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THE NEW APPROACH TO FORMALIZATION AND AUTOMATION OF PROCESSING OF SCHEMES OF WATER SAMPLING IN THE SUBSYSTEM „WATER AND DISCHARGES" ACS "ECOINSPECTOR" OF THE STATE ECOLOGICAL INSPECTION OF THE MINISTRY OF ENVIRONMENTAL PROTECTION OF UKRAINE

There had been suggested the new approach to formalization and automation of processing of schemes of sampling of water during the ecological inspection controlling of specifications of waters of a natural and anthropogenic origin. There had been determined eight typical schemes of water sampling. The new software for automation of processes of input, accumulation, storage and the data processing, collected on the possible schemes of sampling and their combinations had been created and described. The developed algorithms and the software are realized in an author's subsystem "Water and discharges" ACS "EcoInspector" which is used in ecological inspection subdivisions of all areas and regions of Ukraine.

Keywords: *the automated systems of information processing, the ecological inspection control, state of natural and return waters.*

Initial preconditions and problem statement

The problem of anthropogenesis pollution of surface water has always been urgent. In Ukraine functions the net of subdivisions of the State Ecological Inspection (SEI) of the Ministry of Environmental Protection, responsible for controlling over the sewage disposal to the natural water as well as controlling over the pollution of surface waters, influenced by disposals. Regional subdivisions of the analytical controlling carry out the quality analysis of surface, sea and subsurface water in places of water discharges, as well as selective inspection controlling and researches upon the inquiries of physical and legal bodies. The monitoring of surface water is conducted upon the results of the chemical and analytical controlling. The controlling over the enterprises' quality of sewage water, discharged in the natural water reservoir is also conducted. Supply wells, being the sources of water are also the subject to the controlling by SEI. The result of the controlling is the considerable quantity of the data which are subject to processing and generalisation. Within 2005-2006 the scientists of Vinnytsia National Technical University had created the Common automated system of the State ecological inspection and subdivisions of the analytical controlling of the territorial bodies of the Ministry of Environmental Protection of Ukraine (ACS "EcoInspector"; the other name – "the automated monitoring system" – AMS "EcoInspector"). ACS "EcoInspector" has three basic subsystems: "Water and discharges", "Soils and a wastes" and "Emissions". The most complicated is the subsystem "Water and discharges". Works [1, 2] present models, operation algorithms and the interface of the software of one of the first versions of a subsystem "Water and discharges" of the ACS "EcoInspector".

Each of subsystems allows to automate all process of data processing of the certificate of sampling, results of performance of measurements, formation of the report of measurements, conducting registers of many kinds, creation of various reports about ecoinspection activity and a condition natural and return (sewage) waters. System automation is spent on the basis of confirmed in ecoinspection forms of the entrance and initial data — forms of the certificate of sampling, the report, magazines and reports. One of the first versions of a subsystem "Water and Dumps" has been constructed on the basis of forms (models) of the entrance and target data similar to the same models (forms) in subsystems "Soils and Wastes "and "Emissions" [1-3]. However, long-term practical tests have revealed separate lacks of such an approach.

Basic difference of models of the input data of the subsystem "Water and discharges" from the analogical models of other subsystems of ACS "EcoInspector" consists in more complicated

sampling schemes – that is, the return and natural waters with different number of selection points are being controlled over. Moreover, one enterprise can simultaneously have many different kinds and designs of water discharges, which should also be displayed in the system. It is necessary to choose the scheme of the sampling prior to data input, which, accordingly, will affect both, the way of observation results processing and ways of formation of the final reports on the control results.

Thus, there is a problem of working out the new approach to automation of the ecological inspection controlling over the state of the natural and return waters which would consider all possible combinations of sampling schemes, both at a data input stage, and at a stage of their further processing. It is also necessary to improve the interface of the program system for the application of the suggested approach in practice in the subsystem “Water and discharges” of the ACS "EcoInspector".

Formalisation of water sampling schemes during the ecological inspection control

Main principle of the ecological inspection control consists first, in observation of water quality in both, water discharge place, and in polluted natural waters, and second, in comparison of the observation results with the set norms – quality standard of natural waters and standards on maximum permissible discharge (MPD) for the given enterprise. In case of exceeding, the sanctions according to the current legislation are applied. There are certain standards as for how it is necessary to carry out water sampling. As a rule, these are three points – a discharge place, 0,5 km up the stream (a background river station) and 0,5 km down the stream (control river station) [4]. Under certain circumstances the other number of river sections may be controlled. For example, during the group control, when there are several discharges located within 1 km, the task gets complicated. There is also a problem of expenses minimisation, when it is economically efficient to measure only in one river section, which will act as both, the background for one discharge and the controlling for the other.

Besides, ecological inspection laboratories can additionally carry out the control over the water state on co-ordinates and with the regularity, approved by the program of the state monitoring of environment of the region.

The chosen controlling scheme influences significantly the reporting part of the automated system, which separately calculates the number of enterprises (pollution sources) which were controlled over, number of the selected tests, number of the revealed exceeding in the standards for natural waters etc.

For the formalisation of the sampling schemes there had been suggested the following approach. First, on the basis of the analysis of ecological inspection reports there should be singled out the typical sampling schemes with separate algorithm for data processing, which is to be developed for each of them, and second, there should be developed the universal form for adjustment of an arbitrary sampling scheme. Typical schemes will enable to improve the operating speed and ergonomics of the system, and the universal form will improve its functionality, i.e. the possibility to process the arbitrary schemes which can also take place.

There had been developed the information models of all (more then fifty) kinds of reports on results of the ecological inspection controlling over the state of waters and discharges. To determine the typical water sampling schemes, there had been used the author's method of designing of information model of the automated system of the data processing, allowing to minimise quantity of structural elements of the system and connections between them, satisfying the restriction in the form of input and output data with the set and the invariable structure [5]. Such forms-restrictions are the statement of sampling and reports on ecological inspection activity, accordingly. In other words, the method allowed to determine the typical sampling schemes which will enable to synthesise a program part of the system on observation data processing with minimum number of structural elements and connections between them. This will allow to build the set types of reports on ecological inspection activity on the basis of typical statements of sampling.

The following factors basically influenced the choice of typical sampling schemes:

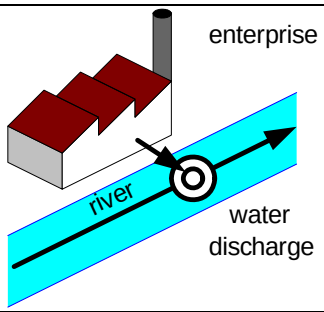
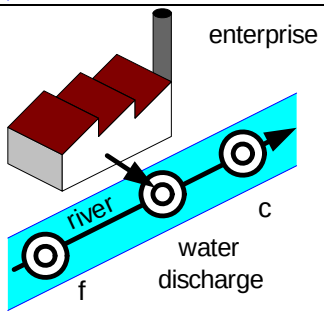
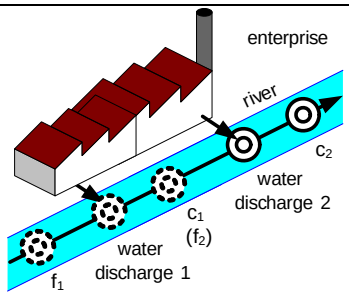
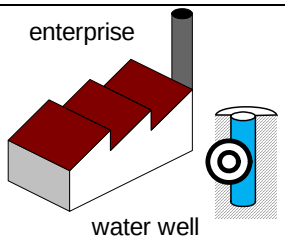
1. Differences in data processing and accounting for different types of waters – return (waste), ballast, underground or superficial.

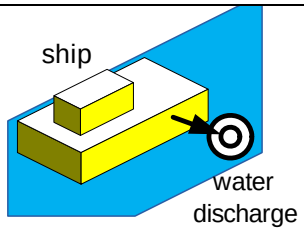
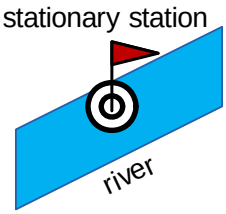
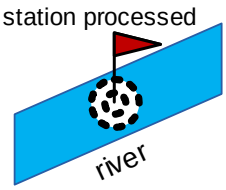
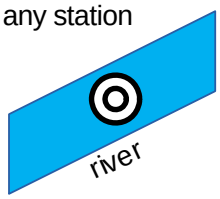
2. Necessity in minimisation of water quality observations at one enterprise or water object in one day which leads to the use of the same results in different schemes (both, background for one discharge and controlling for the other, or as the observation data under the program of the state monitoring).

As a result of the conducted information analysis there had been determined eight typical schemes of water sampling, depending on kinds and ways of discharge (tab. 1).

Table 1

Typical schemes of water sampling after discharges of different types

Number of the scheme	Type of the controlled waters	What exactly is controlled and where	The scheme
1	Return (sewage)	Water quality in the river is controlled in a discharge place	
2	Return (sewage)	Quality of water in the river is controlled in the place of discharge, 0,5 km up the stream (ф - background river section) and down (k - a controlling river section) the sampling place	
3	Return (sewage)	Quality of water in the river is controlled in the place of discharge, 0,5 km up the stream (background river section ф2) and down (a controlling river section к2) the controlling place, but the background river section ф2 is at the same time the controlling one (к1) for the discharge, located up the stream	
4	Return (sewage)	Quality of water in a discharge well	

5	Ballast waters	Quality of a surface water in a place where ballast waters are discharged from vessels	
6	Surface water	Quality of a surface water in the river section with co-ordinates from the program of the state monitoring of environment	
7	Surface water	Quality of a surface water in the river section with co-ordinates from the program of the state monitoring of environment, using the observation data generated the same day but under the other schemes	
8	Surface water	Quality of a surface water in the river section with arbitrary co-ordinates (emergency discharge etc.)	

For example, if any enterprise uses the scheme of discharge of return (sewage) waters according to fig. 1, the measurement and data processing of waters quality is then conducted according to schemes of 2–4 types.

It is necessary to note that each pollution source can simultaneously have not only some kinds of schemes, but some variants of discharges under one scheme, for example, some discharges in the well (type 4) or two discharges in two different rivers (type 2). That is why the determination of the schemes type, which take place, and quantity of discharges, made under these schemes are extremely important for automation.

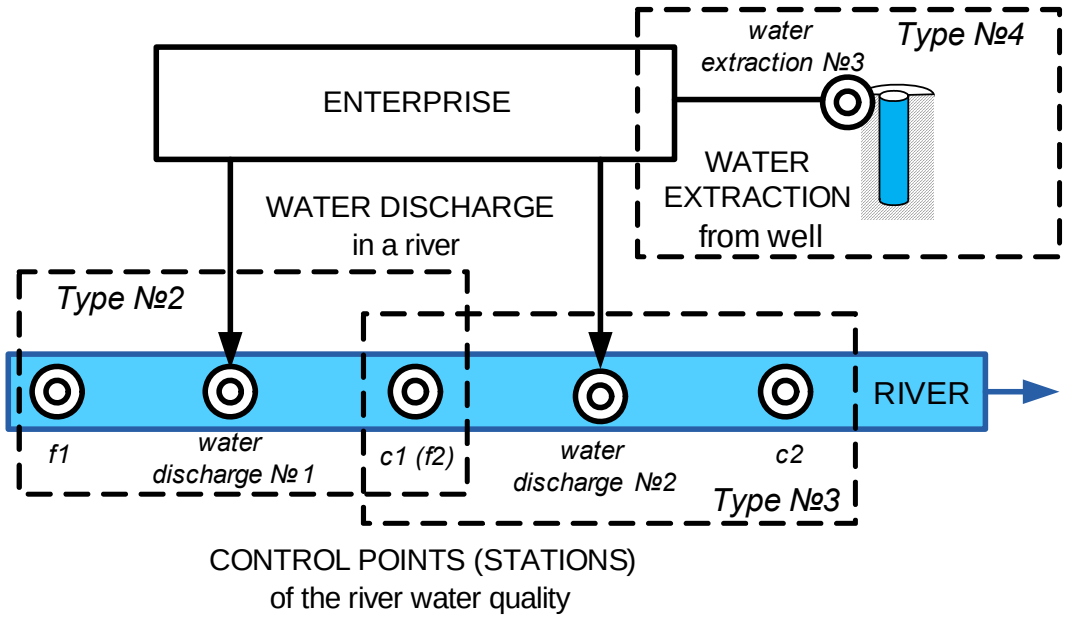


Fig. 1. An example of discharges of one enterprise under different schemes

The following algorithm is suggested for automation of processing of arbitrary sampling scheme (see fig. 1):

1. It is necessary to determine the necessary quantity of sampling points, their location.
2. It is necessary to determine the objects "Enterprise" and "Water Object".
3. It is necessary to determine the discharges and their parameters for the object "Enterprise". For the "Water Object" – river sections and their parameters.
4. It is necessary to determine the conformity between each controlling place, discharges and sections of objects "Enterprise" and "Water Object".
5. It is necessary to determine the schemes of water sampling after discharges of different types, their quantity and a combination for the given statement of sampling.

During the performance of the suggested algorithm, the system automatically determines the additional parameters of each selected test which usually are not specified in the selection statement, but are extremely necessary during the formation of the reports. For each test the system forms the entry in the registrar for tests registration which is automatically filled in with the specified parameters. Thus, the user of the system should enter only some data instead of all of them. Such parameters are:

– a sign of the group of the selected tests, among which there should be a background test;

– a sign of background test which is automatically appointed to corresponding test from the group of tests;

– a sign of the section type of water object; here the variants are possible: "Monitoring", "Control", "Emergency", "Background";

– a sign of the type of the selected water; here the variants are possible: "Return", "Ballast", "Superficial", "Underground";

– a sign of a category of the standard; here the variants are possible: "maximum concentration limit on SanPiN", "maximum concentration limit on regional management of water recourses for a surface water", "maximum concentration limit on regional management of water recourses for the sea waters", "PDS Sd", "PDS Sn (Other standrd)";

– the comment to the scheme of sampling of type "Background - the control – up the discharge", "the Vessel (ballast, waste)", etc.

3. Development of the software for automation of processing of schemes of sampling following the suggested approach in the subsystem "Water and discharges"

To make user-friendly input and data storage from the sampling statement, taking into account the new approach to automation of sampling schemes, there had been developed the new program interface which enables to enter all the information by some steps (stages). For this purpose it is necessary to fill in a number of forms (fig. 2-6).

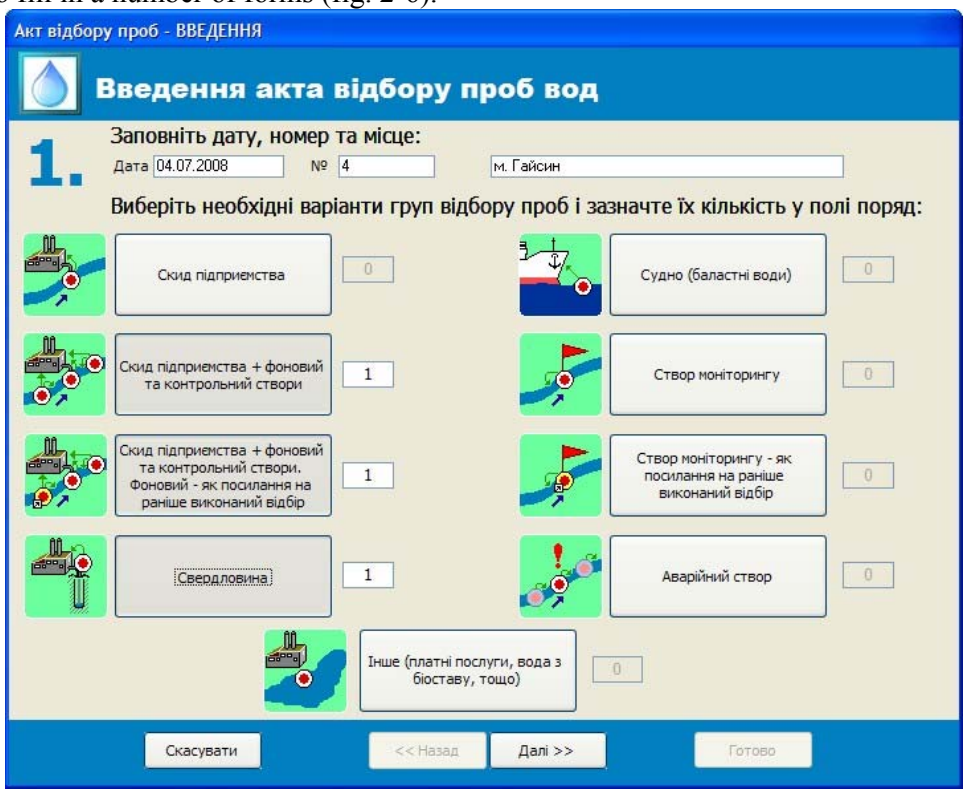


Fig. 2. A step of a choice of the sampling scheme for which the statement is drawn up

On the first step (fig. 2) there should be selected a set of schemes of sampling for which this or that statement of sampling is drawn up. Fig. 2 shows the example of data input for the enterprise from fig. 1. It is necessary to note that in the boxes near the types of sampling schemes it is necessary to indicate the number of such schemes at the given source, which can be more than one. In contingency test selection there is scheme of arbitrary data input. On fig. 2 it has the inscription "Another (paid services, water from the biopond etc.)".

On the second step (fig. 3) there should be determined the objects of the control as well as signs of the purpose and the basis of sampling, representatives of the enterprise and executors of selection. On the third step there should be formulated the lists of measuring equipment (ukr. – «ЗВТ»). The additional information on conditions of selection and transfer of tests for further analysis (fig. 4) is conducted.

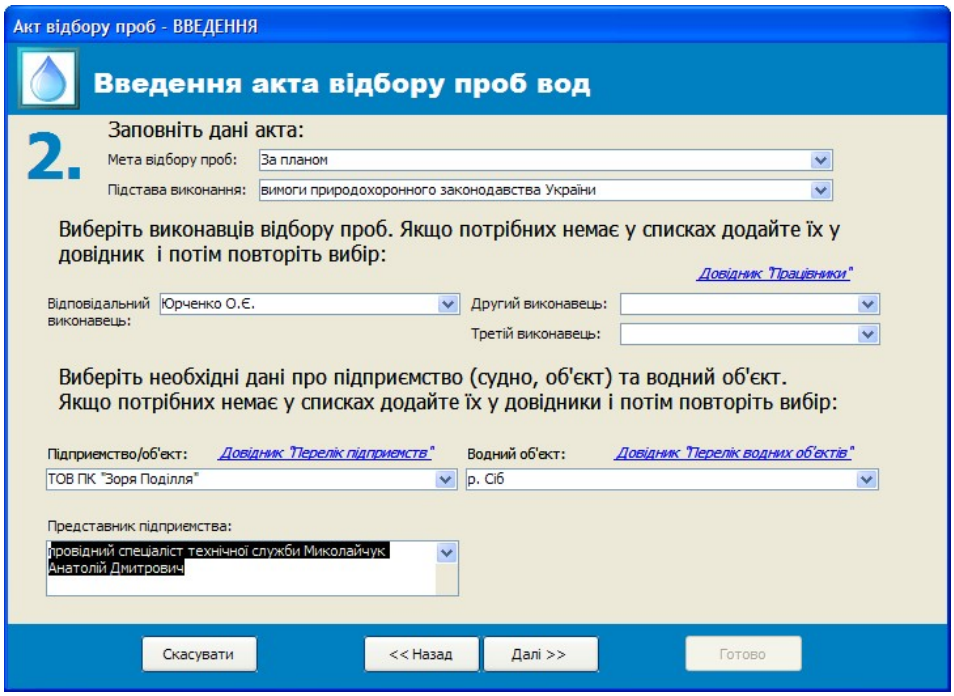


Fig. 3. A step of determination of general parameters of the selected tests

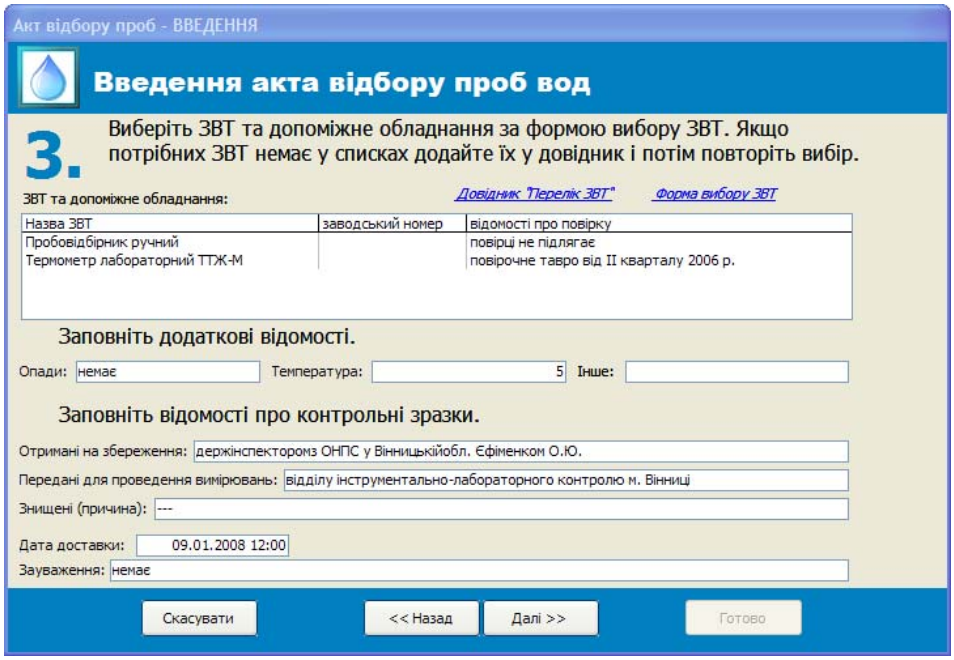


Fig. 4. A step of input of the additional information and the information on transfer of tests on further analysis

On the fourth step the system automatically forms the records on the selected tests which the user should supplement with the certain data himself. This information is displayed in two modes: in the reduced (fig. 5) – when the user sees only the information which should be entered manually, and in the expanded (fig. 6) – when along with the data of the reduced mode it is possible to see and edit the information which the system determiones automatically under the schemes of sampling chosen on the first step.

Using the two modes of a data displaying allows the user to apprehend the information more efficiently and to work with it. There are also the tools on the form of the data which allow to fill in information automaticaly. The verification of data correctness, which the user can change is carried out in the online mode.

Fig. 5. The reduced mode of the form of the data of sampling

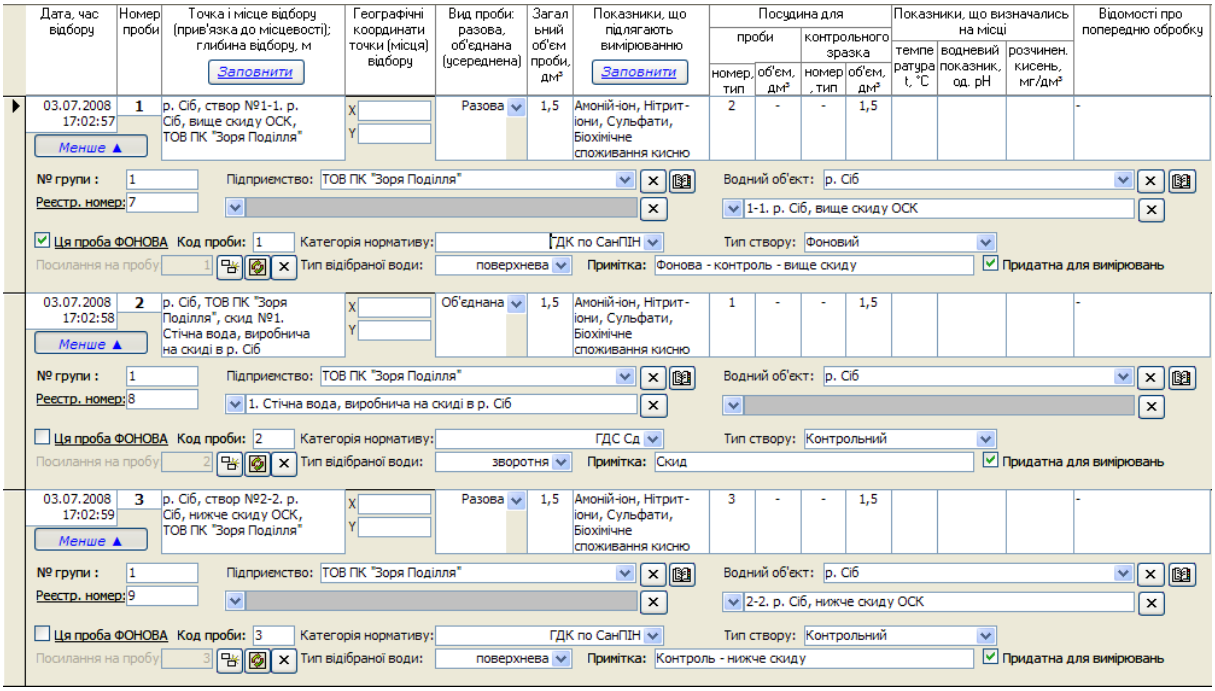


Fig. 6. The expanded mode of the form of the data of sampling

Conclusions

The developed the new approach to data processing automation and the corresponding algorithmic and program maintenance for the ecological inspection controlling over the state of natural and return waters enable in a subsystem “Water and discharges” ACS "Ecoinspector" to automate processes of input, accumulation, storage and processing simultaneously of all possible schemes of sampling places and their combinations, necessary for the accurate controlling over of anthropogenic influence of pollution sources on environment

From the beginning of 2008 all-round testing of the new version of a subsystem “Water and discharges” ACS "Ecoinspector" and its modules in practice in several ecological inspections (Kyiv, Donetsk, Vinnytsia) was held. In the second half of 2008 the introduction of the new version of the software in all the corresponding subdivisions of the State Ecological Inspection of the

Ministry of Environmental Protection of Ukraine is planned.

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