

Refinement of Cadastral Maps

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Making cadastral maps more precise

The amended cadastral ordinance takes effect from 1.7. 2009. Until this date the only cadastral maps for which two lists of coordinates for detailed survey points were filed were digitalized cadastral maps in stable cadastre coordinate systems. The entry into force of the amended ordinance has introduced the obligation to file these lists in all forms of cadastral maps. We have one file with coordinates of image and a second one with coordinates of position. The accuracy of the detailed survey points is defined by a quality code. The quality code is indicated in only one of the lists: either that of the image coordinates or that of the positional coordinates. The type of quality code depends on the willingness of property owners to sign a substantiating declaration of consent regarding the demarcation of a boundary line or the refinement of a boundary line. An integral part of the substantiating declaration is a survey sketch. The paper deals with survey sketch variants with regard to the amended ordinance.

Key words: cadastral ordinance, cadastral map, two lists of coordinates, survey sketch

Introduction

The currently effective ordinance for Act No. 265/1992 Coll. on the recording of ownership and other in rem rights concerning real estate property and Act No. 344/1992 Sb., on the real estate cadastre of the Czech Republic (the Cadastre Act) is, from 1.3.2007, Ordinance No. 26/2007 Coll. (the Cadastral Ordinance). From 1.7.2009 this ordinance is effective as the amended Ordinance No. 164/2009 Coll. (the Amended Cadastral Ordinance). The amendment is a reaction to the currently ongoing digitization of cadastral maps, which has as its goal the conversion of the content of existing analogue cadastral maps into digital format with a prescribed form and data structure. Towards the end of 2009 about 44% of the total amount of land in the cadastre had been digitized. The remaining cadastral maps awaiting conversion into digital format are mainly those with a scale in Vienna fathoms with low precision as concerns the location of property boundary lines. The main tool for solving this problem is the option of bringing greater refinement to geometric and positional determination. It is possible to increase precision if the following conditions are fulfilled. When entering new records into the cadastre of real estate a declaration from the owner must be presented substantiated by a declaration of consent clearly documenting the agreement of the owners of all land parcels to which changes are made along the course taken by the demarcated or owner-defined boundary line. Also, the difference between the situation measured in the field and the situation recorded in the cadastre of real estate must not extend beyond the permitted boundary deviations stipulated by the cadastral ordinance. If the permitted boundary deviations are exceeded it is not possible to refine the geometric and positional determination of the boundary, and in this case this is an error in the cadastral documentation which must be dealt with.

In order to familiarise the reader with such issues this article will firstly contain brief descriptions of all valid forms of cadastral map in which it is necessary to draw up survey sketches; this will be followed by an explanation of terms involved in geometric and positional assessment, positional and image coordinates, and declarations of consent. A key part of the article will be dedicated to various methods by which survey sketches are drawn up.

Currently used forms of cadastral map

The current forms of cadastral map are detailed in § 16 of Ordinance No. 26/2007 Coll.

The earliest used form of cadastral map is on plastic sheeting with a visual presentation and accuracy according to the presentation and measurement methods used in the period when the survey was carried out. The usual term for such a document is 'analogue map'. As the cadastral documentation is being renewed via new mapping, on the basis of changes to land parcels, via the conversion in the form of numerical data of analogue maps into digital format, and via the processing of sets of geodetic information, a digital cadastral map (DKM) is created. The DKM is created via the processing of analogue maps located in the Datum of the Uniform Trigonometric Cadastral Network (S-JTSK). If an analogue map is located

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in one of the stable cadastre coordinate systems (Gusterberg, St. Stephen), a digitized cadastral map is created. The beginnings of its creation can be found in 1998. According to the regulations in effect at the time such a map also remained in digital form located in stable cadastre systems (St. Stephen, Gusterberg) as an isolated map without the alignment of cadastral boundary lines. The creation of such a map was ended on the basis of much criticism in around 2002. According to the Manual for the Renewal of Cadastral Documentation and Conversion [2] a digitized cadastral map is being created from 2008 on the basis of the conversion of rasters of maps from the stable cadastre system (S-SK) into a digital continuous geometric projection in the S-JTSK. In order to distinguish between these two cadastral maps two abbreviations are used. The digitized map with coordinates in the S-SK stable cadastre system has the abbreviation KM-D, while the digitized map with coordinates in the S-JTSK has the abbreviation KMD.

Geometric and positional determination

Cadastral units and real estate recorded in the cadastre are, according to the cadastral ordinance [1], geometrically and positionally determined via numerical data expressing the boundary lines of land parcels, the perimeters of buildings and water control structures which are expressed by the coordinates of break points. These break points are determined via geodetic or photogrammetric methods in the S-JTSK and by the connections between these points or simply the depiction of the boundaries of land parcels, the perimeters of buildings and water control structures on the cadastral map. The precision of the coordinates of the detailed survey points of the planimetric component of the map is expressed by a code for the quality characteristics of the coordinates (quality code). The quality code for the detailed survey points determined by geodetic or photogrammetric methods is specified according to the mean coordinate sampling error value with a dependence on the mean coordinate error m_{xy} . The quality code of detailed survey points determined by digitization from analogue maps is set according to the scale of such maps; see Table 1.

Tab. 1. Quality codes for detailed survey points.

Quality code	Cadastral map scale	Basic mean coordinate error m_{xy}
3		0.14 m
4		0.26 m
5		0.50 m
6	1:1000, 1:1250	0.21 m
7	1:2000, 1:2500	0.50 m
8	1:2880 and other scales not stated above	1.00 m

The expression of boundary lines as numerical data simply takes the form of coordinates in the S-JTSK designated by the quality codes 3, 4 and 5; these coordinates designate real estate both geometrically and positionally. If real estate is not geometrically and positionally designated as numerical data, it is designated merely by the depiction of boundary lines on the cadastral map; this depiction can be:

- in analogue or digital vector form,
- in the S-JTSK or in the stable cadastre system (St. Stephen, Gusterberg).[3]

Image and positional coordinates

The amended cadastral ordinance [1] states the obligation to provide two lists of coordinates for detailed survey points of the planimetric component of maps for all valid forms of cadastral map. Before the amendment came into force this was only applied to the digitized cadastral map (KM-D) for which coordinates were recorded for all detailed survey points of the planimetric component in the St Stephen or Gusterberg systems. If a point was created via a survey sketch which contains lists of coordinates of new and linked control points that were only in the S-JTSK, it had coordinates recorded in the S-SK and the S-JTSK, because the duty of the drafter of the survey sketch was to transform coordinates defined in the S-JTSK into the stable cadastre system in which the KM-D is maintained. From 1.7.2009 all points of the planimetric component of all digital cadastral maps have their image coordinates recorded. In areas with analogue maps the image is printed on polyethylene sheets. Here, the image coordinates of the detailed survey points of the planimetric component originate from the survey sketch. Geodetic and photogrammetric methods can also be used to gain and display positional coordinates. Image coordinates for a detailed survey point of the planimetric component of the cadastral map serve in the depiction of points in the cadastral map. Whether the image and positional coordinates are identical or are different from each other depends on what is termed the proposal for the depiction of changes. Generally, it is possible to adapt the map to a change or a change to the map in the KMD. If the drafter of the survey sketch adapts the map to a change, the image and positional coordinates will be identical; if a change is adapted to the map, the image and positional

coordinates may differ from one another to a value given by the limit coordinate error u_{xy} , which equals an amount double that of the basic mean coordinate error m_{xy} . In areas with an analogue map the image coordinates displayed are identical to the positional coordinates. The quality code applies to both the positional coordinates and the image coordinates with which real estate in the cadastre should be geometrically and positionally determined.

Declaration of consent

Quality code 3 may only be assigned to positional coordinates, while quality codes 4-8 may only be assigned to image coordinates. Which code is assigned to a point depends on the willingness of property owners to sign a declaration of consent documenting the agreement of the owners of all land parcels to which changes are made along the course taken by the demarcated or owner-defined boundary line. According to the cadastral ordinance [1] the refined geometric and positional specification of a land parcel, or the appropriate refinement of the measurements of the parcel, is recorded in the cadastre by the Cadastral Office on the basis of a declaration by the owner substantiated by the aforementioned declaration of consent. An integral part of the declaration of consent is the survey sketch depicting the course of the demarcated or owner-defined boundary line. This means that the declaration of consent is not presented with the documentation for the survey sketch, which is prepared by its drafter for validation by the Cadastral Office and at that moment will not even be ready; however, the signing of the declaration of consent should take place on the basis of a survey sketch which has already been validated.

Survey sketch variants

If the survey sketch drafter is to draw up a survey sketch for the division of a land parcel where the new boundary line will follow on from an existing boundary line which is unclearly marked, they are obliged to mark out the point; the relevant property owners are to be invited. Under the amendment to the ordinance, property owners no longer sign the demarcation protocol (the signatures of property owners now form part of the declaration of consent); all that is stated there is data regarding their attendance during familiarisation with the demarcation (yes/no).

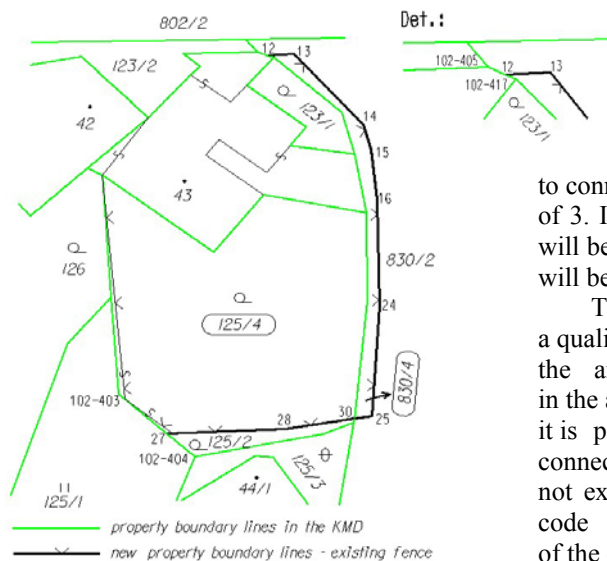


Fig. 1 Survey sketch method – variant 1

according to the regulations [1]. Either the point of connection will be the point of intersection of the current and new boundary line, or it will be the base of the vertical leading from the new point to the existing boundary line. On the basis of this survey sketch, which will be an integral part of e.g. a purchase contract, the registration of this new parcel will take place via insertion. This is a variant without refinement (variant 1) - see Fig. 1.

In the list of coordinates for entry in the CRE the coordinates that geometrically and positionally define the land parcel are always stated, i.e. there may be positional coordinates with a quality code of 3 as well as image coordinates with a quality code of 4 to 8. Positional coordinates are also stated alongside image coordinates if they are different from each other (points no. 12 and 27 in Table 2). If the boundary line in the cadastre is to be refined, it is necessary during registration to submit a survey sketch for the boundary line that is demarcated, or determined by the owner, along with the declaration of consent. In such a survey

sketch the coordinates of the linked points of the new boundary line (after its demarcation and inspectional measurement) are marked as quality code 3 (see Table 3).

Tab. 2. List of coordinates (S-JTSK) for the variant 1 survey sketch.

Point No.	Coordinates for recording in the CRE			Coordinates determined via measurement		Remark
	Y	X	Quality code	Y	X	
102-403	614875.70	1110124.57	8			stake
102-404	614867.76	1110131.91	8			stake
102-405	614861.20	1110084.63	8			stake
102-417	614859.56	1110085.31	8			stake
12	614860.14	1110085.07	8	614860.05	1110084.88	corner of foundation wall
13	614857.46	1110084.91	3			corner of foundation wall
14	614850.27	1110093.21	3			corner of foundation wall
15	614849.43	1110096.07	3			corner of foundation wall
16	614848.87	1110101.87	3			corner of foundation wall
24	614848.63	1110114.31	3			corner of foundation wall
25	614849.34	1110127.14	3			corner of foundation wall
27	614870.64	1110129.25	8	614870.05	1110129.22	corner of foundation wall
28	614858.39	1110128.68	3			corner of foundation wall
30	614851.23	1110127.46	8			

Remark to Table 2: The coordinates of points on the existing boundary line of the land parcel determined via measurement in the field will be adjusted for recording in the cadastre of real estate according to the existing determination of the boundary line via break points with a code characterising the quality of the coordinates which is greater than 3. The reason for this is that no refinement of the boundary line was carried out which must be substantiated by a document demonstrating the consent of the property owners to the course of the line (§ 19a paragraph 4 of the Cadastre Act).

If it is necessary to change the recorded quality code for points, the drafter will add the points to the list of coordinates with a new number. A cadastral office employee will, during validation of the survey sketch, change the status of the original points to “past”.

In this way the survey sketch is validated even if the declaration of consent has not yet been prepared, so the cadastral office will expect in advance the substantiation of the declaration of consent (later substantiation of the declaration of consent is noted on the survey sketch). A second variant is firstly to draw up the survey sketch for the division of the land parcel and, after its recording in the cadastre, to then draw up a survey sketch for the course of the demarcated or owner-specified boundary line of the land parcel (variant 2) - see Fig. 2.

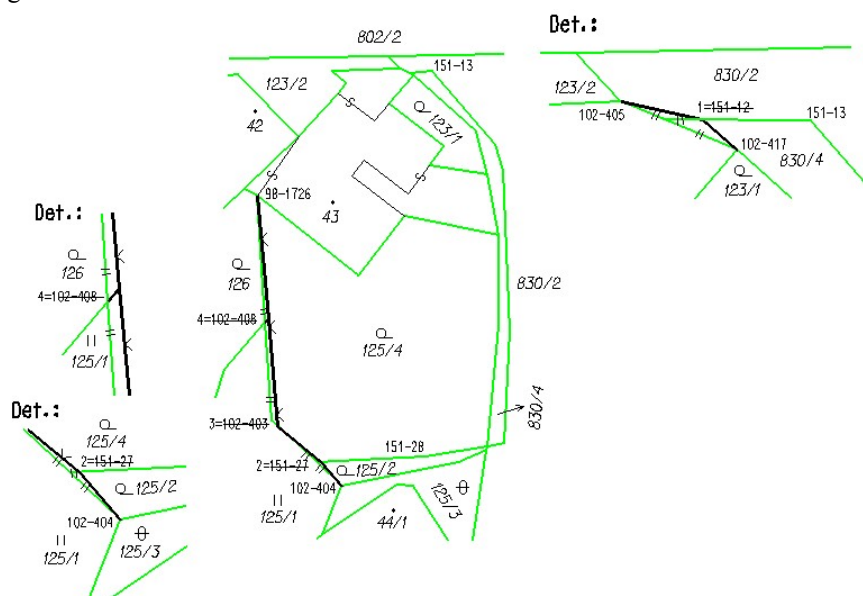


Fig. 2. Survey sketch method – variant 2.

Tab. 3. List of coordinates (S-JTSK) for the variant 2 survey sketch .

Point No.	Coordinates for recording in the CRE			Coordinates determined via measurement		Remark
	Y	X	Quality code	Y	X	
98-1726	614877.39	1110099.06	3			corner of building
102-404	614867.76	1110131.91	8			stake
102-405	614861.20	1110084.63	8			stake
102-417	614859.56	1110085.31	8			stake
151-13	614857.46	1110084.91	3			corner of foundation wall
151-28	614858.39	1110128.68	3			corner of foundation wall
1	614860.05	1110084.88	3			corner of foundation wall
2	614870.05	1110129.22	3			corner of foundation wall
3	614875.02	1110125.18	3			corner of foundation wall
4	614876.13	1110112.94	3			colour on foundation wall

A third variant also exists, where it is possible to draw up both survey sketches within the framework of a single survey sketch, thus resulting in a survey sketch for the course of the demarcated or owner-specified boundary line of the land parcel or for the division of the land parcel (variant 3) – see Fig. 3.

According to the regulations [1] it is possible to use the proposal for the depiction of a change via the adaptation of the map to the change, among other ways, in the case that the existing geometric and positional determination can be refined, at least via the specification of the coordinates of connection points without the specification of linked control points. The map adapts to the change via the connection of the existing state of the planimetric component to the points involved in the change. The image coordinates are identical to the positional coordinates with a quality code of 3 (see Table 4).

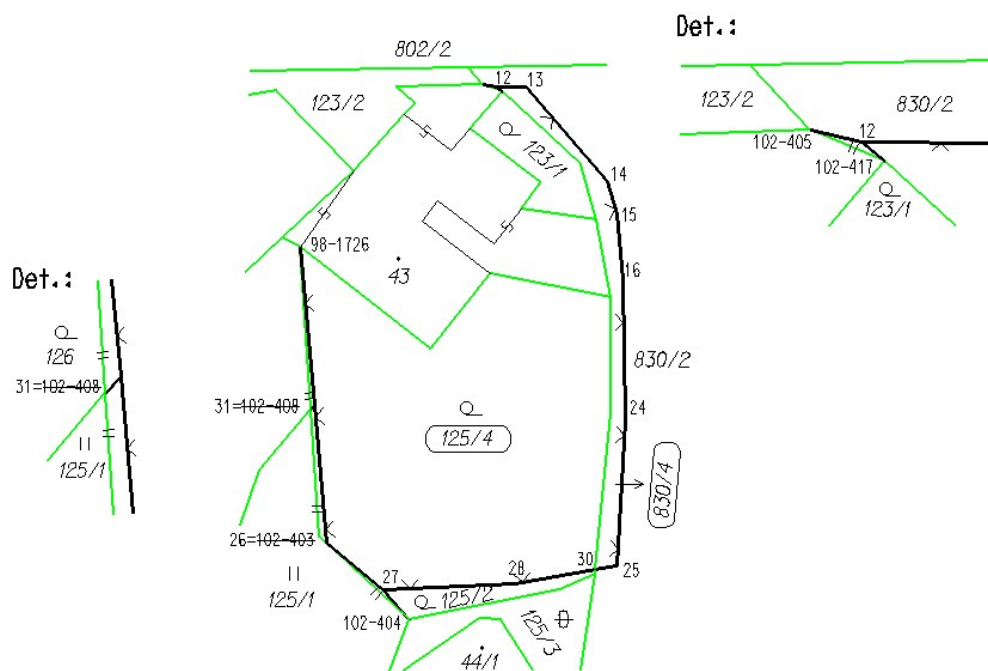


Fig. 3. Survey sketch method – variant 3.

The cadastral ordinance does not exclude the combination of survey sketches for multiple purposes. This technique is risky in the sense that if the refinement of geometric and positional determination does not take place, the desired transfer of part of the land parcel in question will not take place either. It is therefore necessary to arrange the writing of a declaration of consent with the owners of neighbouring land parcels in advance, just like the purchasing of part of a parcel. The change will be recorded in the cadastre after the owner (or one of a group of owners) has announced it, substantiated by a declaration of consent. It is also possible to announce the refinement of just part of a boundary line – of break points – marked on a survey sketch (e.g. when an owner changes their mind about signing a declaration of consent); the cadastral office will only prepare a partial survey sketch in such cases (specifying only the points declared in the

announcement that are substantiated by a declaration of consent). If in the survey sketch it was proposed that the measurements of a parcel be refined, it is necessary to specify all of the break points from which the measurements were calculated.

Tab. 4. List of coordinates for the variant 3 survey sketch.

Point No.	Coordinates for recording in the CRE			Coordinates determined by measurement		Remark
	Y	X	Quality code	Y	X	
98-1726	614877.39	1110099.06	3			corner of building
102-404	614867.76	1110131.91	8			stake
102-405	614861.20	1110084.63	8			stake
102-417	614859.56	1110085.31	8			stake
12	614860.05	1110084.88	3			corner of foundation wall
13	614857.46	1110084.91	3			corner of foundation wall
14	614850.27	1110093.21	3			corner of foundation wall
15	614849.43	1110096.07	3			corner of foundation wall
16	614848.87	1110101.87	3			corner of foundation wall
24	614848.63	1110114.31	3			corner of foundation wall
25	614849.34	1110127.14	3			corner of foundation wall
26	614875.02	1110125.18	3			corner of foundation wall
27	614870.05	1110129.22	3			corner of foundation wall
28	614858.39	1110128.68	3			corner of foundation wall
30	614851.23	1110127.46	8			
31	614876.13	1110112.94	3			colour on foundation wall

Conclusion

The drafter of the survey sketch must know how to work with analogue and numerical maps, the digital cadastral map and the 'cadastral map – digitized', previously in the stable cadastre system and now in the S-JTSK. The amended cadastral ordinance attempts to unify the principles by which all forms of cadastral map are maintained. After completion of the renewal of the cadastral documentation all cadastral maps should be administrated in the Cadastral Real Estate Information System (today the KM-D is administrated outside this system) as a continuous image. Updating should only take place via the new replacement format. The connection of the existing planimetric component to the points which have changed should be implemented with a dependence on the accuracy of the geometric and positional definition of land parcels, and never in the form of a map. When dividing up land parcels with break points with a quality code of 3 it is immaterial whether the map is termed a digital cadastral map or a 'cadastral map – digitized', just as in the case of the division of land parcels with points having a quality code of 8. For points with a quality code worse than 3 it is important that an attempt be made to specify the geometric and positional definition of the land parcel. The list of coordinates in a survey sketch contains the changed points and the linked control points, which are part of the proposal for the depiction of change; identical points are also transferred to the relevant cadastral office. Those points on an analogue map are assigned quality codes according to the scale of the cadastral map. Points on new boundary lines which concurrently are not points connecting a change can have a quality code of 3, as can points on new internal drawings and points connected to existing boundary lines with break points with a quality code of 3 or substantiated by a declaration of consent and a survey sketch for the course of the demarcated or owner-specified boundary lines of land parcels. The rules are set up so that the declaration of consent does not only concern property boundary lines between more than one property owner, but also existing boundary lines between two land parcels belonging to one owner.

More than 50% of cadastral land is still covered by analogue cadastral maps. In these maps it can occur that the numbers of detailed survey points in the planimetric component of the map and the quality code of their coordinates may, with regard to the methods used in the past while filling up the register of coordinates, not be adequate in terms of current regulations. Cadastral offices today are trying to check if the recorded quality codes are correct for all cadastral units in the register of coordinates, and they are doing this in advance before the cadastral documentation is renewed.

*This contribution arose within the framework of specific research at FCE BUT, Brno, Czech Republic.
Translated by Roger Turland.*

Reference

- [1] Ordinance implementing Act No. 265/1992 Coll. on the recording of property and other in rem real estate rights, as amended, and Act No. 344/1992 Coll. on the cadastre of real estate of the Czech Republic, as amended (the cadastral ordinance), *as amended by ordinance No. 164/2009 Coll.*
- [2] Manual for the Renewal of Cadastral Documentation and Transfer, from 20.12.2007, ČÚZK, no. 6530/2007-22, as amended by appendix No.1 from 25.1.2008, ČÚZK, no. 338/2008-22 and appendix No. 2 from 27.5.2009, ČÚZK, no. 2390/2009-22.
- [3] Guide to the application of the provisions of the cadastral ordinance concerning the coordinates of detailed survey points, ČÚZK, *attachment to no. 6495/2009-22.*
- [4] Instruction for work with data from the register of coordinates, ČÚZK, *č.j. 3365/2009-22.*
- [5] 45th Geodetic Information Days, lecture collection, *The Brno Association of Surveyors, November 2009, ISBN 978-80-86433-37-0.*