles	Open parking lots
Engineering facilities (power, heat, gas supply, water supply, wastewater disposal)	Transformer substations
Physical culture and sports facilities	Fitness and recreation complexes, flat facilities
Trade and catering facilities	Built-in grocery stores
Educational facilities	Preschool educational organizations, general educational organizations
Public facilities	Children's playgrounds, landscaping and gardening facilities on adjacent territories
Road and street network	Driveways

Housing construction objects	Residential buildings

3. Calculate the normative size of the adjacent territory for multi-apartment residential development, based on the norms of urban planning design of the Moscow region.

The city of Mytishchi refers to settlements with a population of more than 100 thousand people and is located in the "Mytishchinsko-Pushkinsko-Shelkovsky" urban sustainable settlement system, so the indicator of the need for the adjacent territory per person is determined in accordance with the table RNGP.

Calculation of the minimum land plot under multi-apartment residential buildings is presented in Table 2.

Table 2. Results of minimum area calculations.

№	Address	Area of flats	Housing supply	Population	Specific coefficient for land surveying purposes	Minimum required area
1.	Letnaya street, 24/2	11362	28	406	13,51	5482
2.	Letnaya street, 24/3	10842	28	387	13,51	5231
3.	st. Yubileinaya, 15	4323	28	154	13,51	2086
4.	st. Yubileinaya, 13	4389	28	157	13,51	2118
5.	st. Yubileinaya, 11	4391	28	157	13,51	2119
6.	st. Yubileinaya, 9	4275	28	153	13,51	2063
7.	st. Yubileinaya, 11 to 1	2179	28	78	16,92	1317
8.	st. Yubileinaya, 11/2	2179	28	78	16,92	1317
9.	st. Yubileinaya, 11 to 3	3349	28	120	16,92	2024
10.	st. Yubileinaya, 11 to 4	2694	28	96	16,92	1628
11.	Letnaya street, 20/3	2701	28	96	16,92	1632
12.	Letnaya street, 22/2	3518	28	126	16,92	2126
13.	Letnaya street, 22/3	4420	28	158	16,92	2671
14.	Letnaya street, 22/4	4418	28	158	16,92	2670
15.	Letnaya street, 24/1	10088	28	360	13,51	4867

4. The existing development does not allow to apply the current normative calculations taking into account the level of motorization, which will lead to a deficit of territory and overlap of borders of each other formed land plots. The existing building forms a single internal space with a deficit of territory, so the land surveying is carried out by the method of land surveying with the adjacent territory of the minimum area taking into account the existing land use, up to the borders of the nearest element of organization of the territory of

joint use, but not more than 10 m from the outer walls of the residential building, and allocation of the common land plot for joint common use of houses in proportion to the living area of the house located inside the element of the planning structure

5. The project proposal for the formation of plots in the neighborhood is presented in Figure 8.

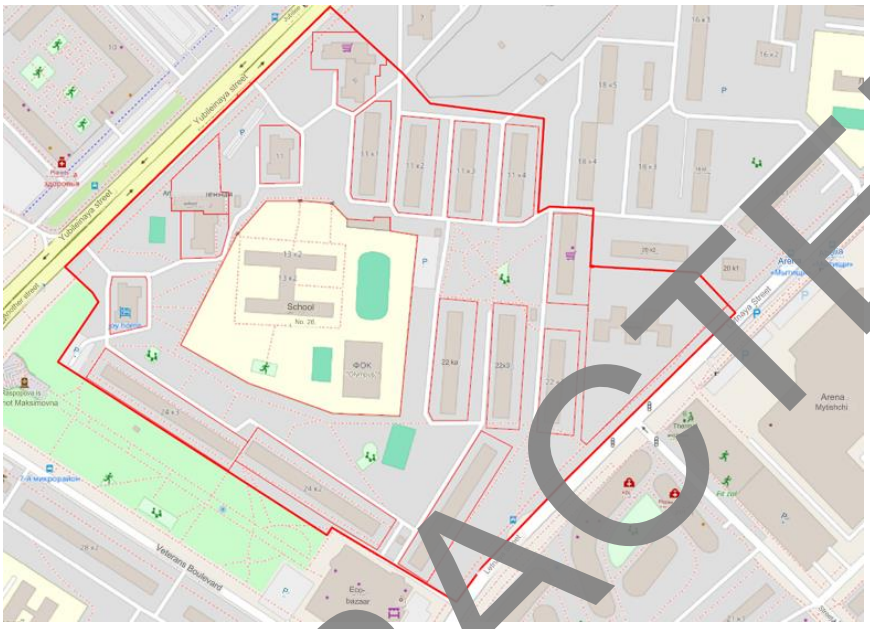

Fig.8 Boundaries of the formed areas of the residential neighbourhood

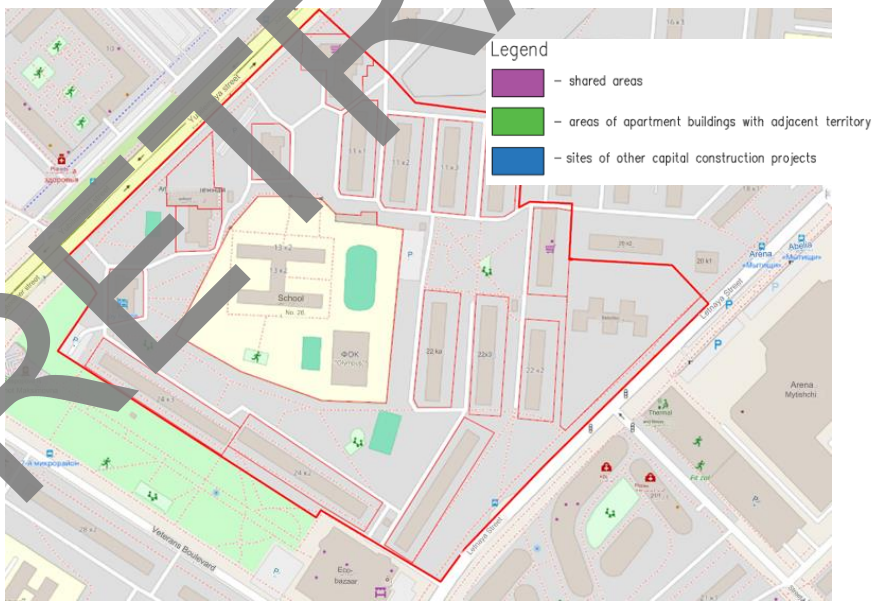

Fig.9 Designation of the land plots to be formed

5 Conclusions

The performed research made it possible to make the following conclusions and recommendations:

1. The existing practices of land surveying foreign and domestic experience, analysis of scientific publications, regulatory and technical documentation were analyzed. According to the results of the analysis, the types of land surveying, their strengths and weaknesses were considered, the main tasks of land surveying were determined and classification by five types of land surveying of the territory of the residential element of the planning structure was proposed;

2. On the basis of the proposed theoretical model of the study, taking into account such input parameters as type of development, composition of planning structure elements, geometric shapes and areas of already formed plots and normative factors, data processing was carried out and optimizing measures were proposed;

3. a block diagram of the optimized urban planning approach to land surveying was developed, which takes into account the main ways of land plots formation in residential districts/micro-districts taking into account functional processes taking place on the territory and urban planning peculiarities of the territory.

4. An experiment was conducted on the formation of land plot boundaries under multi-apartment residential buildings on the basis of urban planning approaches and the proposed optimization tool was tested for the case when there is a built-up area without available planning and land rezoning projects, taking into account a certain deficit of the territory;

5. It was determined that the proposed mechanism for optimizing the process of land rezoning allows to effectively establish boundaries and form functional zones based on the principles of compactness and conflict-free urban environment.

References

1. Savvina L.Ya, Cadastral registration of land plots for multiple houses as a guarantee of reducing the risks of conflicts over the use of such territories. Russian Law: Education, Practice, Science 1, 59-64(2022) DOI:10.34076/2410-2709_2022_1_59
2. Zinatchina G.F., Registration of land plots for apartment buildings on the state cadastral register. Economics and Management in the 21st Century: Development Trends 21, 121 – 125 (2015) EDN: TPDBRJ
3. Frelich A.N., Korneev V.I., Makurina M.E., Registration of land plots for apartment buildings on the state cadastral register. Legal aspects of the process of surveying built-up areas 4, 279-287(2020) EDN: IIGGAM
4. Arzhnikov I.E., Veretennikova K.V., Problems of surveying built-up areas and why should surveying be systematic?. Barnaul: I.I. Polzunov State Technical University 1, 108-124(2022) EDN: DKFWKU
5. Goryunova O.I., The formation of land plots for apartment buildings in existing buildings on the example of Zheleznogorsk. IACJ 4, 108-124(2021) DOI: 10.24411/2588-0209-2021-10347
6. Darchinyan I.D., Surveying on the lands of built-up areas. The current state of the land and property complex: problems and prospects of development, 33-36 (2021) EDN: KPMYPP
7. Mamontova S.A., Mugako A.D., Formation of a land plot under an apartment building. Legal Adviser in Construction 5, 57-60 (2023) DOI: 10.24411/2588-0209-2021-10347

8. Nikonov P.N., Surveying and the image (cut-off) of the city (one of the many aspects). Property Relations in the Russian Federation 10, 14-30(2009) EDN: KWDALN
9. Sorokina E. I., The procedure for surveying a land plot under an apartment building. Scientific foundations of Russian Environmental management: problems, current state, steps into the future, 265-269(2020) EDN: MDRLCO
10. Zagitov B. A., The formation of land plots for apartment buildings by approving the layout of the land plot on the cadastral plan of the territory. Society and Civilization 2, 92-94(2023) EDN: YVCJEW
11. Shoikova S. I., Technology of formation of land plots for multi-apartment residential buildings. Regulation of land and property relations in Russia: legal and geospatial support, real estate valuation, ecology, technological solutions 2, 275-280(2023) DOI: 10.33764/2687-041X-2023-2-275-280
12. Property Rights https://www.econlib.org/library/Enc/PropertyRights.html
13. Tuure, Antti & Ilgin, H.. (2023). Space Efficiency in Finnish Mid-Rise Timber Apartment Buildings. Buildings. 13. 2094. DOI: 10.3390/buildings13082094
14. Cvetić, Radenka. (2021). Right of apartment/condominium owners on the land on which the building is located in the context of conversion of the right of use into the right of ownership on the construction land. Zbornik radova Pravnog fakulteta, Novi Sad. 55. 93-111. DOI: 10.5937/zrpfns55-30418
15. Cvetić, Radenka & Midorović, Sloboda. (2021). Co-ownership of apartment owners with regard to the land on which the building is built. Zbornik radova Pravnog fakulteta, Novi Sad. 55. 737-763. DOI: 10.5937/zrpfns55-35564
16. Bielska, Anna & Wendland, Agnieszka & Dolnicki, Maciej. (2020). Possibilities for the Development of Building Plots with an Unfavorable Structure in the Context of Spatial Justice: A Case Study of Poland. Sustainability. 12. 2472. DOI: 10.3390/su12062472
17. Leptyukhova O.Yu., Firov E.A., Classification of types of surveying of residential elements of the planning structure. Ecology of Urbanized Territories 3, 103-113(2023) DOI: 10.24412/1816-1863-2023-3-103-113
18. Public cadastral map of Rosreestr https://pkk.rosreestr.ru/
19. Zeměměřickýúřad https://ags.cuzk.cz/geoprohlizec/
20. Fastighetskarta https://minkarta.lantmateriet.se/
21. Stadtplan Wien https://www.wien.gv.at/stadtplan/
22. Land Code of the Russian Federation №136-FZ dated 25.10.2001
23. Urban Planning Code of the Russian Federation №190-FZ dated 29.12.2004
24. Order of the Ministry of Construction of the Russian Federation ÇOn approval of methodological recommendations for the work on the formation of land plots on which apartment buildings are located» dated 07.03.2019 № 153/pr
25. The order of the Ministry of Construction of the Russian Federation ÇSP 42.13330.2016 ÇSNiP 2.07.01-89* Urban planning. Planning and construction of urban and rural settlementsÈ dated 30.12.2016 No. 1034/pr
26. SP 476.1325800.2020 ÇTerritories of urban and rural settlements. Rules of planning, development and improvement of residential neighborhoodsÈ
27. Resolution № 713/30 dated 17.08.2015 «On Approval of standards for urban planning in the Moscow RegionÈ

28. Resolution ÇOn approval of the Regulations on the procedure for making a decision on approval of the draft territory planning and land surveying project in the Moscow RegionÈ dated 17.08.2018 No. 542/29
29. Order of the Ministry of the Russian Federation for Land Policy, Construction and Housing and Communal Services ÇOn approval of methodological guidelines for calculating the standard sizes of land plots in condominiums» dated 26.08.1998 № 59