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REPORT
ON SCIENTIFIC RESEARCH WORK

"Environmental Assessment (EA) within the framework of the project "Creation of the Danube – the Black Sea deep-water navigable passage in the Ukrainian part of the delta. Stage 1"

(concluding)

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ABSTRACT

The report on scientific research: 202 pages, 38 tables, 18 figures, 7 supplements.

The subject of research: projected of the Danube – the Black Sea deep-water navigable passage.

The purpose of work – assessment of the DNC impact on environment.

Characteristic of natural, man-caused and social conditions of the region of the DNC creation and a comparative characteristic of the possible environmental effects of the track variants, analyzed in the Investments Feasibility Report "Creation of the Danube – the Black Sea deep-water navigable channel".

THE DEEP-WATER NAVIGABLE PASSAGE, THE DELTA, THE DISTRIBUTARY, THE SAND-BAR, THE ENVIRONMENTAL EFFECTS

CONTENTS

INTRODUCTION

The present research is fulfilled in compliance with the requirements of the States Building Code “DBN A 2.2-1-95” on the basis of the agreement between the Limited Liability Company "Planning-Exploration and Engineering-Design Institute of River Transport (Rechtransproect)", Kiev and the Ukrainian Research Institute of Environmental Problems (UkrNIIEP), Kharkov.

According to the item 1.1 of the States Building Code “DBN A 2.2-1-95” the environmental assessment is executed with the purpose of the ecological foundation of the future activity, with selection of the methods of this activity realization, ensuring normalization of the ecology state and following the requirements of the environmental safety. According to the item 1.4 of the same document of the environmental assessment is executed taking into account the priority of ecological factors and their interaction with the social and economic forces at the local and regional levels.

In the work, according to the requirements specification the environmental assessment, the evaluation of the deep-sea navigation passage (DSNC) with the length of 162.2 km for the ships with the draught of 5.85 m was carried out. The construction of the DSNP was foreseen by the working draft of the first stage of the DSNC construction in the Ukrainian part of the Danube delta. (The variant of the channel track, passing through the branch "Bystryy").

As the choice of the channel track variant and the technical solutions, accepted in the working draft, are tightly connected with the geomorphological development and hydrophysical conditions of the river Danube delta, the untraditional order of the material presentation was accepted in this work. The physiographic and climatic performances of the construction area precede the characteristics of the designed object of economic activities. In this work the following materials were used:

"The Technical and Economic Assessment of Investments in Construction of Deep-sea Navigation Channel River Danube - Black Sea", worked out by the Institute "Rechtransproect".

Reports of the Institute of Hydromechanics of the Ukrainian National Academy of Sciences (UNAS) and Danube Hydrometeorology Observatory about the researches, conducted within the framework of the feasibility study and the working draft of the deep-sea navigation channel.

"Environmental impact evaluation of the variant of the channel track, passing through the branch "Bystryy", which was carried out by the Odessa UNAS’s Branch of the Institute of the Southern Seas Biology in 2001.

The Environmental Assessment of the Variants of the Navigation passage creation “River

Danube - Black Sea", using the locked waterway branch "Solomonov Branch" – bay "Zhebriyansk" and further through the branch Bystryy, which was carried out by the UkrNIIEP in 2002.

The collective monograph "Biological variety of the Danube Biosphere Reserve. Its Preservation and Control".

"Evaluation of the Economic, Social, Legal and International Perspectives of the Construction of the Deep-sea Passage "River Danube-Black Sea in the Ukrainian Part of the Delta and the Public Opinion Attitude" report, produced by the Council of the Ukrainian National Academy of Sciences Studying the Productive Forces of Ukraine

"Environment Assessment of the Design Variants (on the stage of the Feasibility Report) of the Creation of the Deep-sea Passage "The Danube – the Black Sea" in the Ukrainian Part of the Delta" report, produced by the Institute of Hydrobiology of the Ukrainian National Academy of Sciences.

Separate volumes of the working draft, produced by the institutes "Rechtransproekt", "Ukrrybproject", Kiev, and research center "Noosphere", Odessa.

1. Prerequisites for the environmental assessment

The reasons for the environmental impact assessment is the requirements specification for the development of the section “Environmental Impact Assessment” in structure of working drafts “The Creation of the Deep-sea Navigation Passage “River Danube – Black Sea” in the Ukrainian part of delta”, produced by the Institute "Rechtransproekt"

The environmental impact evaluation is carried out in compliance with the legislative acts and normative documents dealing with environmental safety and preservation of the environment which are in force in Ukraine. This work was fulfilled according to all requirements of the States Building Code “DBN A 2.2-1-95”.

Earlier within the framework of the technical and economic assessment of the investments the Odessa UNAS’s Branch of the Institute of the Southern Seas Biology carried out the environmental impact evaluation in which the basic variant of deep-sea navigation channel through the branch “Bystryy” was treated without comparison with other ones [1].

This defect was the principal cause due to which the materials of the technical and economic assessment have been directed on revision under the decision of complex commission of experts in investments. During the process of updating the Ukrainian Research Institute of the Ecological Problems worked out the comparative evaluation of environmental impact of the most perspective variants of the deep-sea navigation channel path: through the locked waterway branch “Solomonov branch” – bay “Zhebriyanskaya” and further on through the branch “Bystryy” [2].

Repeated complex commission of investments experts recommended the variant with branch «Bystryy» as the most economic and ecologically safe for the further design. In the conclusion of the States Commission of Experts, which is the major constituent part of a the Public Examination, it is indicated, that the variant, using the branch “Bystryy”, is the optimal one according to the environmental impact evaluation of the design, disregarding the reserved status of the territory. At the same time it has been indicated that "Due to existing zoning of the Danube Biosphere Reserve, the environmental impact of either of the examined designs would not be allowable". In connection with the existing situation the States Commission of Experts has noted the possibility and urgent need in accomplishment of scientifically reasonable zoning of the territory of the Danube Biosphere Reserve with the obligatory taking into account the possibility of allocation of the deep-sea navigation channel “River Danube - Black Sea” in the zone of anthropogenic landscapes.

The decree of the President of Ukraine on June, 10 of 2003 № 502/2003, based on the decision of the National Safety Council of Ukraine on 6.06.2003 "About the State of Realization of the Decree

of the President of Ukraine from the 10 of August 1998, № 861 “About the creation of Danube Biosphere Reserve and the Perspectives of the Creation of the Deep-sea Navigation Passage “River Danube – Black Sea”", offered to the Cabinet of Ukraine "to develop during two month with the help of the National Academy of Sciences of Ukraine and interested in this problem executive authorities propositions about the optimization of the borders of the Danube Biosphere Reserve, conducting of its territory zoning, taking into account the complex solving of the national, regional and local problems, taking into consideration international obligations of Ukraine, providing additional preservation of valuable natural complexes,…and to transfer the branches of the Danube river, which are needed for the development of the water transport, to the internal waterways”.

The same decree obliged the Cabinet "in accordance with established procedure to provide in three months on the basis of the complex public examination the definition of the most effective variant of the deep-sea navigation passage “River Danube – Black Sea”, taking into account ecological, economic, engineering and other points of view, and to establish an experimental navigation passage, to conduct a series of other tests, additional scientific researches, targeted on minimization of the negative environmental influences of the construction of the deep-sea navigation passage, and to attract the capital, which is needed for realization of this project".

According to the recommendations of the central office of “Ukrinvestexpertiza” the technical and economic assessment for the investments in «Creation of the Deep-sea Navigation Passage "River Danube - Black Sea" in the Ukrainian part of delta», using the variant with "branch «Bystryy»" has been affirmed by the order of the Cabinet No. 598-p on13.10.03 with apportionment of two stages of construction.

On the basis of the Decree of the President of Ukraine №502/2003 from 10.06.03 the first stage of the design and construction, which was allocated in the technical and economic assessment, is considered by the working draft as an experimental one. It provides realization of complex observation (monitoring) both during the construction period and operation. Results of the observation will allow prevention of the negative environment impact. It is especially important in current conditions as navigation passage passes through the territory of the Danube Biosphere Reserve.

At the first stage the working draft foresees the construction of the navigation passage for ships with the draught 5,85 m with principal dimensions: L=125m; B=17m; T=5.85m.

2. Physiographic and Climatic characteristics of the Ukrainian section of the Danube delta and area of deep water navigation passage

2.1 Basic information about the Danube delta and dynamics of Kiliya delta formation.

The estuary area of the Danube belongs to the river-delta type and consists of subdelta plot, the length of which is about 85 km, delta (one of the largest in Europe), the territory of which is 5640 km and estuary beach about 1360 km [3]. The length of delta on its main branch is 115 km, its top is a place of division of the river in two largest branches - Kiliya (left) and Tulchinsk (right) (fig. 2.1). The extent of marine margin of delta is about 180 km, the average breadth of the beach is 6-10 km. The total area of estuary area is about 7000 km [4].

Kiliya branch serves as a sequel of the Danube river and is the main branch of delta. On its extent the branch forms two internal and one external (marine or Kiliya) deltas. Internal deltas were formed as a result of inwashes of miscellaneous parts of once huge The Danube bay. To the present day the majority of branches of two internal deltas died off. The largest of extant branches are Sredniy, Tataru, Kislitskiy (the first internal delta), Solomon, Pryamoy, Babina (the second internal delta). In Kiliya delta the basic branches are Ochakov (left) and Starostambulskiy branches (right). Ankudinov, Poludennyy, Prorva, Potapovskiy, Gneushev branches are detached from Ochakov branch, and Bystryy, Vostochnyy, Tsuganskiy, Limba and other are separated from Starostambulsk branch. All these branches run directly into the sea.

The length of Tulchinskiy branch is 17 km, which is divided in Sulinskiy (69 km) and Georgiyevskiy (109 km) branches. There is a small individual delta in the estuary of Georgiyev branch. Northern border of delta adjoins to the radical coast of Budzhakskiy plateau and pervades on the tops of lakes Yalpug, Katlabuch and Kitay and on the systems of Kiliya branch water-currents. The southwest border of estuary area coincides to the western shore of lacustrine - lagoon complex Razel'm - Sinoye. Numerous basins (lakes, lagoons, firths), the total area of which is about 1400 km, enter into a compound of delta. 22

% of the delta area, namely1240 km, resides in Ukraine; the remaining part belongs to Romania. The frontier between Ukraine and Romania passes on a fairway of the Danube, Kiliya branch and its forkings – Sredniy, Pryamoy, Starostambulskiy and Limba branches.

The modern delta of the Danube began to form approximately 5000 years ago in the extensive marine bay, which has arisen as a result of postglacial advance of sea when the level of the Black sea was some meters higher than the modern one. Thousand years ago the bay was partly blocked from the sea side by the long marine foreland and was transformed into a huge lagoon. Nowadays the series of sand waves, dragged inside the modern delta from the north-east to the southwest (Zhebryanskiy, Letyy, Karaorman patches, reminds about this foreland . Inside the Danube bay - lagoon, under the foreland protection, a fast forming of delta replacement took place. At first the most southern branch of delta (nowadays Georgiyevskiy) come over the line of foreland [4]. Later the foreland had been broken through in the middle part by the central branch of delta (by Sulinskiy). In the estuary of this branch the extensive delta of promotion had been formed, nowadays it is partly degraded by marine heaving.

They believe [3], that fast promotion of Sulinskiy branch in the sea had happened in V - I centuries up to AD that was promoted, probably, by lowering of the sea-level on 2-4 m about the modern one. Then Georgiyevskiy branch became more active again, which had formed the small delta in the sea. And only approximately in the XVIth centuries the northern branch of delta (nowadays Kiliya) became more active. It had by degrees increased the water-bearer and formed in a shallow-water bay two consecutive internal deltas swiftly. In the middle of the XVIIIth century, after inwashes filling of the almost all the northern part of the bays - lagoon, Kiliya branch had left the line of forelands and began to form the delta of promotion called nowadays marine or Kiliya.

According to I.V.Samoylov's data [5] there was no islands jet in the sea on the Bauer's map (1770) in a place of outlet of Kiliya branch. One island is shown on the map of Pustoshkin (1775), and on the map of Kushelev (1800) seven small islands had been marked already. The further history of Kiliya delta development can be recovered by the analysis of more authentic maps from 1830 to 1980 (fig. 2.2) [4].

In its development the Kiliya delta had passed four consecutive phases: one-branched (1740-1800), mild-branched, when the amount of branches did not exceed 20 (1800-1856),

multi-branched, when the quantity of estuary branches amounted to 40-60 (1856-1956) and again the mild-branched one (since 1957), when the quantity of estuary branches had been decreased (from 19 in 1957 up to 16 in 1980, 15 in 1989 and 14 in 1993) (tab. 2.1).

Table 2.1 - Morphometrical characteristics of Kiliya delta [6]

Year	Length, km		Area, км2	Volume of an alluvial fan, км3	Length of marine margin, km	Quantity of estuary branches
	Starostambul branch	Average				
1830	9,3	8,4	80	2,26	36,2	17
1856	13,6	11,5	111	2,89	47,0	20
1871	13.5	11,9	122	3,45	49,5	23
1883	15,5	13,6	174	4,05	55,6	56
1894	15,6	14,2	214	4,64	47,6	36
1922	19,0	16,3	285	5,66	55,2	47
1930	19,3	16,7	291	6,02	53,6	39
1943	21,3	17,4	308	6,55	56,0	25
1948	22.3	17,7	309	7,01	63.0	23
1957	22,3	18,4	328	7,54	70,0	19
1980	23,3	19,3	348	8,26	59,0	16

Kiliya delta was advanced in to the sea, always preserving its asymmetry. In the process of deceleration of delta advancement to the sea and the reduction of the quantity of estuary branches the indented marine margin of delta (MMD) was leveled by degrees . After 1930 the line of delta sand beaches became to form along a bank. Their total length increased: from 4 km in 1930 up to 12 km in 1943, 17 km in 1957 and 20 km in 1980 by degrees. Simultaneously the general length of the marine margin of delta reduced a bit, because the forelands had superimposed small bays - kuty [4].

The most active growth of Kiliya delta is marked in abounding in water 1871 - 1922; the area of delta for this time had increased for 163 km^2 at the average annual gain of 3,1 km^2. In the last decades the growth of the area of delta slowed down (in 1943-1980 it was only 1,1 km/year) in connection with an outlet of delta on deep - waters, raise of the level of the Black sea and reduction of an effluent of inwashes of the Danube. For the period of 1955-1979 (fig. 2.3) the shore advanced in the areas of a confluence in the sea Ochakovskiy and Starostambulskiy branches swiftly, in a smaller measure - at the branch of Bystryy (Novostambulskiy) [7]. By 1980 the area of delta made up 348 km, volume of an alluvial fan - 8,26 km^3.

In some parts of marine margin of delta of the Danube in the last 30 years washout became more active and deviation of a shore takes place. Such plots of washout of a shore are located between the estuaries of Bystryy and Vostochnyy branches (delta Kiliya) where washout in some years achieves 10-15 m / year and on the big extent of a shore to the south from the estuary of Sulinskyy branch. For 1962-1992 here the general loss of lands had made 2200 hectare (77 hectare/year); washout of a shore in the most cases was about 200 m (in some places up to 340 m) [8].

The amount of the effluent of Kiliya branch the most abounding in water increased up to the end of XIXth - the beginnings of XXth centuries, and then began to reduce, having been decreased to the present day up to 53 % (tab. 2.2). Apparently, this redistribution of an effluent for the benefit of Tulchinskiy and Sulinskiy branches was stimulated by deepening and rectification of Sulinskiy branch in 1880-1902, and also due to grinding and advancement of Kiliya branch to the sea . For the last 140 years the amount of effluent of Sulinskiy branch has constantly increased (especially since the beginning of the century) from 7-8 up to 17 % of an effluent of The Danube.

The amount of the effluent of the died Georgiyevskiy branch was decreased approximately from 30 up to 20 %. In 1984 a line of bends on Georgiyevskiy branch has been straightened. At present the effluent of Georgiyevskiy branch makes up 27 % from the effluent of the Danube [4, 9].

Table 2.2 - Water flow distribution on the basic branches of the Danube delta

In % from the average effluent of the Danube

Year	Kiliya branch	Tulchinskiy	Sulinskiy	Georgiyevskiy
1872	63	37	8	29
1895	70	30	7	23
1921	68	32	12	20
1928	66	34	14	20
1943	64	36	16	20
1960	63	37	17	20
1970	61	39	18	21
1980	59	41	20	21
1990	56	44	20	24
2000	53	47	20	27

Channel network of Kiliya branch is dynamic. In the first internal delta of this branch large lateral branches - Potorocha, Kartenko, Rydvan, Dibab, Kislitskiy, Stepovoy (to the north of the basic channel), Popadya, Tataru, Dzhetkovo-Saha, Repedeya (to the south from the basic channel) in the XVIII-XIX centuries were observed. Nowadays the majority of

them died off. Kislitskiy branch still exists, but decreases the amount of the effluent (from 10 % from the effluent of The Danube in 40th years up to 5 % in 70) rapidly. Stepovoy branch practically died off in 50th years and had been covered. Tataru bears no more than 1 % of the effluent of The Danube. The basic effluent is centered in Sredniy branch gathering about 90 % of the effluent of Kiliya branch (more than 50 % of the effluent of The Danube).

In the second internal delta of Kiliya branch the effluent is distributed on branches Solomonov (27 % of the effluent of The Danube), Pryamoy (19 %) and Babin (about 10 %) nowadays. A set of lateral branches died off: Laptysh, Murza, Chat, Zolotoy, Dyra, Stepovoy (Dunayets), Abraimok (to the north from the basic branches), Chernovka, Sulimanka, Chamdzhyyev, Bretushka, Potakova (to the south of the basic branches).

In Kiliya delta a process of concentration of a run-off of the water in the limited amount of the largest branches evidently takes place (tab. 2.3). Thus such large branches as Polunochnyy, Shabash, Sredniy, Zavodninskiy has already died off; rather large branches such as Potapovskiy, Starostambulskiy, and as well as small lateral branches such as Belgorodskiy and Limba reduced in the share of the effluent. At the same time the branches became more active in the direction of Starostambulskiy (headstream) – Bystryy. It is evident that a pronounced redistribution of the effluent from Ochakovskaya system to Starostambulskaya takes place. These branches would die off in the middle of XX century. [4, 9} but for the constant deepening of an inlet in the Belgorodskiy branch and deepening of a bar of Prorva branch.

Table 2.3 – Water flow distribution on branches of Kiliya delta in % from the average effluent of The Danube

Branch	**1894-1895**	**1942-1943**	**1958-1960**
Ochakovskiy			25,3
Belgorodskiy	1,4		0,1
Polunochnyy	1,0	0,4	0
Prorva	10.0	4,6	6,1
Potapovskiy	5,7	20,0	15,0
Starostambulskiy headstream			37,2
Sredniy	10,5	1.7	0,7
Bystryy		6,6	10,2
Vostochnyy		1,0	1,5

Continuation of table 2.3

Branch	**1966-1970**	**1976-1980**	**1986-1990**	**2000**
Ochakovskiy	20,7	18,0	16,9	14,5
Belgorodskiy	0,1	0,1	0,1	0,1
Polunochnyy				

Prorva	7,7	7,6	7,6	7,1
Potapovskiy	8,2	4,3	3,1	2,7
Starostambulskiy headstream	40,5	40,7		38,5
Sredniy	0,2	0,1	0	
Bystryy	12,4	14,3	16,5	17,6
Vostochnyy	1,7	2,3		2,3

Bystryy is one of the most perspective branches of Kiliya delta; it existed in Kiliya delta even in the beginning of XIX century. In connection with degradation of the other minor branches in the southeast part of Kiliya delta the share of the effluent of Bystryy steadily increased. In the end of X1Xth - the beginning of XXth century it made up $\leq$5 % of the effluent of The Danube. Since the 40ths, this share has increased from 6,6 up to 17,6 % gradually.

The most dynamic plots of the channel network of delta are the delta bars. Their natural depth does not exceed 2-2,5 m even in the most abounding in water branches (Potapovskiy, Bystryy, Starostambulskiy, Georgiyevskiy) [10].

The basic morphological elements of the delta bar (fig. 2.4) are the left and the right estuary forelands and their underwater parts, the central sea bar or the bar part, the bar hollows. The line, perpendicular to the axis of the stream passing through the extremity of the shortest surface estuary foreland, is considered to be the estuary range. The delta bar has a crest – this is a line connecting estuary forelands and passing through the most shallow-water parts of sea bar [11].

Morphological and morphometrical characteristics of delta bars depend on the run-off of water and inwashes of the river or the river-delta branch and the features of the estuary beach (depth and fall of the bottom, heaving, rising tides, whipped and fetched phenomena), as well as ice processes and artificial measures conducted on the estuary plot of the river and beach.

In the non-tidal rivers estuaries the effluent of inwashes of a water-current and energy of marine heaving have a basic influence on forming of bars and their dynamics. The role of the effluent of inwashes in a bar morphodynamics increases in a snow melt flood, and a role of marine heaving - in a mean water. Depending on combination of these two factors in non-

tidal estuaries of the rivers river bars(I) and river - marine (II) types are formed [12, 13]. The second type of bars, typical for the branches of the Danube delta, consists of four subtypes.

Promotion of a bar and snowmelt flood and partial wave breaking down in a mean-water is typical for subtype IIa. The delta bars of the large branches having well expressed estuary forelands, bar part and 1-2 bar hollows relate to the bars of this subtype.

Promotion in a snowmelt flood and practically complete wave breaking down in a meanwater is peculiar to the bars of subtype IIб. Such bars are formed in the medium-sized branches. They are poorly advanced to the sea, their estuary forelands are very short, bar part are not expressed and frequently have only one bar hollow.

The basic features of the bars of the subtype IIв are negligible promotion in a snowmelt flood and exceeding wave breaking down in mean-water. Such bars can be formed in the estuary of the small river-delta water-currents. The bars of this subtype are split along the seacoast, their estuary forelands are very short, usually the bar hollows are curved aside a prevailing alongshore flow of inwashes.

The blocked bars of subtype IIг are formed in the estuaries of the dying off branches. In a mean-water the wave effect can superimpose the channel flow by wave-cut slanting completely.

Characteristics of the bars are changed during the natural or anthropogenous redistribution of the effluent between the branches. The bars are extended when the effluent of branches are consequently increased and their depth is normally increased [12, 14]. In particular the bar length in the estuary of the Bystryy branch has been increased from 500 up to 1400 from 1940 to 1973, and then - up to 2500 m by 1994 (fig. 2.5). The bar was appreciably advanced into the sea, and its subtype IIб was replaced by subtype IIa for the last 30-40 years [11].

The area of the Danube delta relates to the deflection areas with the speeds of land lowering ~1 mm / year. According to [11] the intensity of land subsidence makes up 1,8 (Seaside, 8 sm for 40 years) - 0,2 mm / year (Renni town, 0.8 sm for 40 years). This phenomenon can be explained by a deflection of the earth crust under the heaviness of river-delta sedimentation and their gradual condensation [15].

2.2. Geomorphology and relief

In the geomorphological plan the territory of Kiliya delta of the Danube is within Dunaysko-Dnestrovskiy subregion of geomorphological area of Prichernomorskaya lowland and flat Crimea. The surface of delta is almost horizontal, with small rise in northern part where its crossing to loessial steppe it is raising above the sea level not more than 5-7 m of the absolute mark.

Its highest parts are sub channel patches and seaside foreland of the islands, the average relative height of which is 0,5-1,0 m. The central parts of islands have the flat lowered relief with lakes and channels.

Sub channel patches are formed along the branches and erikos. The asymmetric structure caused by washing away activity of water-currents is peculiar to them. The highest parts of patches are located near water-currents. They are lowered in the direction of the center of islands, which defines the general relief as a saucerform. Forming of the patches directly depends on the magnitude of inwashes, especially during snow melt flood, owing to their increase at the expense of sedimentation of slurry and sand. Thus the height of the patches in the crown of islands (1,0-1,5 m) is considerably large in comparison with the bottom (0,5 m) where the snowmelt flood is much weaker. The patches are interrupted by lowerings of the miscellaneous area, which have been formed in the places of former interisland water-currents. Sub channel patches are the places of the basic forestry forming and, partially, meadows.

On the territory of Kiliya delta of the Danube there are artificial raises - dikes, shafts alluvial (formed owing to deepening of the channel plot) except natural ones.

The seaside forelands are the positive ground features besides the sub channel patches. They are formed on the defined distance from the islands being a result of the interactions of the water-currents and the sea. At the first stage (Vostochnaya foreland, for example) they have no appreciable rises of the relief, negligible as for the length (up to 1,5 km). Seaside forelands play an important role in the desalted bays forming. Increasing in the sizes, they fence off a part of the beach shoals from the seawater influence. Further on the upper plots of forelands incorporate with the sub channel patches of islands, forming the bay, which is transformed to a half-closed basin gradually. Depending on the character of

alluvial process the seaside forelands incorporate to the land geocomplexes of delta further and function altogether as a structure of geocomplexes either of the island.

Stentsovsko-Zhebriyanskiy fluxes (SZhF), which are the internal basin of initial delta of the Danube, may serve as an example. These fluxes were formed after the ancient marine firth siltage, which had been separated from the sea by Zhebriyanskiy foreland. In the central and eastern parts of fluxes on depth of 4-7 m the plastic slurries of firth origin with initializations of numerous marine shell macaroni products has been found out, that proves the existence of the marine superficial firth here in the past. Fluxes are located in the northern part of delta between the inhabited locality Kiliya and Vilkovo. The fluxes are separated from Solomonov branch of Kiliya delta of the Danube by the sub channel levees and a radical shore, and in the southeasten part from the Black sea –by sandy intersperse – Vilkovo composed of siltage sands predominatingly of marine origin.

2.3 Climate

The climate of Kiliya delta is moderately continental with rather short and warm winter and long, hot summer. Among the flat areas the Black Sea Coast is characterized by the warmest winter (the average temperature of January is 2, 0 ^{0}C). The frost-free period continues up to 200 days, vegetative - 235-245 days, the sum of active temperatures is 3500-3600 ^{0}C. The mid - perennial amount of precipitations achieves 400 mm, and evaporation power - 800 mm / year. According to the general climatic zoning of Ukraine the territory relates to the continental area of the climatic zone of moderate latitudes, and according to the agroclimatic zoning of the territory of Ukraine - to the very arid moderately hot zone with mild winter.

Duration of solar radiation in the Danube regions exceeds 2300. The highest month significances are in July - till 350 hours, the lowest - in December - within 60 hours. The total solar radiation makes up to 4800 MJ/m^2, minimum is in December (about 110 MJ/m^2) and a maximum - in June (up to 800 MJ/m^2). The radiation balance during one year is positive and for a year is about 2100 MJ/m^2. The large part of heat of radiation balance is spent for turbulent heat interchange of the earth's surface with the atmosphere, the rest - for moisture evaporation from the earth's surface.

The atmospheric circulation has a well-defined seasonal character. During a year about 48 revolving storms and 36 anti-cyclones pass on in the south of Ukraine at an average. Anti-cyclones are less mobile, therefore anticyclonic weather lasts about 230 days, and cyclonic - up to 135 in the course of a year. Cyclonic activity is more intense in the cold periods of a year, the amount and duration of anti-cyclones increases in summer and in autumn.

Short and rather warm winter proceeds from the middle of December till the second decade of February. The beginning of spring falls on the last decade of February and the first decade of March. The long and hot summer begins in the first decade of May and lasts till the third decade of September. Autumn begins at the end of September - the beginning of October.

The average temperature of July is 22,4-23,7°C in miscellaneous areas of delta. The greatest raise of monthly average temperature is overseen within the period from April to May (on 10^0), and the decrease gradually on 5-6°C takes place every month since August till December. The annual amplitude of temperature between the coldest and the warmest months is 24,4°C. The amplitude of daily average temperatures makes up 41,5 °C. The absolute annual amplitude of temperatures is 70°C. The frost-free period proceeds within 200 days.

The least relative humidity is fixed in May when the air temperature (up to 70 %) is increased rapidly, the greatest - in January (up to 90 %).

The mid-annual temperature of water in delta of the Danube is 12,7°C. Waters of the estuary part are getting warm mostly in July - August (at an average up to *24,1°C*). The maximum in this period reaches 27,6°C. The duration of the period with the temperature of water up to 5°C makes up 265 days (16.03-06.12) at an average, up to 10°C - 213 (10.04-09.11), up to 15°C - 16 (04.05-13.10), up to 20°C - 108 (31.05-16.09).

Abundance of heat, water and high fertility of soils promote the development of dense vegetation, moisture-loving including, which occupies fluxes, shores of water-currents and basins. The most spread is cane, which occupies more than 2300 km^2 (about 1850 km^2 – in the territory of Romania). Cane-brake in delta of the Danube are the most compact in the world. There are afloat and fixed thick carpets of died and alive greenery - "plaura", formed from the residuals of cane, reed-mace, bulrush in some lakes of delta.

The fauna of delta is very rich and diverse. 150 species of birds, inherings to 18 groups inhabit and hibernate here [3]. White, gray, red and yellow herons, big cormorant, pink and curly pelicans, gray goose, the mute swan, gray duck, bald-coot and other are the most spread. Among the mammal such as wild boar, mink, otter, muskrat, hare, wild wildcat etc. live in the delta.

Delta – is the place of spawning and graziery of valuable breeds of fishes; ways of migration of checkpoints and half – checkpoints fishes pass through it. Ecological effect of delta is felt far outside of it. In delta natural reserves, including the Danube biosphere reserve, are located.

2.4 Hydrophysical conditions of delta formation

The average annual aquatic runoff of the Danube for the period from 1921 till 1993 made up 203 km3 per year (6460 m3 / c) (tab. 2.4). Mid-annual flow rate of Kiliya branch of the Danube is 3990 m3 / c, mid-annual effluent volume of Kiliya branch is 126 km3.

Table 2.4 - Perennial characteristics of water runoff and The Danube inwashes.

Period	Average drain of water, m3 / c	Maximum drain of water, m3 / c		Average drain of inwashes, kg / c	Average feculence of water, gr / m3
1921-1960	6320	10100	15300 (1941)	2150	340
	6630	11700	16000 (1970)	1340	202
1961-1993	6460	10800	16000 (1970)	1790	277

A share of Kiliya branch makes up 61-62 % from the total amount of an effluent for the perennial period. In turn, at bifurcation of Kiliya branch in a marine part of delta in Starostambul branch passes about 67 % of an effluent, in Ochakov branch it makes up 30 %, in Ankudinov is 2-3 %, in Belgorod and Sredniy up to 1 %. For the period since 1884 till now the length of Starostambul branch has been increased for about 9 km, Ochakov for 6 km, Belgorod for 2 km, that accordingly has changed a share of an effluent which passes through them (see tab. 2.2, 2.3).

The most big-water months in a year are April, May and June the share of which makes up 10-12 % of the annual water runoff (tab. 2.5). The least effluent is observed on

September - October (about 5,5-6 % of an annual effluent). Maximum drain of water in a highwater reaches 15-16 thousand of m3 / c. Drain of water are dropped up to 1300-1500 m3 / c in a mean water[4].

Table 2.5 - Averaged intraannual the Danube flow distribution for the period of 1921-1997, m3 / c.

Month											
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
3700	3960	4660	5400	5690	5190	4370	3330	2800	2630	3030	3570

The note: flow rates since 1950 were measured at top of the upper internal delta - at Izmail fold (50 km above the city of Kiliya on Kiliya narrow strait), for the period till 1950 flow rates has been recovered.

In the last decade the sharp swing over of an effluent of the Danube from 132 up to 236 km per year (tab. 2.6) has been marked.

Table 2.6 - Dynamics of annual volume of an effluent of the Danube, км3*

Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Effluent	213	207	177	132	198	172	154	181	230	236	224

*According to the data of Izmail hydrometerobservatory.

Non-reversible drawoff in the Ukrainian part of delta consists of 0,9 km / year at an average. Economic activity has not caused the reduction of a run-off of water of the river, moreover, the period of 1961-1993 (when the water storage basins on the Danube and its runs were built and irrigation diversion had been increased) appeared to be more abounding in water, than the period of 1921-1960.

At the same time for the last decades the average intensity of flow for October (approximately on 500 m3 / c) have appreciablly increased, and the average intensity of flow

for May, on the contrary, were lowered (approximately on 800 m3 / c) as a result of a control of an effluent of the river [15].

In Kiliya branch the mid-annual intensity of flow were lowered almost for 570 m3 / c (at an average from 4250 up to 3680 m3 / c), average intensity of flow for October have increased approximately on 70 m3 / c (with 2740 up to 2810 m3 / c), and for May were decreased approximately for 470 m3 / c.

The greatest flow rates are fixed, as a rule, in May, within the period of passing of a spring snow melt flood, and the minimal ones - during an aestivo-autumnal low-water. Extreme intensity of flow in delta of the Danube are shown in tab. 2.7.

Changes of Kiliya branch effluent are caused by two reasons: "external" (change of an effluent of the Danube) and "internal" (redistribution of an effluent between branches). For the period of 1958-1997 the share of Kiliya branch effluent in an effluent of the Danube was decreased from 62 up to 58 % under the average conditions and from 65 up to 59 % in a low-water [15]. Therefore in a sleeve reduction of mid-annual the intensity of flow has been increased, and ascending of the mean water rates was slowed down to some extend.

Table 2.7 - Maximum intensity of flow in Kiliya delta for the period of 1921-1997, m3 / c

River-Fold	Daily average flow rates	
	Maximum	Minimal
Kiliya narrow strait – Kiliya	8380	1410
Kiliya narrow strait – Vill	9290	1360

The angles of a water table in Kiliya delta are changed within the limits of 1-7 sm / kms (disregarding the whipped-fetched events).

The Danube delta level regime is characterized by sharp and continuous fluctuatings during the year. In its annual course the high spring-and-summer snow melt flood, autumn and winter high waters - snow melt floods, the low summer and winter low water is outlined. Spring snowmelt flood is characterized by the highest levels, and takes place almost every year (from March till July) and passes with the several waves, superimposed on each other. The aestivo-autumnal low-water (that takes place in the period from July till November) is characterized by the lowest annual horizons. Low-level aestivo-autumnal high waters, which

spikes exceeded spikes of a spring snowmelt flood in shallow years (1972, 1974), were sometimes observed. In the period from December till March winter high waters, the spikes of which in some years (1942,1985, etc.) was observed also could exceed the spikes of spring snow melt flood. Largely it is linked to formation of ice gorges, the reason of which were the exclusively high levels on the marine delta part (1925, 1946, 1967, 1998).

Perennial amplitude of levels fluctuatings in city-Renni range (the distance is 136 km from the delta margin) makes up 6,26 m (the maximum level ps 5,83 m, minimal --0,43 m), in Kiliya range (distance from delta margin is 47 km) - 3,04 m, in Vilkovo range (distance from the delta margin is18 km), connecting the lower internal and marine deltas, - 2,39 m and 2,09 m in harbour area of the Black sea adjacent to delta.

Characteristic settlement water levels in various ranges are introduced in the tab. 2.8.

Tab. 2.8 - Daily water levels (mBS) of various provision in the period of 1990-2002

Provision, %	The name of water posts and points							
	Mouth of the Bystroyy, 10 km	Prut river MKD	Renni	Izmail	Chatal	Izmail	Kiliya	Vilkovo
1	5,41	5,18	3,85	3,22	1,71	0,83	0,61	-
10	4,60	4,33	3,11	2,53	1,31	0,63	0,46	-
50	2,81	2,66	1,87	1,50	0,71	0,29	0,19	-
99	**0,49**	**0,41**	**0,17**	**0,05**	**-0,18**	**-0,24**	**-0,26**	**-0,48**

For settlement for shipping industry according to snip 2.06.01-86 the lowest shipping water-level by provision of 99 %, defined on the daily data for the paleocrystic period is accepted.

Delta basins and fluxes are the natural effluent regulators, collecting a part of water on the snow melt flood rise and returning it in the branch on the snow melt flood recession and in the mean water. The areas of delta deluging on unreinforced spaces depend on the flow intensity of the river. Earlier all delta territory except for the high patches, deluged at the flow intensity about16000 m^3 / s. Owing to branches reinforcement and islands at the flow intensity 16000 m^3 / s in the Ukrainian part of delta no more than 1/4 of the territory is deluged, that has resulted in raise of maximum water levels in the snow melt flood on 0,2-

0,3 m. Complete double-ended delta branches reinforcement can increase maximum levels of water for 0,5-1 m [4].

Whipped-fetched phenomena have the defined effect on the level regime of internal the Danube Kiliya delta. Whipped phenomena are formed by the action of western winds, fetched - eastern directions. From the winds of wavedangerous directions, the activity of which is the factor of shores processing intensity, the winds of N, NE, E, SE and S rhumbs, creating heavy sea and longshore transference of inwashes to the north from Bystryi branch, are the most important. The closer to delta margin, the whipped-fetched phenomena effect is stronger. Fetches, caused by strong north-easten, eastern and southeastern winds, sometimes on the Danube beach makes up to 1 m. The greatest fetch has been fixed on December 5-9 1945, when the magnitude of water-level rise was 78 sm in Vilkovo region, 59 sm – in Kiliya region and 4 sm –in Renni region. Thus a number of islands had been flooded in the marine delta part. At the wind change the fetch can vary on whip as it was observed on 20.11.1960, when the fetched rise of the level up to 45 sm was interchanged on fall up to 75 sm. Thus, the whipped-fetched phenomena considerably influence on forming of the delta level regime.

The propagation fetch length in delta is the bigger, the more is their magnitude in the beach and less the river effluent. The fetch in the sea of 1 m can be spread by the magnitude of 350 km at the Danube flow intensity about 3000 m^3 / s. So, the fetch magnitude on January, 30 - on February, 2, 1962 has made: up the beach of 88 sm, in Prorva (3,6 km from the sea) - 56 sm, in Vilkovo (18 km) - 50 sm, Izmail (93,6 km) - 30 sm, Renny (163 km) - 10 sm, Brail (206 km) - 8 sm. The ordinary fetches, the height of which is 0,4-5 m) do not spread further than 200 km from the sea.

Even the strongest whips on the estuary beach makes up no more than 0,6 m. Such whips are spread in the delta branches to the distance up to 100 km. So, whip in September, 28-30, 1959 has made: on the beach of 56 sm, in Prorva - 36 sm, in Vilkovo - 40 sm, in Kiliya - 24 sm, in Kislitsy (68 km from the sea) - 6 sm. Whip was not spread up to Izmail (94 km) [4].

In tab. 2.9 the meanings of the Danube monthly average levels in Kiliya delta for the periods of observations are indicated: 1921-1998 - on the Kiliya ranges (1) and Vilkovo (2),

1945-1998 - according to Primorskiy post in Zhebriyansk bay of the Black sea (3), actually on the threshold of marine delta margin .

Table 2.9 - Monthly average water-levels of the Danube Kiliya delta for the period of observations, m

N	Месяц												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I-XII
1 2 3	0,56 - 0,04 - 0,14	0,65 0,09 - 0,13	0,84 0,15 - 0,10	1,07 0,25 - 0,06	1,13 0,28 - 0,06	1,02 0,23 - 0,06	0,77 0,13 - 0,10	0,44 - 0,03 - 0,13	0,26 - 0,13 - 0,18	0,20 - 0,16 - 0,20	0,34 - 0,09 - 0,20	0,53 0,01 - 0,17	0,65 0,06 - 0,13

The statistical analysis of the data concerning the actual mid-annual ones which are the average for the most shallow month (October) and the most water abounding month (May) water-levels on hydrological posts (h/p) in Kiliya branch of the Danube delta (Izmail, Kiliya, Vilkovo) and on the estuary beach (Primorskiy) for 1958-1997 has shown, and it is evident that the mid-annual water-levels on h/p Izmail and Kiliya were sank, and on h/p Vilkovo and Primorskiy were increased; monthly average levels during October on all posts were increased; on h/p Izmail and Kiliya the mean levels during May were sank, and on h/p Primorskiy were increased a bit; on h/p Vilkovo the trend of May levels is not detected [15]. The main reasons of water-levels changes are : in the crown of branch (Izmail, Kiliya) – the changes of the branch effluent , in the bottom (Vilkovo) - raise of the Black sea level. The carried out contribution account of the effluent changes in the water-levels changes has shown, that the mid-annual levels because of these changes in Kiliya branch were decreased, and the mean water levels were increased.

Raise of the Black sea level in the XXth century – is the well known fact, which is explained by the majority of explorers as the positive water balance. In [16] it is marked, that, since 40th of XXth century, the intensity of evstatic rise of the Black sea level on the average is 3-4 mm / year. According to the accounts carried out [15], retaining component of water-levels changes for 40 years in Primorskiy (beach) has made of 17 sm at the average

conditions of the effluent and 24 sm in the low water, and the zone of by degrees fading affluent has captured, accordingly, 70 and 160 km upstream the Danube.

The effluent of the Danube inwashes according to V.N.Michaylov's accounts [4] in 1921-1960 was at an average 67,7 million t/year. After recommission of some reservoirs, in particular, Dzherda reservoir (Zheleznyye vorota) in Romania and Yugoslaviya (1969-1971) with the payload volume of 3,0 km^3 and the affluent magnitude at the lock of 34 m, the inwashes effluent was decreased at an average up to 42,2 million t/year. The water muddiness in the river was accordingly decreased from 340 g/m in 1921-1960 up to 202 g/m^3 in 1961-1993 (see tab. 2.4).

Flow distribution of inwashes on sleeves of delta of the Danube is approximately proportionally to the flow distribution of water. An exception is made only for the most intensely developing and dying off sleeves. It is pointed out that the first has relative ascending effluent of inwashes, and the second - a reduction in comparison with the shares of an aqueous runoff.

The change of the inwashes effluent along the large and long branches (Kiliya, Sulinsk, Georgiyev) is not significant, and an alluviation inside the delta in the modern phase of its development is also insignificant. By some estimations [17] the flow rates reduction of inwashes lengthways of Kiliya branch in the snow melt flood is no more than 5-10 %, that. is within the limits of measurements accuracy of inwashes flow rates. Nevertheless, an alluviation on the indefensible plots takes place and the slow increase of the delta surface and siltage of lakes proves it. Siltage of lakes is promoted by the development and degradation of aquatic greenery. The area of some lakes is slowly moderated in the internal part of delta .

The water temperature in delta branches is the greatest in July - August (at an average of 23-24°C, maximum 28°C), and the least - in December - February (at an average of 1-1,5°C, minimal – about 0°C).

The ice phenomena in the Danube delta does not happen every year, and the resistant ice standing is fixed less, than for 50 % of winters. Quite often the branches are plated with ice 2-3 times for winter but in some winters there is no even ice motion on the river. The average ice standing duration is 18 days, maximum - 70 (1954-1955). The average dates of pre ice standing and spring ice motion are accordingly on January, 6-15 and on February,

18-25. The greatest ice depth is 60 sm (on separate plots - up to 80 sm) is fixed at the end of January. Ice motions (especially spring) are rather frequently escorted by the ice blocks. In the last decades for the navigation extension and prevention of ice gorges the ice sheet is broken artificially. The strong ice gorge in the Kiliya branch low ground has taken place, for example, at the end of January, in 1967. The water-level was lifted up to 2-2,5 m. [4]. The threat of catastrophic deluging has hung above Kilija and Vilkovo cities. 2400 houses were flooded In Vilkovo. Within 5 days scrambling with element was led; thus icebreakers and aim bombing from aircrafts were applied

In 40-50x years of the last century the effluent of the Danube river salts was equal at an average of 52 million t/year [18] that corresponded to the average mineralization about 260 mg / dm^3. The precise tendency of increase of the average mineralization of the Danube water in delta about 290-300 mg / of dm^3 in 1948-1965 up to 370 mg / of dm^3 in 1985-1989[19] has been revealed in the next years. Thus, the effluent of the Danube salts has increased from 60 up to 76 million t/year.

The seawaters as "wedge" of salted waters can penetrate into some delta branches during the low effluent and fetches. This is the shallow branch such as Belgorod one or rather large branches, the bars of which are deepened for the purposes of shipping industry (Prorva and Sulinsk). Seawaters regularly penetrate at the bottom of these branches during the low water. The maximum range of seawaters penetration has been fixed in Prorva on 20.11.90 - 16,8 km [20]. The critical flow intensity in Prorva and Sulinsk branches, at the excess of which the seawaters do not penetrate in to the branches makes up 570 and 1350 m^3 / s. The dependence accordingly between the length of salted waters "wedge» in Prorva branch$_{Ls}$, (m) and the flow intensity in this branch Q, (m^3 / s) is established

$A=14,1 \times 10^9 Q^{-2,63}$ [20].

2.5 Hydrophysical conditions of estuary beach of Danube.

There are two types of beach currents - wind and effluent. Within the Danube estuary beach the wind currents are usually directed alongshore - from the north on the south - at the winds of northern rhumbs and from the south north-up - at the winds of southern rhumbs. Almost all the year above the beach the winds of northern rhumbs predominate. Their repeatability within the year exceeds 40-50 % and only in May and June is decreased up to 38-39 %. Repeatability of the southern rhumbs winds during the most part of the year makes up 30-38 %, being increased only in May and June up to 40-44 %. Therefore and the longshore currents are directed more often to the south. Consequently the most part of inwashes is transferred to the same part and the coast forelands and all Kiliya delta accrue more intensely in the same direction. Velocities of wind currents at steady wind more than 14-15 km/s can makes up to 1 km/s [4].

Discharge currents are watched on the beach before the mouths of large branches. Simultaneously behind the delta bars crests of Potapov, Bystryy, Starostambulsk, Sulinsk and Georgiyev branches the discharge currents in the snow melt flood makes up to 1-1.5 km/s. Discharge currents swiftly die off aside the seas , being traced not further 3-4 km from the mouth.

Heaving on the Danube beach is moderate. The average height of waves is about 0,5 m for the period from 2,5 up to 5,5 sm. According to the prevailing winds the wind heaving of the northern rhumbs (65 %) predominates, which is also the strongest. So, the winds with the velocity more than 10 km/s are characterized by repeatability in January of 16-18 %, in February of 12-14 %, and on March up to 15 %. All of them basically relate to the northern half of the horizon. Strong winds and heavings are not almost marked in summer [4].

The accumulation of fluvial sediments on the beach happens basically during the calm weathers or moderate seas up to 2-3 balls. The velocities of discharge currents from the Kiliya delta edtuary even at 1,5-2.0 km from the estuary ranges fall to such extend, that the mass accumulation of the basic part of the material [12] appears to be possible. Distribution of the weighting inwashes in the thickness of waters also proves it: lime concentration in the estuary ranges makes up to 200-300 mg / dm^3, and in 4-5 km from the range aside the open sea - only 30-50 mg / dm^3, that. is 4-10 times less. This difference of concentration is one of the parameters of fluvial sediments intensity accumulation on the beach. At the same time,

after heavy seas the local washouts of being already formed of accumulative cone surface [7] had been fixed.

According to M.V.Mikhaylova [6] the total formation of Kiliya delta for 240 years the components of inwashes balance are the following: the gain of volume of the alluvial fan - 8,26 km^3; the inwashes effluent of the branch - 8,363 km^3; carrying out of inwashes on the big marine depths - 0,03 km^3; contribution of marine inwashes from the north with the longshore flow - 0,029 km^3 and contribution out of inwashes to the south - 0,102 km^3. Thus, on the forming of estuary alluvial fan (within the marine depths 15 m) and delta almost 99 % of fluvial sediments were taken. A share of the inwashes, which have been carried away from delta and estuary alluvial fan, makes up little more than 1 %. Thus it was specified, that a share of the fluvial sediments remaining in the estuary alluvial fan, in the process of Kiliya delta development was steadily being increased (from 60-80 up to 99 %). As a whole it is possible to consider, that to the present time the Kiliya delta is in the condition of dynamic equilibrium within the quantity indicators of river and marine inwashes [21]. mentioned above

By U.D.Shuisky's [7] estimation, made on the comparison of cross profiles of the underwater slope of the Danube Kiliya delta, the average specific accumulation for the period of 1955-1979 makes up 220 m^3 / m annually. At the length of line, which is outlined the marine delta margin and is to, equal 53 km the total volume of alluviations has averaged 11,5 million m^3 annually inwashes or 71 % of the flow rate of inwashes in Vilkovo. The similar estimation for the underwater slope of Bystryy bar has shown, that only 21 % of the Bystryy branch effluent (147,1 m^3 / m year) is accumulated on the beach. It can explain why the promotion is slowed down in the sea of the bank line on this delta plot. According to the estimation (7) about 4,7 million m^3 of weighting and inwashes come from the Danube Kiliya branch in the open sea, which had the deep-sea sediments of the adjoining part of the Black sea. The carried out sedimentary material is transferred to suspensions by currents basically to the southeast and to the south, alongshore within the harbour area, adjoining Romania and Bulgaria shores [3].

Researches of river-delta processes of the Danube river, received as a result of the comparative analysis of the retrospective data of space shooting (1975-1988, 1988-2001) [22], have shown, that Starostambulsk branch system is in the condition of activization as a

whole . The sediment runoff in Starostambulsk, Bystryy and Zyganka branches has increased. In some places of Bystryy branch the processes of shores processing takes place. At the expense of the effluent accumulation islands (forelands) on the south from Bystryy and Starostambulsk branches (fig. 2.6) were formed. Dry territory has increased in the Tsyganskiy Kut bay and the area of Kuriles islands. Accumulation process of the bank line along all marine coast from Potapov branch to Starostambulsk branch is obscured. The analysis of snapshots has shown, that the tendency to the changes, described above, has a constant character within the period of not less than 30 years (fig. 2.7, 2.8).

The temperature of water in the surface layer of the beach has definitely seasonal course, being increased in July - August on the average up to 21-22°C (maximum is up to 26-27°C) and being dropped in December - February at an average up to 2-4°C (sometimes up to-0, 3 -0,4 ^{0}C). In summer the temperature of water in the surface layer is higher, than the temperature on the depth for 4-6°C (sometimes for 12°C). During the greatest heating in the layer of temperature curve its vertical gradients reach 3-5°C on 1 m of depth. Homothermia (the identical temperature on miscellaneous depths) is observed on the beach only in March - April and September - October [4].

The ice phenomena on the beach are not observed annually. The process of ice formation normally begins in December - January (for 2-4 days later, than in delta branches). The solder breadth in Zhebriyansk bay (to the north from delta) can reach 20-25 km, in other places of the beach - 10-15 km. In the second half of February the ice sheet starts to demolish. In March the beach is completely cleared of ice.

Main and ecologically the most important feature of the estuary beach regime is the dependence of water saltiness and the areas with the various degree of water desalination on the Danube effluent and wind regime [3, 23]. The surface layer of waters on the beach, where the saltiness of water can be changed from 4 up to 15-16 ‰, is the most subject to the effect of the effluent and wind to the grate extent. On the depths more than 8-10 m the saltiness of water in all seasons of year is usually more than 16 %.

By the recent researches [23] it is revealed, that the internal border of mixture zone of the river and seawaters in the surface layer on the estuary beach (isohaline of 2 ‰) is at an average of the distance of 0-4 km from the estuary branch depending on the phase of the river regime. The external border of mixture zone (≈16 ‰) is located at the distance of 3-

20 km from the marine delta margin in miscellaneous seasons. The increase of the Danube effluent widens a zone of water desalination, the reduction of the effluent narrows it; and it happens being late in time.

Winds of eastern rhumbs as a whole narrow a zone of water desalination in the surface layer, winds of western rhumbs widen it.

"Tongues" of desalted waters against the estuary of large branches are normally spread in the snowmelt flood to the distance up to 20 km. During significant snow melt flood or strong whipped wind the desalted waters in the surface layer can reach Zmeinyi island, located more than in 30 km from the marine delta margin , resulting in decrease of water saltiness up to 4-7 ‰ (at ordinary meanings of 14-16 ‰). At the same time at the interbranch plots seawaters with saltiness up to 10-12 ‰ approach marine delta margin.

2.6 Economic activities impact on the Danube delta formation and hydrophysical conditions.

Anthropogenous effect on the river bed evolutions of delta forming is traced from the end of the XIX century. [4]. For example, it is known, that at the end of the last century the tendency of Tulchin branch degradation, for the renewal of which hydrotechnical works on its rectification and deepening were conducted in 1880-1902, had been revealed. Before the First World War Russia performed similar works in Severnyy branch with the purpose of its usage for shipping industry. Thus a period of large-scale intervention to the natural regime of the Danube delta had begun. First of all, it was practically complete bilateral reinforcement of the riverbanks (from Renni to Vilkovo from the Ukrainian side practically completely and partially from Romanian, the islands including, with the subsequent involving inundated continental and island lands to the agriculture processes; to the branch of the Danube basins from the river system of locks and channels; replacement of natural anabranch for channels (Skunda, Rapida and other), clearing and deepening of the beds (Sulinsk branch), the intake and interception of water along the river, etc.

The reinforcement of shores, which, handicapping the water outlet on the wide bottomland, changes slopes, velocities, regime of inwashes movement, especially during the active forming of the channel (high waters, snow melt floods) and has great influence on the

delta forming. For example, in the range of 40-th km (Laptysh branch, now Mezhkolkhoznyy channel} the breadth of water flood reached up to at a passing of significant high waters in natural conditions 10 km. In the conditions of reinforcement the flow was concentrated in the basic channel up to 900 m of breadth, that had excluded a number of stabilizing capacities of great volume, which transformed freshet waves and essentially changed the water regime of the Danube delta from water exchange.

By 1971 the area of diked lands in the Romanian part of the delta has already reached 430 thousand hectares, in Ukrainian - more than 30 thousand hectares. The length of dams only in the Ukrainian territory along the Danube and delta branches has made up to 118 km, and from the Danube lakes side - 71 km, on the islands - 102 km.

The largest Danube lakes adhered to Kiliya delta and located in the territory of Ukraine days play the role of reservoirs, with which the irrigating areas about 73 thousand hectares are linked that correspond to the normative volume of drawoff of 250 million m^3. The actual area of irrigation and the volume of drawoff varies from year to year, but these meanings give the idea concerning the degree of delta water resources involving in the agriculture processes. In the delta the rich net of irrigating and drainage channels, where water goes by gravity, through locks or with the help of the pumps, is built. Lagoon Sasyk (to the north from delta) is railed off the sea and also converted into the reservoir for the Danube water; complete and useful volumes of this reservoir makes up accordingly to 0,53 and 0,235 km^3 [4].

In the beginning of XXth century the harbour area of Stentsovsko-Zhebriyansk fluxes stretches from Shevchenko village up to Primorsk village [24]. In the middle of the 30th the motorway Vilkovo-Primorsk had been built, and in the 50-60 the active assimilation of inundated lands with the reinforcement of separate plots began, which were then built up, occupied and actively involved in the crop rotation. For the prevention of periodic delugings of localities the protective lock lengthways Kiliya estuary and Solomon branch had been built. At the same time the Laptysh channel, which was the water-supply of the fluxes, had been graveled and the lock and the channel Mezhkolkhoznyy (1950), lock and the channel Tupikovyy (1974) are built instead of it, which have bridged Danube and SZhF in modern borders. In 1971 the channel Mezhkolkhoznyy has been continued by the Danube channel , which had crossed the bottomland up to the radical shore and had submitted the Danube

water up to the file of irrigating (Tatarbunar irrigating system), that had actually converted the basic rivers of the drainage basin of Nerushay and Drakulyu fluxes into the antirivers. Simultaneously northern border of fluxes also had been separated by the locks within the stripe message of the radical shore with the bowl of fluxes down up to Primorsk village. In the body of the lock of Vilkovo-Primorsk motorway, built in 30th, bridges in 70th have been replaced by locks - spillways and, thus, fluxes have been ultimately separated from the Danube and the Black sea and inhibited in modern borders. Their regime became to be completely under controle. These structures have decreased the SZhF area almost for 20 %. In the 70th the southern part of fluxes was separated by the Prapor and Gosleskhoz locks and occupied for I, II and III Liskovsk rice systems that has decreased the SZhF area by 30 %. Thus, prior to the beginning of 80th the general SZhF area was moderated in the comparison with the natural almost by 50 %. In 1980 the channel Danube – Sasyk was built, which crossed SZhF area and shared this area in Stentsovsk and Zhebriyansk parts, informed only through duker under the channel with the general area of cross section of 8 m^2, which is places at-sight the mouth of Murza river. Thus, the forming of not only modern bowl, but also the circuit of water flow in SZhF area had been finished.

In the natural regime fluxes ate the Danube water and the natural runoff of own drainage area. At the modern level of the development on water-producing SZhF area a number of irrigating systems, five reservoirs is placed, the water-producing net is converted into the collector-drain ways and submits to fluxes the mixture of natural runoff and collector-drainage waters. Contribution of the Danube water thus happens practically by the residual principle. Hydrodynamic regime of SZhF area has a number of differences from the regime Danube branches: the slowed down current of water, the big roughness of the channel because of the greenery development, availability of dead spaces in ranges, etc.

As the subject of anthropogenous effect fluxes are unique proceeding from the ratio magnitude of the anthropogenic load and the natural resources.

2.7. Conclusions to chapter 2.

1. Kiliya delta of the Danube river, in which ship way navigation channel passes, represents itself as a constantly changed system of branches and territories between them (islands), the large surface part of which is covered with water and is occupied with the fluxes. High velocity of delta evolution is linked to the big mass of the river sediment runoff.
2. The feature of EIS ship way navigation channel in Kiliya delta is that the continuous delta evolution and the consequent variability of hydrological and hydrophysical conditions renders determining effect on all natural and technogenic entities located within it.
3. The general direction of delta evolution is defined by the interaction of the river and the sea and revealed in the following phenomena and processes which permanently take place:

   - Advancement of changeable marine delta margin aside the sea;

   - Origin of the new and degradation of the old delta branches, change of their quantity and redistribution of the river flow between them;

   - Formation of the shallow-water plots of the beach - bars – in front of the branches mouths as a result of sedimentation and inwashes in a zone of river and flow interaction with the marine currents and heaving;

   - Change of the water regime of the islands territories in the direction of water exchange deceleration in fluxes, and lowerings of the water level during the process of degradation and reduction of the branches number.
4. The analysis of the Kiliya delta history shows, that its alluvial fan, basically, was formed at the beginning of the XXth century. Within the XXth century computed range-component increment of volume of the alluvial fan has made about 10 % of its volume, that allows to characterize the modern condition of Kiliya delta as a phase of relative dynamic equilibrium. As a whole the accumulative processes in delta and the processes of abrasion (capes and bars) compensate each other. Thus the alluvial fan almost completely consists of fluvial sediments.
5. Since the end of the XIXth century on the delta development escalating effect is rendered by anthropogenous factors, first of all – branches reinforcement reduced to the scale change of the water regime of branches and islands and laid the foundation of

agricultural assimilation of inundated continental and island territories. Anthropogenous intervention has amplified with the regulating and drain of some delta water-currents. So, on the water-producing area of Stentsovsko-Zhebriyansk fluxes a number of irrigating systems, five reservoirs is placed, the water-producing net is converted into the collector-drain ways and the mixture of own natural runoff and collector - drainage waters submits to fluxes. However even such large-scale technogenic effect has not resulted in significant changes of the basic laws of the delta development, though has seriously broken the water regime of some territories.

6. At the same time the effluent regulating on the overlying plots of the Danube river has resulted in the consecutive reduction of hard inwashes effluent during the last several decades without reduction of a mid-annual aqueous runoff of the river. This phenomenon measurably inhibits the process of branch siltage and can be considered as the positive factor for the creation of ship way navigation channel.
7. If the present tendency of sediment runoff reduction in the Danube river will be preserved hereinafter, then on the background of the predicted rising of the sea level and growth of the relative role of marine heaving the Kiliya delta can change the tendency of the development further on and proceed in the delta type, which is formed in the conditions of marine factors prevailing.
8. Together with evolutionary changes in delta there is also a number of periodically repeating processes takes place, themost important major of which are the whipped-fetched phenomena in the estuary zone, inside and interannual changes of flow intensity and hard inwashes in the Danube river. These processes cause the fluctuatings of water levels in the branches and fluxes, and also deformations of the bottom and of water-currents shores.
9. The technogenic effects of construction and ship way navigation channel operation will happen on the background of the determining effects of the above-stated natural processes, strengthening or weakening some of them.
10. According to the analysis of delta hydrodynamic conditions in the area of the approved variant of the ship way navigation channel line it follows, that for its creation the positive factors of environment are:

- the slowest promotion of marine delta margin in comparison with the other plots in the estuary area of Bystryy branch;
- constantly increasing share of the river flow of Kiliya delta, passing through Bystryy branch;
- carrying out of the great bulk of inwashes effluent from Bystryy branch outward the beach (though this factor is not stable: for the last years the process of bar prolongation in front of the branch and its advancement in the sea with the simultaneous development of the right-bank foreland, which has received the name of Ptichya) became more active;
- rather fast ascending depths of water behind the bar area .

3 General description of entities of designing and economic activities in the impact zones

3.1 Necessity of creation of deep water navigation passage in the territory of the Ukrainian part of the Danube delta

The Danube river that streaming within the territories of Germany, Austria, Slovakia, Hungary, Yugoslavia, Bulgaria, Romania, Moldova and Ukraine is the major transport way of the Central and Western Europe. 15 countries of Europe have connection with the Danube as with a transport artery. Due to acting channels such as the Danube – Main – Rhein – North sea – Oder - Elba - Baltic sea and the Danube – the Black sea practically all the river ports of Central and East Europe have a direct outlet in the seas of Atlantic ocean, the Black sea including. Channels which will bridge Danube with Adriatic and Aegean seas are projected and built.

Countries of European Economic Community are looking for the ways of transportation of cargoes to the Asian region and back, trying to form transport corridors (the Black and Caspian seas including) in which the significant part of the cargoes can be shifted on a water transport being the cheapest method of transportation of goods.

Tulchinsk, Sulinsk and Georgievsk branches of the Danube belong to Romania now, as well as the monopoly of the dropout of vessels to the Danube-Black sea part on shipping lines.

During the XIX-XXth centuries Romania had created the base for organization of the ship course line:

- Sulinsk channel is an artificial international navigation channel, the width of ship pass - 60 m fit for the passing of ocean vessels and the vessels of mixed river-sea floating;
- Channel Chernavode - Constanta - South with two locks, width at the bottom is 80 m;
- Channel Medzhiya - Novodari port , links Novodari port with Chernovode - Constanta channel at the area of Medzhiya port;
- Georgiyevo narrow strait straightening is carried out additionally (tab. 3.1).

Having introduced the Chernovode channel with Medzhiya-Novodari take-off (an estimated value about two billions of US dollars), into operation in 1986 Romania had intercepted a flow of cargoes at the Danube river (passing draft up to 2,5 м) - Black sea.

Table 3.1 - Ship courses acting within the territory of Romania

Names of channels	Date of inlet, km	Extension	Depth
Sulinsk	1858	79,6	7,30
Chernovode-Konstantse	1984	64,2	7,0
Medzhiya-Novodari	1988	26	
Georgiyevsk narrow strait		121,6	–

At present Ukraine has no deep water outlet to the Black sea of its own though it possesses the deepest Kiliya branch of the Danube river. The large Ukrainian sea ports are located there. They are Reni and Izmail, as well as Kiliya and Vilkovo. Prosperity of all Pridunaysk region directly depends upon efficiency.

The ship passage through Ochakov branch, Prorva and the connecting channel existing now in Ukraine which provide the passage of vessels with draft up to 2,5 m, is continuously being soiled, and the operational volumes of dredging works are constantly increasing.

Sharp shortening of cargo-passenger flows of the Ukrainian ports (Reni, Izmail, Kiliya, Vilkovo and Ust-Danube), high channel dues for passing of vessels of Sulinsk narrow strait have such a result that cargo processing, ship-building and ship-repair works were practically stopped. Consequently, the deductions to the social needs were sharply reduced. The reduction of work places, overprofiling of the highly skilled staff and worsening of social-economic situation of the population leads to the socio-economic decrease in the region.

The creation of the deep water ship course of its own for Ukraine is considered now as one of the most urgent problems of geopolitic and economic significance without the decision of which Ukraine will finally lose one of the branches of the transport corridor, and the shipping line of the Danube with the Black sea will be completely monopolized by Romania. Such a situation is leaded to the large economic losses not only for Ukraine, but also for the countries of Europe, first of all for the Danube ones.

Taking into account the geopolitic key position of Ukraine in the Euroasian region at the crossing of the shortest transport ways, the government has ratified the program of creation and functioning of the national connection lines of international transport corridors.

In relation to the water transport fundamental principle that all marine and river ports of Ukraine are the part of the international transport system and connected with the nearest transport corridors directly or through the radial courses is taken as the basis of the program.

МКТ №7 (Rhein - Main - Danube), that includes Izmail, Reni, Ust-Danube ports is the priority passage having connection with the ports in which it is necessary to create the specialized fundamental water transport-warehouse complexes (TWC) – terminals. Availability of such a high-power water-way as Kiliya branch is the presupposition for creation of the ship course line connected with this corridor of the ship passage at the Ukrainian part of the Danube delta with the guaranteed depths of the vessels outlet to the sea.

The international community is interested in realization of the considered transport lines. Their interest is dictated, first of all, by the economic reasons which are caused by the reduction of the cargoes delivery way from Europe to the countries of the Middle East, Northern Africa and back.

For Ukraine the deep water ship course (DWSC) line creation in the strategic relation will cause the increase of military, fuel energy, trade-economic independence.

In the social-economic aspect the creation of DWSC will allow to ensure the employment of the population of the region and to raise its standard of living.

In economic aspect the creation of Ukrainian DWSC will violate the monopoly of Romania at the Danube waterways, and, accordingly, it will cause the reduction of cost of ship passage through the Danube.

Ukraine can gain the greatest economic advantage by engaging of transit cargo (freight) flows - as it had been already done in recent times by a number of countries of the Central and Northern Europe.

For the definition of the supposed size of ship flow according to the order of "Delta - pilot" state enterprise, the adviser of joint venture " Tikon " - has carried out an audit-marketing investigation, an expert estimation of the basic strong and weak aspects of the future DWSC including in comparison with the such ones of the competitors. For the definition of competitiveness of the undertaking the experienced authoritative experts had been involved. As a result of the analysis the forecast estimation of the market share which can be developed was given: as for native shipowners - 81 %, foreign shipowners - 65 %.

The market analysis has shown, that the average quantity of ship passages per a year across Tulchinsk channel after Yugoslavian bridges breaking down has made up to 850 ship passes, native shipowners make up about 13 % of it.

Thus, forecast quantity of ship passages through the projected channel at present base will make:

а) for native shipowners 850x0,13x0,81=89 ship passages,

б) for foreign shipowners 850x0,87x0,65=480 ship passages.

In total: 89+480=569 ship passages.

After the reconstruction of Yugoslavian bridges (2004-2010) the quantity of ship passages can be restored up to the meaning of the 80th years - 1100-1700 two-way ship passages.

In the table 3.2 are given the forecast data concerning the quantity of two-way ship passes, as well as the real quantity of the other kinds of services - pilotage and RSVM (regulation service of vessels movement).

Table 3.2 - Physical volume of services (quantity of units)

	2003 year	2004 year	2005 year	2006 year	2007 year	2008 year	2009 year	2010 year	2011 year	2012 year
Services of RSVM – oversea floating	379	492	596	718	841	955	1051	1149	1246	1343
Services of RSVM - coastal shipping	70	91	110	133	156	177	195	213	231	249
Ship pass (channel dues) - native shipowners	70	91	110	133	156	177	195	213	231	249
Ship pass (channel dues) - foreign shipowners	379	492	596	718	841	955	1051	1149	1246	1343
Pilotage services (dues) - up to Reni - oversea floating	379	492	596	718	841	955	1051	1149	1246	1343
Pilotage services (dues) - up to Reni - coastal shipping	48	63	76	92	107	122	134	147	159	172
Pilotage services (dues) - up to Izmail coastal shipping	22	28	34	41	48	55	60	66	71	77

3.2 The choice substantiation of the ship navigation passage

Searches of ways of shipping conditions improvement in the Danube mouth have begun in the middle of XIX century mostly in connection with the international transitional shipping industry. Various variants had been submitted: deepening of shallow-water delta bars, branches rectification, structure of sluiced spreaders from the branches, etc. [3, 4, 1025].

According to the Parisian Agreements in 1856 the Danube had been declared as the river free for international navigation [26], and hereinafter the European Danube Commission had been framed (EDC) with the purpose of normalizing of navigation (shipping) in the Danube delta under aegis of England and France. The estuary sea bars, the depths above which seldom exceeded 2-2,5 m were considered as the main obstacle for shipping development .

The work management was entrusted to English engineer Gartley. Georgiyev and Sulinsk branches had been investigated substantially; the projects of usage of Kiliya delta branches were put aside without explanations.

In spring of 1858 Gartley has offered to EDC two variants of marine shipping navigation provision: formation of deep water outlets through the mouth of Georgiyev and Sulinsk branches, preferring Georgiyev branch. The principle of estuary river reinforcement and advancement of two parallel dams into the sea for an isobathic line of 5,5 meters and deeper had been put as the basic ones. One of the basic demands to the dam arrangement was the following: the distance between the dams should be equal or smaller than the breadths of shipping branch in the plots with the depth, approaching or exceeding the project depth of the flow compressed by the dams. In the process of new bar formation it was supposed to extend the dams.

In 1858 the Technical Commission, consisting of the recognized experts from different countries, having expressed basically for Georgiyev branch, had made the conclusion that the construction of pair moles in the estuary of the large river, running into the tideless sea, was not capable to suspend the fluvial sediments carrying out into the sea and bar formation at the outlet from the dams, and the only way, which could cardinally decide the problem, was the construction of self-supporting lock channel away from the

existing mouth. Engineer Gartley had started the project of the channel development with the lock for Georgiyev branch.

At this time the attempt to dig through the shipping well boat in the delta bar of Sulinsk branch had been undertaken. The well boat worked before the first serious storm after which nothing was left from it. Therefore, with the purpose of the prompt providing of the interests of shipping industry suffering heavy losses, EDC had decided to start to fulfill the original project of Gartley for the temporary (for 5-6 years) arrangement of Sulinsk estuary with two cheap dams with the increase of the depths on the bar up to 4,0-4,5 m.

Construction of the temporary dams had been completed on September 3, 1861. The depth above the bar had been increased from 2,9 up to 5,3 m only at the expense of washout by its river flow. Taking into account such a reassuring result and considering the disagreements of the experts concerning Georgiyev branch, EDC in 1865 had made the decision on transformation of the temporary dams in to the permanent ones dams and on providing of navigation on Sulinsk branch. Works on rectification and deepening of Sulinsk branch had been simultaneously begun, and one of the first measures was the dam construction in the headstream of Tulchinsk branch with the purpose to intercept Kiliya branch part of the effluent and correspondingly increase Georgiyev and Sulinsk branches liquid water content.

In 1878, after the end of war, the border between Russia and Romania had passed along the Prut river and Kiliya branch, and Russia demanded to repair the natural hydrological conditions of Kiliya branch therefore the dam in the headstream of Tulchinsk branch had been partially destroyed.

Since the end of XIX century, Russia undertook similar practical steps for the creation of its own inlet to the Danube through one of the estuaries, pertaining to it. In Kiliya branch the attempts of Polunochnyy, Potapovskiu and Prorva branches bars deepening were undertaken.

The channel in the estuary of Polunochnyy branch was being built under the project of engineer Rummel, at the development of which the recommendations formulated by Gartley in 1889, had been taken in to account. It was supposed to deepen the estuary up to 4,8 m with the breadth the bottom of 62 m, however the officers of high rank, who led the building works decided to "rationalize" the project. The works begun on June, 1900 and had

been completed at the end of October of the same year. The channel had the length of 1 km at the breadth of the bottom of 44 m and the depth of 2,7 m. During its construction 70000 m^3 of the ground had been excavated. The double moles and channel straightening structures had not been raised. Blocking (covering) of the channel intensely began therefore in 1901 it was offered to deepen and widen it. These works had not been carried out. Such deviation from the original project had sharply shorten the duration and the cost of the channel construction, but had stipulated a fast lay-up because of the intense alluviation in Zhebriyansk bay in front of its outlet.

In 1904 after the execution of three-year detailed investigations from city Kiliya up to the estuary beach an engineer Chekhovich had offered the project of the lock channel from Solomonov (Stepovoy) branch to Zhebriyansk bay [25] forasmuch as in the beginning of the channel construction in Polunochnnyy estuary he predicted its prompt ruin. The channel, offered by Chekhovich, had two turns and was laid on dense soils of the basic shore. The channel line of Chekhovich was scheduled at the place where the main channel of the unfinished system " Danube - Dnepr " is built now, and in front of the inlet to Zhebriyansk bay the construction of lock with the length of 140 m, breadth of 18 m and depth of 7 m, as well as the building of the estuary port had been planned. Carrying out the vessels through the channel was assumed by tow of electric locomotives for which the rails were laid.

In 1918 the channel in the estuary of Ochakov branch was dug under the command of admiral Potapov. This channel, as well as the channel in the estuary of Polunochnyy branch, died off swiftly.

Based on the experience of shipping lines construction and operation in Sulinsk, Ochakov, Polunochnyy branches the Romanian engineer Nikolau Pomniliu in 1938 had offered the design of the channel construction, connecting the Danube river (checkpoint of the draft up to 2,5 м) near Chernavode port with the sea near Konstantsa port. This channel was basically a repetition of the engineering decision of V.P.CHEKHOVICH project. They began to build the channel at the end of 50th years and after 30 years it was ready for operation. In its mouth the construction of Konstantsa - Yug port for the transshipment of cargoes from the riverboats in to the ships and backward began and proceeds now.

In 1957 in the mouth of Prorva branch the experimental shipping mortise was formed, which passes over the vessels of the "river - sea" type - Ochakov and Kiliya branches. СДП

vessels and other shipping companies of the Soviet Union with the draught of 3,5-4,0 m used this ship course, passing through the territory of the former USSR.

The volumes of repair bottom recession works, which makes up to 150-200 thousand m^3 of the ground annually in the first years of the channel Prorva exploitation, rapidly increased and in the middle of 80th years had increased in 20 times, thus the bottom recession works were carried out during the whole year. In 1994 the channel had ceased to function; in 1997 it was recovered partially, and in 2 months the depth on bar parts of the channel has already been decreased up to 1,2 m.

In 70th years in the mouth of the died off Shabash estuary in the southern coast of Zhebriyansk bay the base for processing of the vessels - lighter carriers, renamed in Ust-Dunaisk port later on, had been built. For the communication providing of the harbour area with the Danube to Prorva estuary the temporary technological connecting channel with the breadth at the top about 20 m and in the depth of 2,5-3,0 m was dug. After introduction to work of the base of lighter carriers it should be filled up. This condition had not been carried out from it, and the channel had turned to be the deep branch with the breadth of 80-100 m and the prevailing depths about 4 m. On this channel in harbour area and further to Zhebriyansk bay about 4 million tons of inwashes arrives annually. Forasmuch as the inwashes, which have got in to this bay, are not carried out from it, the bay becomes shoal.

Since 1977 the navigation in Ochakov branch is carried out exclusively through the connecting channel, where passing of vessels with the draught up to 2.5 m is ensured at the permanent use of earthy packet. The navigation in Ochakov branch is complicated with rifts. Reduction of the depth or breadths of a ship course on these plots periodically leads to the line closing.

In 1989 according to the order of the Danube Shipping Company the institute of «Chernomorniiproekt» had developed the Feasibility Report of the channel construction with the locks, as the alternative to Prorva channel, which was at the end of its resource. The lock channel should ensure perspective total vessel rotation in the way Danube – the Black sea and Ust-Dunaisk port. The Feasibility Report had been agreed and approved by all official institutions, the Ministry of the Environment and Natural Resources Protection of Ukraine including. The objective necessity of this work performance had been caused by such important parameters, as the ports gross ton-kilometer hauled of the Danube shipping

company, which reached 26,0 million tons, and vessel rotation of Prorva channel in the way the river – the sea - 10,0 thousand units annually [27].

The line of this channel passed from Ochakov branch to Ust-Dunaysk harbour area. According to the basic technological-economic parameters, rated vessels flow should make 19-21 thousand vessels annually. The extent of the channel- 4,3 km, project depth - 7,5 m, breadth - 140,0 m, lock dimensions in the plan - 300x37 m. The supposed cost of the construction amounts to 60 million US dollars.

In 1995 " Chernomorniiproekt" Institute had executed technological-economic calculation of the various variants of the present ship course preservation through Ochakov estuary and Prorva channel with bringing its parameters up to the channel parameters in Sulinsk estuary, the secured depth of 7,2 m including. Significant vested interests for the construction of ship outlet lock complex, shore reinforcement, as well as for the single (about 18 million m^3 of the ground) and annual operational (from 2,5 up to 3 million m^3 of the ground) bottom recession works were defined . The sizes of the costs for the works done at the transportation of the ground to the projected near marine waste tip amounted to 48,3 million US dollars, and to the present long-distance marine waste tip - up to 60 million US dollars. The term of the construction was supposed to be 5 years [27, 28].

In 1996 PKF "Proektgidrostroy" made a proposition about the construction of the lock channel connecting shipping Solomon branch with the sea away from the natural mouth of this branch. According to the authors plan [29] the channel should pass above Vilkovo and bridge Solomonov (Stepovoy) branch of the internal Kiliya delta branch, stabilized long ago, with Zhebriyansk bay. The line of the channel should be laid on the deck edge of the sand wave called “ Vilkovo kuchugury ”.

The objects (sites) of the channel are protective heel of the masts, accumulating and settling pools, single-chamber lock, full profiled channel, protective dam, marine channel and the anchor berth in Zhebriyansk bay - should ensure fail-safe round-the-clock movement of transportation means (with the draught of 7,5 м). At the construction the usage of part of the developed ground was provided. The construction of the channel provides caravan method of vessels passing on the ship course at vessels quantity (maximum meanings) in the caravan up to ten units. The time for one caravan passing is about 4 hours. Hereafter the velocity can be increased for 35-40 %.

The most wasteful part at the construction of the channel is earthmoving the total amount of which had been estimated in 16 million m^3 of the ground. To the authors' opinion [29], the large part of the works for the construction can be executed by dry method, namely before filling the channel up with water. Thus the part of the evacuated ground will be used for the territories reinforcement along the shores of the channel, the other (about 6 million m^3 of qualitative building sand) - can be sold and only a small part of the ground will be removed to the marine waste tips. The supposed volume of scoop repair works makes up to 200-300 thousand m^3 / year.

According to [29] the general term from the beginning of surveys carrying out and up to the end of the construction will make about five years at stable financing. The total cost of construction of the site (disregarding the cost of design and exploration works, copyrights, lease of land, will amount to 60 million US dollars compensation to the nature protection organizations, costs of pilotage service).

The authors point out the following advantages of the offered variant of tracing and arrangement of the channel:

- Channel parameters are fully comply with the demands of the Danube commission and ensure normal navigation with track capacity up to 12500 vessels annually (with the opportunity of increase up to 18000);
- The line of the channel is laid outside the area of outstanding natural beauty along the unused infertile lands, in the grounds with a good bearing strength;
- Damping is practically excluded at creation of the passage along this line and the part of the evacuated ground (sand) is used the project material;
- The inlet to the channel on the part of the Black sea is supposed to be within the northwest part of Zhebriyansk bay with the stable depths, which are not the subjects of intense chokness (blocking up);
- The outlet to the Danube river is supposed to be above Vilkovo rift on the plot with stable depths of the river, with convenient ship fairways and shunting zone on Kiliya estuary and Solomonov branch interface;
- Creation of a passage at the stable plot of the river in sandy bottoms ensures durability of the structures and does not complicate a supply of communication lines;

- Protecting heel of the masts, provided in the composition of the channel, as well as the rotary locks, decrease the blocking up of the channel and the adjoining harbour area of Zhebriyansk bay.

In the last few years the problem of the reconstruction of navigation on Starombulsriy branch of the Danube had been investigated. Till June, 1941 it was the basic shipping one and on which it was possible to support steadily depths in 7,2 m. Romania, being involved in the war at the German fascist part, was afraid of intrusion of Dnepr military flotilia to the Danube. Therefore the channel on the marine bar was heaped with boxes of stones, then the northern winds and currents which had covered a bar with sands had finished the process. Since then Starostambul branch became non-navigable [30].

Since 1991 the problems of assimilation of a new fairway along Starostambul branch had been investigated by " Rechtransproekt " Kiev institute . In the performance of the order of vice-premier V. Durdinets the National Agency of Marine Researches and Technologies had concluded the agreement with " Rechtransproekt " Institute on performance of the Feasibility Report of arrangement of navigation along Starostambul branch of the Danube in the summer of 1997. As the carried out measurements of depths from settlement Vilkovo up to an outlet to the sea and engineering - geological works on a marine bar revealed the depths more than 7,5 m were preserved along all part from Vilkovo up to a marine bar. Near the stone heap, overlapping the channel of Starostambul branch at the beginning of a marine bar, the eddy waters and the depths not less than 7,5-8,0 m are observed along the length of a marine bar (7 kms) at a part of 4,5 kms the depth made up less than 5 m and at a part of 1,35 kms. - from 2 up to 3 m. Rocky breeds on a bar during the engineering-geological works had not been observed.

According to the design studies carried out for " Rechtransproekt " Institute at the development of a marine bar at Starostambul branch and the construction of the streamdirecting dams at it which will cause an increase of the current speed the steady depths at all Starostambul branch can be supported by the annual dredging works with the volume up to 500000 m3; for the creation along Starostambul branch of the alternative to Sulinsk ship passage it is required to spend up to 19-19,5 million US dollars, the construction works will take two years.

One of the alternative variant is the creation of deep water ship course with an inlet to the sea from Starostambul branch along Tsuganka branch.

If the navigation at Starostambul branch will be recovered a transit port similar to Ust-Danube on the approach to a marine bar hereafter will be required. Propositions to create it had been already done. For this purpose it is necessary with earth packets to develop a mid-ocean channel (its length is in 3-4 times shorter, than to Ust-Danube port), harbour area and to arrange it with the means of navigation protection.

There are the supporters of the idea of a renewal of navigation along Ochakov branch with preservation of Ust-Danube port. The variant of construction of the channel from Ochakov narrow strait to Prorva channel at an outlet to the sea has been introduced in publication by V.TARAN the director of Institute " ChernomorNIIproekt " and chief engineer O.SOLDATENKO [31]. At the first stage (one year) the performance of bottomdeepen works on finishing depth of ship course up to 5,0 m is provided at the breadth not less than 80 m at Prorva channel and a part of ship course adjoining it. The cost of works amounts to 2086,0 thousand dollars. At the second stage, the other works excluding, it is planned to execute bottomdeepening of Prorva channel from the 3-rd km up to a mouth up to the depth of 7,55 m and widening of a bottom up to 95,0 m. The cost of works for four years amounts to 13156,0 thousand dollars.

In 2001 in accordance with the Protocol of the meeting at the First vice-premier of the minister of Ukraine of 01.12.2000 and the Order of Ministry of Transport of Ukraine No. 710 of 15.12.2000 the research institute " Rechtransproekt " had worked out the Feasibility Report of investments for the “ Creation of deep water ship course the Danube - the Black sea at the Ukrainian part of delta ” [32] in which a variant SWNC for Bystryy branch had been investigated and recognized as preferable for the first time.

During investments Feasibility Report elaboration the comparison of 8 variants of problem decision of navigation organization at Ukrainian part of Danube delta taking to account their basic project parameters (tab. 3.3) had been made and their basic advantages and lacks (tab. 3.4) had been pointed out.

The variants of building of the ship course the Danube - the Black sea are introduced with the fig. 3.1 and 3.2 under the numbers corresponding to the numbers in tab. 3.3 and 3.4.

Except them in fig. 3.1 number 9 the variant of a ship line course, offered by the State Hydrological Institute is introduced. This line consisting of 7 bends, passes through the straightened Ochakov branch, leaves for a shallow-water near-shore area, and then, after turn in the opposite direction, crosses the territory of islands Prorvinsk and Shabash, Prorva branch (subject to overlapping) and coinsides with the acting marine approach channel to Ust-Danube port. Extent of a line is 12,34 kms, breadth of ship course of 140 m, the depth of it - 7,5 m, the volume of bottomdeepening works makes up more than 20 million m3. Ecology-economic estimation, carried out by a team of experts in 1990[33], has shown, that this variant essentially loses in comparison with the variant of a lock channel construction from Ochakov branch to the harbour area of Ust-Danube.

At number 10 in the figure one of the variant of a line of lock channel - Solomonov branch – Sasyk lake is introduced. This line, as well as a variant of Solomonov branch is Zhebriyansk cove, crosses plavni (reed beds)* of Stentsovsko-Zhebriyansk, however its effect on flora and fauna can be smaller because of crossing of plavni takes place on relatively less valuable plot of reserved territory along the existing watersupply Danube-Sasyk channel (that allows to avoid the additional separation of plavni and to reduce the size of allotment areas (sites) assigned for the building works execution). At crossing of the Sasyk lake the channel and harbour area cut off by it is supposed to be protected with the dam with the purpose of preservation of a present water regime of the lake and hereinafter to use for the organization of a sea port. At the dividing braid within an outlet of the channel to the Black sea the construction of a lock is provided. Technological-economic parameters of the given variant yield to the variant of Solomonov branch - Zhebriyansk cove [34].

** dense reeds bushes near the banks of the river*

The comparison of the listed versions was difficult because of the fact that the design development works were carried out by different organizations and at different time. The attention was directed towards the passage of the vessels with different overall dimensions

(including draft). The series of the designs did not take into consideration the works in the area of the branch Kiliya. Because of it both the scores and the cost parameters, presented by the developers, are placed in the table 3.3 as well as the reduced expenditures and efforts, considering all the length of the navigable channel up to the border with Romania.

The analysis of the versions, placed in the tables has shown the following.

All the designed versions of the navigable channels' trucks include the plot of the Danube riverbed and its branch Kiliya from the port of Reni up to the port of Kiliya and also both completely or partially the area of the channel between the port of Kiliya and the port of Vilkovo.

By the nature of the tracks outside the listed areas all the versions can compose two groups:

- The A-group versions, providing the usage of natural branches of the active area of the delta;
- The B-group versions, providing creation of the artificial channels with sluices.

The A-group includes the versions No. 2, 4, 5, 6, 7, 8, and 9. The B-group includes the versions No. 1, 3, and 10. The No. 2 version, with the small area passing through the existing artificial connective channel, is referred to the A-group version because there are no sluices on the track. Therefore this track is not protected from drifts.

The choice of the most perspective variant from every group for the detailed comparison, fulfilled in the Evaluation of the Environment Impact in the Feasibility Study of the investments [2] was made on the ground of the complex of the technical and economical criteria.

The track version selected from the A-group referring to the branch Bystryy (No. 6) corresponds to the following criteria:

- The dredging volume in the operational period is one of the smallest;
- From the number of the choices with the similar operational dredging volumes is the one with the minimal volume during the period of building;
- The competitive value of the construction.

The favourable hydrological conditions for the building of the navigable channel by the following version were taken into consideration additionally (table 3.4):

- The little-meandered riverbed with sufficient natural depths;

– The relatively small velocity of the delta movement forward in the area of the maritime border adjoined to the branch mouth.

In accordance with the data of the table 3.3 the versions No. 2 and 4 surpass the chosen version (No. 6) for the reason of the complex of the listed facts. But the data of the versions No. 2 and 4 correspond to the significantly smaller vessel molded draft (3 and 4.5 m, accordingly) in comparison with the version No. 6 (7.2 m). In case of the acceptance for these versions of the molded draught of 7.2 m their technical and economic indices will be significantly worse than the version No. 6. In this way the version No.5, intended for a vessel with the draught of 6.3 m, the track of which coincides with the one by the version No. 4, now provides the excavation volume during the construction period which is five times higher than the one by the choice No.6, and the volume of the operational excavation, which is three times higher than the one by the version No.6.

The versions of the B-group by the criteria of the building cost and the excavation volumes during the construction period are worse if compared with the A-group versions.

The principal B-group advantage is the possibility to take out the navigable channel track completely or partially from the delta active part. This will allow the usage of the navigable channel track fully or partially during longer time and with more stable volumes of operational dredging than by the version of the B-group because of the delta development mechanism.

Inside the B-group the preference is given to the No. 1 version because by the No. 3 version the navigable channel upstream the channel in the active area of the delta comes through the disappearing system of the Ochakov branches (table 3.4). The version No.10 would be competitive in relation with No. 1 choice, but this variant was not considered within the feasibility study.

On the basis of the analysis of the environment impact of the selected alternative versions of the deep-sea navigation channel, which was carried out in the technical and economic assessment, it was ascertained that the major part of the influence processes forecasted in the period of construction and exploitation are directly or indirectly, determined by the volume of the extracted ground and by the area of the allotted land. The quantitative comparison of this key indices have unambiguously testified the advantage of the track through the Bystryy branch in comparison with the version of the lock channel

through the Solomonov branch – Zhebriyanovskaya bay (the version No. 1). In the different sectors of the branch from Vilkovo up to the delta coastline, which are located on the territory of the Danube Biosphere Reserve, the proportion of the excavation volume is 1:50, and the proportion of the areas of the land allotment is – 1:135 in favour of No. 2 version. The fulfillment of No. 1 version will result in the loss of more than 500 hectares of useful areas, which form the part of the buffer area and the area of anthropogenic landscapes of the Danube Biosphere Reserve. In accordance with the Environment Impact Evaluation criteria the building of the lock channel was defined as inadmissible, especially as the series of the other navigable channel tracks' versions, listed in the tables 3.3 and 3.4 provided the greatly less interference into the reserve's landscapes.

In case of the comparison of the versions impact on the separate components of the environment, there were made the following conclusions.

The principal negative consequences of the fulfilling of the version Solomonov branch – Zhebriyanovskaya bay, concerning surface water, subterranean water and sea-water are the following:

- The scale change of the water conditions on the territory of the Zhebriyanovskaya spit and flooded areas Zhebriyanovskaya plavni.
- The creation of the artificial water body with unstable and unbalanced processes of the water quality formation, which would have a negative influence upon the processes within the basin of the Zhebriyanovskaya bay.
- The water quality deterioration in the Zhebriyanovskaya bay as the result of the channel dredging during the construction and in operational period.
- The pollution of the water area and of the ground of the Black Sea in the region of the sea dump.

The track of the navigable passage " Bystryy Branch " runs along the natural river-bed and, for the organization of the navigation in the areas, which have never been used for this purpose, it requires much less intervention into the environment, including the aquatic one. The principal negative influence in this version would be due to the works connected with the deepening of the sand-bar of the Bystryy branch. At that the negative consequences for the forming of the water in the branch as well as in the area of the sand-bar would be possible. Considering the wide flowage of the branch and the water exchange in the adjacent

water area of the seashore the alterations concerning the water quality will be not so expressed as in the case of the fulfillment of the alternative version in the Zhebriyanovskaya Bay. Because of smaller volume of the excavation and ground storing the pollution of the water area and of the ground of the Black Sea in the zone of the sea dump during the fulfillment of the version " Bystryy Branch " is considered to be smaller too.

The opening of the sand-bar of the Bystryy branch would entail the flow off redistribution in the Kiliya delta; this is impossible in the case of the version the Solomonov branch – the Zhebriyanovskaya bay. However in the source of the branch it is provided for the hydro engineering structures construction, which are capable to make the processes adjustable and will not allow the rise of the negative consequences of the water conditions in the delta. The amount of the influence on the water environment was the reason to recognize the " Bystryy Branch " version as the preferable one**.**

Concerning the comparative analysis of the influence of the two selected versions of the track on the plant and animal kingdom, it was taken into consideration that in conformity with the biologists estimates [9] the territories in the area of the tracks were recognized as equal. At the same time in the Environment Impact Evaluation, elaborated by the UkrNIIEP [2], it was concluded that the scale of the influence, concerning the plant and animal life of the "Branch Solomonov – Zhebriyanovskaya bay " is worse than the " Bystryy branch ” version, because the area of the direct influence on the territory of the flooded area in the first version is considerably higher in comparison with the second variant. The exclusion is the water fauna. Concerning it the negative consequences of the fulfillment of the both versions were recognized as equal in general.

Considering the fact that the creation of the lock channel will cause the fragmentation of the flooded areas Zhebriyanovskaya plavni, and it will have considerable and irreversible influence on the water regime of the adjacent reserve territories and, finally it will result in degradation of the biocenoses in the areas, which much more exceed the territories, provided for the construction, the version " Solomonov Branch – Zhebriyanovskaya bay " was recognized as unacceptable from the standpoint of the protection of the reserve’s plant and animal life [2].

In this way the version of the Deep-Water Navigation Passage, providing for the passage of the track along the Bystryy branch, considering the complex of ecological

criteria, was accepted as preferable, though in the Environment Impact Evaluation of the feasibility study has been recognized that the fulfillment of the each variant would be impossible without the decision on the State level of the problem, concerning the ways of the projected economical activity on the territory of the Danube Biosphere Reserve, which would not contradict the environmental regulations.

In 2003 some steps were taken in this direction (see the chapter 1 of the Environment Impact Evaluation). As the result now the proposals about the scientifically grounded zoning of the territory of the Danube Biosphere Reserve with allocation of the water area of the Bystryy branch and the adjacent riversides to the zone of the anthropogenic landscapes.

3.3 The characteristic of the project design concerning the creation of the deep-water navigation passage (DWNP)

The type and the class of the projected deep-water navigable passage was defined as the alternative to the navigable channel through the mouth Sulinsk gyrlo, which is referred to the VII class of the inner water ways of the «E» - category.

In this way the DWNP has the following characteristics:

- The type of the waterways – of the international importance;
- The class of the waterway – super main waterway in accordance with the rules of State Standard of Ukraine DSTU B V 2.3-1-95;
- The VII class – in accordance with the European classification of the waterways.

The area of the main river-bed of the Danube (Izmail Chatal - Reni), which is the part of the projected DWNP, was referred to the higher, the VII class of the waterways of the “E”-category.

The working draft provides the creation of the navigational channel on the first phase , which will guarantee the passage of the vessels with the draught of 5.85 m and with the following dimensions of the taken into account ship: L=125 m; B=17 m; T=5.85 m.

The complex of the first phase works provides the following:

- The creation of the sea entrance channel and plot of the levee on the sand bar;
- The construction of the river-bed part of the navigable channel divided by convention into the following sectors:
- The Sea - Vilkovo;

- Vilkovo - Izmail Chatal (the source of the Kiliya branch);
- Izmail Chatal - Reni (the table 3.5).

Table 3.3 - Comparison of the analyzed alternatives of creation the navigation of the Danube channel - the Black sea in the Ukrainian part of delta

No	Alternatives of navigation organization	Rated draft of a ship, m	The length of the single-direction navigation channel, km	The construction value, million US dollars		Earth excavation, million m^3/year		Operational dredging volume (due to silting) million m^3/year		Requisition of the Danube Biosphere Reserve territories, hectares: constant temporary	Recoupment of capital investment, years	Notes
				By the developers data	By comparable volumes	By the developers data	Including channel	By the developers data	Including channel			
1.	The lock channel: Solomonov branch – Zhebriyanovskay bay	7.2	18.0	57	110*	16	22.5	0.3	0.3+0.80 = **1.1**	400 500	30	PKF "Proyekt-gydro-stroy" 1997
2.	Ust-Dunaysk port– connecting channel – Prorva branch **	3.0	18.0	2.5	2.5	1.2	1.2	1.2	1.2+0.95 = **2.15**	Data are absent	-	ChNIIP, archive No. 614-41
3.	Lock channel from Ochakov branch to port Ust-Dunaysk water area	6.25	-	40	69 *	7	10.8	0.6	0.6+0.95 = **1.55**	~ 150 100	20	ChNIIP, archive No. 3852, restricted

* The construction value is presented in the letter of "ChernomorNIIproyekt", PP5-4/45 of 09.01.02 including the cost of works in the bed of the channel (million US dollars). The cost of the requisition of the Danube Biosphere Reserve territories is not included in the construction value.

** The opportunity of construction of a deep-sea navigation channel without additional, not calculated by the developers charges, which exceed the presented costs is absent in the variants 2, 4, and 5.

1. In all considered choices the routs of navigation channels pass through the territory of the Danube Biosphere Reserve.

No	Alternatives of navigation organization	Rated draft of a ship, m	The length of the single-direction navigation channel, km	The construction value, million US dollars		Earth excavation, million m^3/year		Operational dredging volume (due to silting) million m^3/year		Requisition of the Danube Biosphere Reserve territories, hectares: constant temporary	Recoupment of capital investment, years	Notes
				By the developers data	By comparable volumes	By the developers data	Including channel	By the developers data	Including channel			
4.	Renewal of the navigation channel through the Prorva** branch	4.5	18.0	2.8	2.8	1.2	1.2	1.6	1.6+0.95 = **2.55**		-	ChNIIP, archive No. 819-1
5.	Deepened navigation channel in Prorva** branch	6.3	18.0	48.8	57.8	21	25.5	3	3.0+0.95 = **3.95**	Is not required	-	ChNIIP, archive No. 614-41
6.	The Bystryy branch	7.2	13.0	30	30	4.76	4.76	1.17	**1.17**		10	Rech-transproyekt archive No. 0115, year 2001
7.	Starostambul branch	7.2	3.0	27	27	6.93	6.93	1.25	**1.25**		-	
8.	Tsyganka branch	7.2	5.0	27	27	8.73	8.73	1.025	**1.025**		-	

** The opportunity of construction of a deep-sea navigation channel without additional, not calculated by the developers charges, which exceed the presented costs is absent in the variants 2, 4, and 5.

1. In all considered choices the routs of navigation channels pass through the territory of the Danube Biosphere Reserve.
2. The routes of navigation channels in alternatives 6, 7 and 8 pass through the zone of strict forbidden state of the Danube Biosphere Reserve.

Table 3.4 - Advantages and disadvantages of the variants of construction of the navigation the Danube channel - the Black sea in the Ukrainian part of delta

No	The name of the alternative of the navigation channel	Advantages	Disadvantages
1	2	3	4
1.	The lock channel: Solomonov branch - Zhebriyanskaya bay	• The channel does not pass through the zone of the Danube reservation. • The channel passes outside the active zone of delta.	• Very high price of construction, which makes up nearly 100 million US dollars taking into account the costs of sea pass and cleaning of rifts. • Great volume of dredging, a problem of allocation of rejected excavations (16 million m^3 disregarding a ground from the sea pass). • Allotment of nearly 900 hectares of land with its deforestation for the construction of the channel. • Necessity of building of highway bridges with dimensions, providing the passage of sea ships. • Uncertain conditions in bay Zhebriyanskaya, it actively becomes shallow by some literary sources (Ju.D. Shuyskiy's works). • Negative impact on the environment (on Zhebriyanskaya ridge in particular), which is much greater, than from the Danube - Sasyk channel.
2.	Ust-Dunaysk port– connecting channel – Prorva branch	• The channel does not pass through the zone of the Danube reservation. • Renewal of the existing route of the navigation channel	• The system of Ochakov branches is disappearing • Necessity of the accompaniment by a tugboat of all vessels. • Necessity of the constructing of roll-out in the connection point of the channel and Prorva branch. • Necessity of the construction of a floating gate, a guide bank and bank consolidation.

Table 3.4 continuation

1	2	3	4
3.	Lock channel from Ochakov branch to Ust-Dunaysk port water area	• The channel does not pass through the zone of the Danube reservation. • The negligible volume of repair dredging .	• The channel comes into water area of Ust-Dunaysk port which is intensively inwashed. • The volume of dredging of the port water area was not taken into account. • The system of Ochakov branches is disappearing. • The passage for the ships with draft 7.2m is not ensured. • Volumes of repair dredging are considerably underestimated: only on Vilkovo and Ochakov rifts volumes reach 0.8 million m^3. • Necessity of bank consolidation.
4.	Renewal of the navigation channel through the Prorva branch	• The channel does not pass through the zone of the Danube reservation. • Renewal of the existing route of the navigation channel.	• Volumes of excavation and repair dredging are considerably underestimated, and their costs are underestimated also. • The creation of deep-see navigation channel is not provided. • The channel can be considered only as temporary one, as the system of Ochakov branches is disappearing. • The radius of the roll-out at the exit from the Prorva branch to the Ochakov branch is very small - only 400m.
5.	Deepened navigation channel in Prorva branch	• The channel does not pass through the zone of the Danube reservation. • Renewal of the existing route of the navigation channel.	• The system of Ochakov branches is disappearing. • The creation of deep-sea navigation channel is not provided. • Considerable volumes of excavation and repair dredging. • High cost of construction. • The necessity in bank consolidation and wing dam extension.

Table 3.4 continuation

1	2	3	4
6.	The Bystryy branch	• Little meandering channel with sufficient natural depths. • Negligible speed of the delta overgrowth. • Entrance radius of the Starostambul branch is 950m. • The Possibility of a port building in the mouth of the branch in future.	• The navigation channel passes over 7km through the territory of the Danube Biosphere Reserve. The necessity of bank consolidation at 3 plots. • One-way traffic of ships on the reach with the extent of 13km.
7.	Starostambul branch	• Stable wide natural race course with sufficient depths. • Double sided navigation. • A steep gradient of isobaths on the depths below than 20m.	• The navigation channel passes over 5km through the territory of the Danube Biosphere Reserve and 4km along its borders. • Very close distance from the Sulinskyy channel. • The crawling of the Starostambul sand bar over the entrance to the Sulinskyy channel.
8.	Tsyganka branch	• A short bar. A steep gradient of isobaths on the depths below than 20m. • Far enough from the Sulinskyy channel	• The navigation channel passes over 3.5km through the territory of the Danube Biosphere Reserve and 4km along its borders. • The exit from the Starostambul branch with the radius of 400m.

Table 3.5 Description of the parameters of the DWNP- by Sectors.

Sector No.	Draft set	Sector name (conditionally)	Sector borders*, km	Sector length, m	DWNP- width by the bottom, m	DWNP- depth, m	Slope base
1	0115-1.1-GDN.1	The sand-bar part	–1.840 – 1.534	3 374	100	7.65-8.32	1:9
2	0115-2.0-GDN.1	The sea – Vilkovo	1.534 – 10.000 10.000 – 20.585	8 466 10 585	60** - 120	7.0	1:6
3	0115-3.0-GDN.1	Vilkovo – Izmail Chatal	20.585 – 116.000	95 415	120	7.0	1:6
4	0115-4.0-GDN.1	Izmail Chatal - Reni	116.000- 162.500	46 500	120	7.0	1:6

* affixment of the linear coordinates of the beginning and ending of the sectors was made in accordance with the fixed position of the hydrological post of Vilkovo – at 18 km from the mouth of the Bystryy branch.

** It was accepted by analogy with the Sulinsk and Prorva channel.

The depth of the DWNP was determined under the conditions of the assured passage of the taken into account vessel and calculated water-levels for the super main water-way.

The least navigable (rated) water-level (LWL) was accepted in accordance with the Regulations and Norms of Construction (SNIP) 2.06.01-86 with provision of 99%, which was determined on the ground of the everyday monitoring data during the multiyear set navigational period (see table 2.8).

The design parameters, concerning the depth of the navigable channel provide the limitation of the velocities in the separate areas of the riverbed part and in the area of the entrance channel in case of the extreme conditions, i.e. when the water-level will correspond to 99% of the provision of the everyday navigational levels. The limitations of this type exist now in the international area of the sector Izmail Chatal - Reni.

During the calculation for the sand bar-part the sanding-up capacity is accepted – 0.5 m; wave height – 2 and 3.2 m, windspeed – 14 m/s.

At the first phase the maritime entrance channel with the extension of 3 km was designed with the width of 100 m by the bottom, with the depth of 7.65 m and with the LWL of minus 0.48 mBS (metres of Baltic System). The mark of the designed bottom-level is - minus 8.13 mBS. The slope base 1:9. The parameters of the bend curve of the sea entrance channel are calculated with the radius of 2000 m. The direction of the sea entrance channel track – 126.07º-306.07º. The ships move in single direction.

On the first phase the construction of the levee is provided for besides the sea entrance passage in the sector No. 1. The function of the dam at this phase is to avoid the sanding up of the sea entrance passage by the alongshore drift and, partially, with the purpose to execute a function of the breakwater. What concerns the constructive aspects, the dam was designed with the trapezoidal section, having the slope base of 1:3 and with the creast breadth of – 3 m on the mark of 0.52 mBS. The drop-fill rock is provided by the stone with diameter of 300 mm. On the outside slope, which is submitted to the wave influence it is foreseen the enrockment by the stones with diameters of 800 mm and 400 mm (in the area of break). The calculated altitude of the wave in this sector would be within the limits of 3.2 … 1.5 m [21] in accordance with the data of the Institute of Hydromechanics of the National Academy of Sciences of Ukraine. The sector of the dam with the length of 1040 m (310+730) was designed at the first phase as the temporary construction, the building of which would be continued up to attaining the full profile and the designed length of the levee in general with the corresponding calculated values.

Apart from the classic version of the building of the levee in the working draft the versions of the constructing of the dam using the gabions and utilizing the structures with application of geotextiles (linen and sleeve) were analyzed. The «Rechtransportproyekt» Institute has directed the lists to the specialized firms with the proposal to participate in the elaborations of the versions of the levee from the materials and constrictions on which they have the licenses and with which they have the building experience. The regulation documents concerning this constructions, materials, fabrication methods and building and operation methods are absent in Ukraine. Because of this such construction would have only the experimental character. The experimental building would be recommended in any separate sector.

The version of building the dam from the gabions is designed by the STONE UKRAINE Company, which represents in Ukraine the «McCaffery Gabions» Company.

The version of building of dam from the constructions with usage of geotextiles (linen and sleeve) was elaborated by the «SELTON» Company, which has the materials concerning the utilization of geotextiles.

The area of the navigable channel in the sector Sea - Vilkovo (1.534 km…20.585 km) was designed with width by the bottom up to 60 m (one-way way running 1.534 km -10.000 km) and 120 m (two-ways running, 10.000 km - 20.585 km). The slope base is 1:6. The curves on the bends were inscribed with the radius of 1000 m and more. The exclusion is the radius of the turning in the area of the entrance into the branch Bystryy from the branch Starostambul (800 m). In this area the rift on the entrance of the branch Bystryy is to be cleared (up to 7.26 mBS).

In the area of the mouth Stambul gyrlo downstream of the source of the mouth of the branch Bystryy the partial cleaning of the right lateral passage is provided up to the mark of 7.26 mBS. It will ensure taking aside the water flow and drifts from the navigable channel. The length of the cleaning area is 550 m. This technical action is confirmed by the conclusions of the Institute of Hydromechanics of the National Academy of Sciences of Ukraine.

This area of the navigable channel will demand the special supervisions and, maybe, the solution of the question, concerning the acceleration of building of the hydraulic structures foreseen by the feasibility study in this junction.

The area of the navigable channel Vilkovo – Izmail Chatal (20.585 km…116.000 km) is designed with the length by the bottom up to 120 m (two-ways running). The slope base is 1:6. The curves in the bends are inscribed with the radius of 1000 m and more.

The axis of the track of the designed navigable channel in the first phase as far as it was possible for guaranteeing, the shipping safety and with the purpose to reduce the dredging volumes, has been approached to the maximal and designed depths of the existing Danube riverbed.

In this sector 11 rifts are to be cleared. The geological engineering surveys made in 2003 have testified the existence of the stiff loams in the clearing layer, and this would let expect the stability of the designed profile after the rifts cleaning.

In the area Reni – Izmail Chatal in the first phase the works with the channel dredging are not fulfilled. The navigation is carried out by the existing waterways and with the pilot chart of the Danube river through the Sulina.

The basic efforts are given in the table 3.6. The situational plans of the track of the navigable channel and of the area of the sea approach channel are given in the appendices

1 and 2.

The temporary storing of the ground, excavated during the dredging, which is provided for in the section Vilkovo – Izmail Chatal, is carried out into the specially equipped coastal dumps with the altitude of 2–3 m, which are assigned to the river dikes to be repaired, with the future usage of the dump ground for the repair of the damaged dam sections. The removal of the ground to the sea dumps in the first phase of the works is not foreseen. The inwash is supposed to be carried out, escorted by the construction of the core pools along the shore, because the dump areas with the length of 1.1–5 km ensure these conditions. The general need for the allotment of the land for the temporary damps is 96 hectares.

The creation of the temporary dumps of the excavated ground in the areas downstream Vilkovo is not foreseen in the working draft. The removal of this ground is carried out to the coastal dumps upstream Vilkovo. The same dumps are provided for the removal of the part of the ground (620 000 m^3) from the sand-bar area.

Table 3.6 Efforts for building of the sea entrance channel and for the rift clearing.

Kilometers (location of the rift)	**Excavation volume, m^3**	**Area of the bed damage , m^2**
1. *In* ***the section Reni – Izmail Chatal*** during the first phase the works are not fulfilled. The navigation is carried out by the existing waterway, according to the pilot chart of the river of Danube through Sulina.		
2. ***Area of Vilkovo (km 20) – Izmailsky Chatal (km 116)***		
73-74	218480	99000
69-70	6000	8000
67-68	62350	34000
64-66	210800	127800
61-63	230950	117280
52-53	13750	102000
47-49	332370	216625
35-38	751910	248500
31-32	80800	40600
28-29	278140	126800
24-25	6650	8500
Total	**2192200 –** work of the hydraulic dredge with filling the coastal dumps	**1129105**
3. ***Area Sea – Vilkovo***		
11	**170000** – work of the multibucket hydraulic dredge	**171000**
4. ***Sand-bar area***		
4.1 Sea approach channel (0-3 km)	**2155600** – work of the multibucket hydraulic dredge	**482850**
4.2 Levee L=1040 m Crest elevation at the first phase – 0.52 mBS Crest length - 3 m	Excavation of **90000 m^3** – the construction channel, the work of the floating crane or of the multibucket hydraulic dredge. Enrockment on the layer of the crushed stone – 95110 m^3 – by the floating crane	**96200** Including: the construction channel - 47600; the dam body – 48600

The remaining part of the ground excavated from the sand-bar area of the DWNP will be removed to the sea dump. The ground from the temporary dumps, which was not used during the construction works, would be removed to the same dump later.

The location of the sea dump has the position: **45˚19′13″; 29˚51′58″** with the expansion diameter of 1 nautical mile (appendix 3).

The ground dump is located south of the entrance into the sea approach channel axially to the flow of the sweet water. In the season of the high water it gets to the zone of the maximum ejection of the suspended matter. It is very important for the process of the natural burial of the stored ground and for the prevention of the carrying-over of the contaminants from the stored grounds into the water column. The bottom sediments in the area of the designed ground dumps correspond to the A–II pollution class, concerning the contaminants content. The local contamination sources don't exist.

The ground storage area possesses the optimal combination of the hydrologic and hydrobiologic factors and satisfies the economical criteria. The hydrologic conditions in this case testify that the excavated ground will not enter the zone of the tractional loads, which are formed by the general transfer, i. e. these alluviums will not enter the zone of the channel.

Considering the temperature conditions and the oxygen regime in the layer adjacent to the bottom, the recommended place of the ground dump is submitted to the short duration hypoxia in the spring-summer period (approximately not more than 2–3 weeks). It means that during the last 30 years the deficit of the oxygen caused certain depression of the benthos in the bottom layer. As the result of the long-term investigations of the Danube seaside it has been shown that the recommended ground dump place would not be the cause of the existence of the area of the permanent or long-term hypoxia.

The selected territory is located in the zone of the depleted species diversity of the benthos. It is the cause of the reduction of the extent of the damage to the benthos biocenose. The volumes of the hydro mechanization works were the determinative ones, when the construction duration has been calculated. For the calculation the following data as well as hydrological and ecological restriction were accepted:

- **The tie-up in the period of the fish spawning – 1 month in the year;**

- **The work unit during the fulfillment of the works in the sand-bar – 12 days in one month, 165 days during a year;**
- **The work unit during the fulfillment of the works concerning the river – 22 days in one month, 250 days during a year;**
- **The rough sea period with the Beaufort number up to 2 makes up 74.8%;**
- **The repetition of the wind with the velocity of 10 m/s makes up 21.05%; with 25 m/s – 0.08%;**
- **The daily output of the hydraulic dredges is 3500–4000 m^3/day;**
- **The daily output of the hydraulic dredges with the scoops is 2000 – 2500 m^3/day.**

The use of the hydraulic dredgers is to be considered possible only in the case of the river conditions during working out the rifts. On the sand-bar the excavation is only possible using the chain-bucket hydraulic dredges or a floating crane, because the construction site is located within the borders or not far from the territory of the Biosphere Natural Reserve of Danube.

Considering the aforesaid it is recommended to use four scoop hydraulic dredges simultaneously during the construction of the navigable channel on the sand-bar.

During the excavation of the rifts three hydraulic dredges can operate simultaneously.

Considering the fact that the working areas are distributed along the river-bed and on the seaside this number of the working hardware is technologically possible, economically defensible and ecologically sure.

The construction of the hydraulic structures is fulfilled parallel to the excavation. During the construction the floating cranes, barges, seagoing tugs, scows (shalandas) and lighters will be used.

This permits to reduce the construction period. This calculation provides for the construction term of 41 months, including the preparatory period of 2 months.

<u>The preparatory period</u> in the first phase does not require the full scale organization of the operating floor as well as the construction of the land infrastructure, because the hydraulic dredges provide for the autonomous operational status. The uninterrupted supply of the hydraulic dredges with the fuel, auxiliary fleet (tugboats, scows, refuellers and the vessels for the scavenging) is of high importance. The crew would have the food and the conditions which are necessary for their work.

3.4 Analysis of the environmental impact sources, types and factors

During the fulfillment of the works concerning the creation of the deep-water navigable channel the principal factors of the environmental impact are the following:

- The machinery and floating facilities, used for the excavation of the bottom deposits in the area of the of the deep-water navigable channel (predominantly in the areas of the existing rifts) and for the transportation of these facilities to the areas of the temporary and the permanent storing;
- The machinery and floating facilities, used for the creation of the cut, which is necessary for the passage of the vessels through the sand-bar of the branch Bystryy, for the construction of the levee and during the transportation of the excavated deposits to the sea dump;
- The bottom deposits, transported to the places of the coastal and underwater storage from the channel part of the track as well as from the area of the branch Bystryy sand-bar.

During the exploitation time of the deep-water navigable channel considering the importance of the periodical fulfillment of the damage control all the mentioned sources of the influence will remain, although the intensity of their influence will be considerably reduced.

The principal sources of the environment impact will become the changed, after the carried out works, hydro-morphological parameters of the delta elements, through which the route of the DWNP will pass. It concerns also the freight and passenger vessels, passing through the created navigable channel.

The factors of the influence of these sources on the **geologic sphere** are the changes of the bottom and coast relief, taking place during the carrying out the works as well as the

eventual changes of the delta evolution, caused by the alterations of the hydrodynamic conditions in the sand-bar area of the branch Bystryy.

The factors of the influence on the **aquatic environment** are the following:

- The damage to the bottom surface in the places of dredging operations as well as the building of the check dam and the ground damping;
- The alteration of hydrologic and hydrodynamic regimes in the branches of the passage of the deep-water navigable channel and in the area of the sand-bar of the branch Bystryy as the consequence of carrying out of the mentioned works and due to the passage of the vessels;
- The intake of the suspended matters and of the soluted contaminants into the water from the repeatedly suspending and storing bottom sediments in the phase of the creation and exploitation of the navigable channel;
- The intake of the contaminants into the water due to violation of regulations of the passage of the vessels and in cases of emergency.

The factors of the influence on the **air** in the period of creation and operation are the gas- and-aerosol emission of the pollutants into the atmosphere as well as the noise in case of the operating of vessel engines, constructional mechanisms and auxiliary floating facilities.

The factors of the influence on the **ground** in the period of the creation of the navigable channel are the dumps of the excavated bottom sediments in the specially allotted areas and the eventual changes of the water regime of the delta grounds.

In case of the heightened content of the radioactive nuclides in the bottom sediments the operations with them would cause, in ***addition*** to the above mentioned ***physical and chemical*** influences, the ***radiological*** impact on the environment.

All the above mentioned man-caused factors, changing the abiotic conditions of the delta ecologic system can influence indirectly (in same cases directly) on **the plants and animals life** of its principal biotypes – waterways, flooded areas and seaside.

The descriptions of the above mentioned factors and processes, which can be caused by them in the components of the environment, as well as the possible ecological consequences, are given in the table form (Table 3.7).

3.5 The description of actual status and of future prospects of economical activities in the navigation passage under project

The economic area adjacent to the river of Danube includes the districts of Izmail, Kiliya, Bolgrad and Reni of the Odessa region. The inhabited localities are situated here predominantly along the river Danube and along the shores of the sweet water reservoirs (the lakes adjacent to the river Danube). The zone of the Danube River is characterized as the area with the predominance of big settlements, where 60-70% of the inhabitants are concentrated. The unique geographical location of the area adjacent to the river Danube caused the creation of the big commercial, distributive and transport centers (Izmail, Kiliya, Reni, and Vilkovo). These centers considerably determine the level of the development of the whole economical zone [35]. The centre of the zone is the town of Izmail, in which the important functions of the national economy are concentrated, i.e. the industrial ones, the transportation ones, port distribution, administrative and management ones, educational and cultural ones and etc. For other big towns (Kiliya, Reni, and Vilkovo) the transport and industrial functions are mainly characteristic.

The transport complex, using the geographical advantage of the Danube waterway is the principal factor for the creation and development of the towns in the area of the river Danube. The principal territorial structural characteristics of the area adjacent to the river Danube are formed by the functioning of the Danube waterway. On the whole in the functional structure of the region the food industry predominates (about 60% of the commodity output). But the industrial specific character is formed by the industrial spheres of the maritime cycle – shipbuilding, ship repair, and fishery. In the industrial center of the town of Izmail the most important components are the food industry, mechanical engineering and metal-working industry (including two shipyards) as well as the pulp and paper industry.

The Danube cities are characterized by smaller scales of industrial production and similar functional-structural features. So the main body of Kiliya industrial center is the local ship-repair plant where 1/10 part of the population of the city is occupied. The industrial platform where some of the food enterprises use an industrial infrastructure of a ship-repair

plant is formed nearby. The Danube transport highway located in 35 km from the nearest railway station and has a crucial importance for Kiliya.

Development of a river and sea facilities determines specialization of a region in inter-regional and international distribution of the cargoes. Izmail and Reni ports are specialized mainly in export, but Ust-Danube in import freight traffics. The major carrier of cargoes on the Danube river in Ukraine is Ukrainian Danube shipping company (UDSC), which structure included 4 ports (Reni, Izmail, Kiliya and Ust-Danube), and 2 ship-repair plants. Before the termination of a through ship course on the river of UDSC transported up to 12,5 million tones of cargoes; general cargoes processing of ports made up more than 21 million tones (Renn - 10,8 million tones, Izmail - 8,1 million tones, Kiliya - 0,3 million tones, Ust-Danube - 2,1 million tones). Ships of the shipping company provided significant volume of passenger transportations on a line « From the Alps up to Black sea ». However in the beginning of the 90th the role of Kiliya narrow strait as navigable sleeve of Danube connecting the Ukrainian ports with the sea, has considerably decreased because of the long periods of unprovided required depths on channel Prorva. Ships of UDSC have been compelled to use Sulin narrow strait even for coasting transportations and to carry out significant foreign currency charges. The situation was aggravated by the war in Yugoslavia and blocking of a through course upwards across the Danube.

At present the territory of delta is an agricultural area the population of which traditionally is engaged in manufacture of grain, meat and milk products, and also viniculture, gardening and cultivation of garden and commercial crops [24]. The greatest areas for cultivation of rice are located here in Odessa region. More than half of these lands are the irrigated lands. Construction of powerful irrigating rice systems in Kiliya region began in 1965. For agriculture it meant the additional areas for rice and other cultures, smaller dependence on weather-climatic conditions. Now rice checks are mainly used for cultivation of forages, and sowing of rice is reduced.

The fishery in ponds became unprofitable, therefore many ponds are used for cultivation of crops. Trade fishery in water area of the delta, is still of a great importance for local population though this branch suffers now from economic trouble and demands organizational-structural reorganization. Unfortunately, the recent official statistics of industrial catches does not reflect the situation as it is, but it is possible to guess that the

average catch in the Ukrainian part of the Danube is kept with the certain fluctuations at a level of 900 tones in a year, and about the third part of this quantity is obtained in the limits of DBR (tab. 3.8).

Table 3.8 – the dynamics of fish catch (metric centners) in 1991-2000 within delta of the Danube (within the border of DBR) according to the data of DBR

Species	Year										Ave-rage	%
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000		
Beluga	24	17	1	-	-	-	-	-	-	-	4,2	0,1
Sturgeon	41	32	17	-	4	5	15	9	1	3,8	12,8	0,3
Stellate sturgeon	2	4	-	-	-	-	-	1	3	3,5	1,3	-
Herring	3232	3083	1697	2931	2185	2664	2726	1594	169	714	2099,5	56,1
Clupeid herring	-	2	1	9	2	13	16	-	1	-	4,4	0,1
Sazan	548	448	327	324	390	214	40	59	38,5	31,9	242	6,4
Pike perch	166	56	41	84	15	14	-	7	3	6,1	39,2	1
Cat-fish	1	-	2	4	4	1	-	1	1	4,3	1,8	-
Vimba	26	55	58	27	46	18	5	19	7	13	27,4	0,7
Bream	734	179	66	171	178	131	122	159	72	24	183,6	4,9
Crucian	1751	992	769	420	1047	938	662	555	547	401,5	808,2	21,6
Pike	-	-	1	-	1	6	1	-	-	2	1,1	-
Cuprinid	50	29	42	33	51	67	39	27	17	13,5	36,8	0,9
Silver carp	28	189	485	677	500	299	74	55	25	-	233,2	6,2
White amur	2	3	-	-	-	-	-	-	-	-	0,5	-
Rudd	106	9	30	-	-	-	-	23	28	17,3	21,3	0,5
Roach	12	10	2	5	-	-	-	16	2	2,7	4,9	0,1
Silver bream	-	9	48	20	6	-	-	7	6	14,4	11	0,3
Sicklefish	-	-	-	1	-	-	-	-	-	-	0,1	-
Perch	73	4	5	1	3	-	-	-	2	4	9,2	0,2
Red-finned mullet	-	-	-	-	-	3	-	2	1	5	1,1	-
Total	**6796**	**5121**	**3592**	**4707**	**4432**	**4373**	**3700**	**2534**	**923,5**	**1261**	**3743,6**	**100**

** Danube Biosphere Reserve*

Almost a half of trade fishery catch (48,6 %) is made up by Danube herring. It is a typical through passage fish, which spawns outside the Ukrainian part of the river. Owing to

pelagian type of a caviar it appeared to be less sensitive to sharp reduction of the hatchery area. The average long-term number of herring is relatively stable, and natural annual number fluctuations is a typical specific feature of herring family. Catch reduction at the end of the 90th years can be connected also with the herring sale avoiding fish stations.

Partite sites of delta Kiliya, such as Ermakov island, territory of Zhebriyanskaya seaside ridge, and the area on periphery of Stentsovsko-Zhebriyanskiy flux serve as places for pasture of large horned livestock and horses.

The widespread form of nature resources use on Zhebriyanskiy ridge is extraction of sand which has mainly legal character.

On the basis of quantity indicators, in particular, floristic structure and values of phytomass the four stages of pasture degradation of herbage of DBR has been allocated the corresponding skeleton map was made. It is evident from the skeleton map, that the most degraded due to cattle pasture is vegetation of Zhebriyanskiy seaside ridge and northern parts of Ermakov islands (fig. 3.3). The delta of Kiliya mouth of the Danube is less degraded in this respect. Thus the subbed and seaside ridges of delta, as well as Ermakov island appeared to be the territories for excessive pasture of large horned livestock.

At present the number of cattle at the islands of a lower reaches of Kiliya delta of Danube has been decreased particularly in connection with the curtailing of the activity of separate cooperative farmings. However an excessive pasture at Ermakov island is proceeding. An influence of pasture at the seaside areas of Zhebriyansk ridge is significant, as well as the territory located near the villages Liski and Primorskoye and the city of Vilkovo. In a seaside part of Zhebriyansk ridge, except of pasture, regular burning of herbage at the significant parts of the salted - meadow and marsh areas takes place in the second half of a summer.

The basic part of subbed areas of the branches of Kiliya delta and Ermakov island are covered with the natural or planted artificially willow forests the wood of which is mainly used as fuel. The part of subbed areas (approximately 300 hectares) is occupied with the gardens and vegetable gardens.

Woods of Zhebriyansk seaside ridge are excluded from its principal use, a scheduled storage of fruits and herbs here is made here, the local population gather mushrooms and fruits of sea-buckthorn berries.

Preparations of reed are also developed in Kiliya delta. Some reed is mowing in order to feed domestic animals during the vegetative period. Reed collected in winter is used as local building material.

Both legal and illegal hunting are developed in the land. They hunt usually on a hare, a pheasant sometimes bag a fox, a roe, the trade of the muskrat is also popular but its number has essentially decreased: if in 70th years it was baged near by 18 thousand of individuals, now bags up to 2 thousand. The main object of the hunting is a waterfowl.

Within the territory of DBR the beekeeping is developing. It is caused due to the climatic conditions of the territory, specific riches of bees plants and long season of honey yield (from March till November).

Recreation and tourism belong to the developing kinds of wildlife management in the delta the potential of which only starts to be used at present

3.6 Conclusions to chapter 3

1. Design works of ship course lines variants in the Ukrainian part of Danube delta has been executed by the different design organizations during the different periods of time and were oriented to passage of ships with various dimensions (including draughts).
2. The part of Danube channel and it Kiliya branch from the Reni port up to Kiliya port is included in every developed variant and a part of a channel between Kiliya port and Vilkovo port completely or partially.
3. The chosen variant of a line on Bystryy branch are satisfied according to the following criteria:

   It is one of:

   - the least size of operational dredging;
   - the least size of dredging during construction from a similar in operational dredging size
   - and obtains competitive cost of construction.

   The following favorable hydrological conditions for creation of deep-water navigable channel according to this variant were additionally taken into account:

- small meandering channel of Bystryy branch with the sufficient natural depths that excludes necessity of carrying out of civil work up to the branch;
- rather small speed of delta advancing at the part of its sea land that adjoining to the branch mouth;
- rather abrupt increase of depths behind the sand-bar area that allows to expect relatively length long exploitation of deep-water navigable channel.

4. Creation of navigation channel gives some straight and mediated influence on the basic components of the natural environment the influence zones of which can differ essentially. Their estimation is showed in the following chapters of EIA.
5. The analysis of economic activities in Danube delta shows that the development of the river and sea economy determines the specialization of a region in inter-regional and international distribution of the cargo. An industrial regional specialization is determined by manufactures of a sea cycle: ship-building, ship-repair, fish-processing. The transport complex which uses a geographical advantage of Danube waterway serves as the basic hail growth factor of the Danube cities development.
6. The reduction of navigation occurred in the last years at the Ukrainian part of the Danube because of the long period of precariousness of required depths at trapped Prorva branch results in a degradation of the industrial and transport centers. Creation of deep-water navigable channel is a necessary revival condition of these leading regional economy branches.
7. Now the delta territory is an area with the advanced agriculture, fishery, hunting. At unsubmerged territories of DBR the pasture of livestock takes place. Trade catch of fishes is executed in the delta branches (Bystryy including).
8. Exploitation of deep-water navigable channel creates certain handicapes to fishery, but does not prevent the other kinds of economic activities in the territory of delta.

* *Environmental impact assessment*

4 Description of Environmental and Assessment

4.1 Geological environment

4.1.1 Description of geological environment

Delta of the Danube enters into structure of the Black sea concave located within the alpine geosynclinal region. Northeast part of the Black sea is attached to the outlying districts of East-European plate, where deep lying sedimentary rocks of tertiary, Mesozoic and Paleozoic periods mildly slope down to the southwest. On these ancient rocks in the delta the thick deposits of Cenozoic are located.

In structural-technical respect the area under study is within southwest part of the Black sea adjacent area concave. Its formation is connected with sinking of Precambrian and epiherzinskiy blocks of Russian platform, which are divided by the belt of rift-valley type depressions. So the deposits forming the concave lay on crystal rocks of various age and genesis. The nearest laying rocks to the surface are terrigenous-carbonat formation of Miocene and early Pliocene, which are presented with clays, which upper boundary in the area of the Danube delta occurs at the depth of 50-120 m.

The most ancient formations relate to the upper Pliocene period and are presented by clays, sand and shingles. Their upper boundary occurs at the marks of -20m – -36,8 m. In the area of Izmail town the deposits of kuyalnik layer are presented with heavy light-yellow loamy sands occurring at the marks of -4 – -9 m.

Thickness of alluvial Holocene deposits is characterized with variety of lithologic composition. Mixed character, unevenness of separate layers and variety of soils both in thickness and extension are subject to peculiarities of sediment accumulation in the delta of the Danube. The river waters flow supplies bringing fragmental terrigenous material forming the delta sediments predominantly clay ones. Its accumulation is facilitated by absence of strong sea currents near the estuary part of the river, coagulation of thin material brought by the river. Among delta depositions there are sizable delta sediments of organic remnants mainly vegetable ones.

These depositions form powerful thicknesses among which there are rocks of various composition forming strata, beds, lenses, very often sharply tapering out, facially substituted here and there by other petrographic diversity of the rocks. It is typical for them the fine interleaving of rocks of various composition.

Delta top of the Kiliya river mouth is situated near Vilkovo town. Here the geological-lithologic cross-section of the river-bed differs with particular mixed character: as a rule, on the surface there are clay and loamy silts of 3,3 m thickness, with fine and medium size sand with great contents of detritus and shell rock of 1,2 to 3,0 m thickness spreading under. Below a layer of loamy-clay depositions of various consistency and color ranging from dark blue to gray with dark-colored minerals and mica inclusions and admixture of organic matter here and there can be traced.

In up-stream alluvium there is an increase in sand fractions: silts change for clay sand loamy soils, clays transform into clay sands, thickness of sand soils increase. Silt sediments are attached mainly to the bank areas of the riverbed, sand and clay sand ones are attached to the places where there is maximum of flow depth and power.

The river, its arms and temporary rain showers currents, transports present-day alluvions of the Danube. The above-water and under-water delta is formed by its alluvions and the soils various in quality and properties are shaped on the temporary flood plains. Alluvions of the Danube sorted out by the river and the sea serve as good building material.

Soils of the riverbed consist of alluvions carried by the river and the soils of the current bottom weakly washed out. At the length from Reni river to Izmail Chatal (160,5 km – 116 km), with high speeds of the current, there happens to be fine sand with predominant particles of 0,1–0,25 mm, in the river channel line the larger particles (0.25–0,5 mm), and there are dusty and silted sand near the banks. Under thin layer of sand there are blue-gray ancient clue.

For the section from Izmail Chatal to the town of Vilkovo (116 km – 18 km) the typical is a wash out of gray-white and yellow gray ancient clay though the current here in the channel line carries fine sand in the bottom going into silt near the banks. In Kiliya delta the banks and river bed consist of clay silt (particles less of 0.01 mm) with sand interlayers. In the largest river arms (Ochakovskiy and Starostambulskiy) the fine sand moves along the water-way even in low water and in the smaller arms of the river it moves only in a flood. In some arms the move of the sand does not happen even in a flood.

In various years the Rechtransproekt organization and other organizations carried out engineering-geological studies in the riverbed area at the rift places of the Danube river and

at the sand- bar of Bystryy arm. In 2001 an engineering-geological work package was carried out along the riverbed in the rift places. Composition of the bottom part of the riverbed area was specified.

The wells opened quaternary alluvial-dealluvial depositions, represented by the micaceous small sands with cockleshell inclusions, loamy and clay silts as well as the loams.

Along the route of the riverbed from Izmail to Vilkovo there are three engineering-geological elements (EGE) marked out:

EGE-1 Clay and loamy silt;

EGE-2 Mica fine sand saturated with water;

EGE-3 Heavy dusty, gray, yellow-gray loam from the soft supple to the hard supple consistency.

In the area of 47th kilometer near the port of Kiliya an upper boundary of Pontos chalkstones was met with at the depth of 6,5 m.

Soils of the sea edge of the delta are represented with fine and medium-sized sands, clay sands, heavy and light loams, loamy sand and loamy silts. On the seaside of Kiliya delta a zone distribution of soils from the shore to the sea is noticed, mainly in parallel with sea edge of the delta.

A sand area occupies the sand-bars of the river arms and the coastal strip up to 5 m depth line. Here and there the boundary of this zone shifts to the depth lines of 6-10 m, or to the shore sideways to the depths of 1-3 m. The zone width reaches 3-3,5 km.

By its composition the sand in the mentioned zone is rather similar, mainly fine-grade, well-sorted out. Closer to the shore an admixture of medium-sized sand is met sometimes, closer to the sea there is the dusty sand with 5% of silt particles admixture.

Zone of sludgy sand is located on the underwater slope of the beach at the depths of 5–7 m and adjoins the sand zone.

Silt zone lies in wide band at the depths of 10–25 m. Opposite the Bystryy river arm it makes about 3 km. A zone of clay silt is situated inside the silt zone at the depths of 15–20 m.

So, while cleaning the river bottom in the rifts and sand-bars in order to make deep water ship passage the various lithologic differences can be met in the soils varying in their physical-mechanical features

Physical-mechanical features of the soils by the engineering-geological study reports carried out at different time by Rechtransproekt, Chernomorniyiproject, Ukryuzhgiprovodkhoz are presented in the table 4.1.1.

Table 4.1.1 – Averaged physical-mechanical features of the soils

Name of EGE	**Density, g/m3**	**Porosity coefficient**	**Angle of interior friction, degrees**	**Adhesion, mPa**	**Soil group by the difficulty to work**	
					By SNiP 1У-5-	**By norms of**
1	**2**	**3**	**4**	**5**	**6**	**7**
Chernomorniyiproject, "The Danube –Black sea channel". The arm of Bystryy mouth						
loamy sand silt	1,88	0,943	15	0.005	I	I
Loam silt	1,85	0,992	2	0,012	I	I
Clay silt	1,68	1.514	0	0,012	I	I
Light soft supple loam	1.95	0,807	8	0,009	IV	III
Heavy clay, leaky supple	1,64	1.573	5	0,011	VI	IV
Dusty sand, medium density	1,86		23	0,002	II	III
Rechtransproekt "Vilkovo Repair- Operational Base of the Fleet"						
Loamy, clay silt	1,76	1,246	12	0.011	I	I
Leaky supple heavy loam,	1,89	0,969	17	0,014	VI	III
Heavy loam, hard supple	1,97	0,760	18	0,022	VI	V
Fine to medium-sized sand with cockle-shell inclusions	1,97	0,380	31	0	II	III
Rechtransproekt "Berths of complex services of the fleet on the Danube river near Izmail town (76-79th km of the route of ship movement, Kislitskiy arm)						
loamy and clay silt	1,63	1,385	14	0,017	I	I
Heavy loam soft supple.	1,84	1,000	18	0,030	V	IV

Light loam hard supple	1,86	0.780	19	0,030	V	V
Rechtransproekt, "Engineering-geological Conditions of the berth construction of Izmail pulp mill"						
Loamy sand silt	1.80	0.960	12	0.003	I	I
Fine sand	2.00	0.720	28	-	I	II
Heavy loamy sand heavy, leaky	1,98	0.789	16	0,010	II	II
Ukryuzhgiprovodkhoz, "Regulator-gate of the "Prorva" channel (near Orlovka village)						
Clay sand silt to loamy silt	1,77	1,122	12	0,015	I	I
Supple clay sand	1,90	0,829	22	0,020	II	II
Fine sand	2,02	0,616	32	-	I	II

4.1.2 Analysis of impact of planned activities on geological environment and the relief shaping processes

Impact on the geological medium while building DWNC (Deep-water Navigation Channel) will be made by construction works for deepening the riverbed in the area of Reni -Vilkovo, however this impact is similar to the natural wash-outs and will not lead to the negative consequences.

More fundamental influence is possible due to making a navigable cut through the sand-bar of Bystryy arm with underwater protective dam. At this the undesirable consequences may be caused by disruption of natural processes of shaping the underwater relief and instability of underwater relief shape. Stability of underwater constructions to the gravity and wave factors in the medium is provided by the adopted values of side slopes in Technical Economic Ground) however its adherence to the accumulation of alluvions makes it necessary to carry out permanent maintenance work of cleaning.

At the period of maintenance the protective dam and the opening, which trap and accumulate the alluvions can change the course of natural processes, which in the last years resulted in the growth of Ptichya spit. At the same time the dam will serve as a protection from the wave impact to the Ptichya spit under the heaviest northern winds.

One of the most remote consequences of building the protective dam can be the speeding up of natural process of advancing the Maritime Edge of the Delta in the area of

sand-bar, building-up of near-estuary islands on the side of the dam and their junction with the shore.

Fears were also expressed regarding possible washing out of the spit as a result of passing ships, however according to the calculations of IMG (Institute of Maritime Geology, National Academy of Sciences of Ukraine) (*hereafter* IMG) [51] the spit stability, which minimal distance from the shore to the opening of the sea approach channel makes over 500 m, does not cause the fears as the impact of the waves in the area sufficiently yields to the impact of wind waves and along -shore streams, which facilitated the spit creation.

The opening of the sand- bar of Bystryy arm provided by the project together with availability of natural hydraulic factors existing on the margin of the river and sea part of the delta leads to the speed change in a number of geomorphological processes both in the arm itself and in the active part of the delta.

Then uncontrolled increase of the water flows in Bystryy arm can result in gradual wash-out of the arm banks, disappearing of alternative arms of the delta and worsening water conditions of the dependant massif of water meadows. These phenomena at present are already traced both in view of natural processes of the delta development as well as a result of hydraulic engineering work on the territory of Romania in order of redistribution of the Danube water flow in favor of its territory.

Within definite limits the increase of water consumption in the arm of Bystryy can facilitate preservation of water content of Kiliya delta (to the contrary of the measures taken by Romania to increase the water content of the arms of the Danube, through-passing its territory

Calculations made by IMG using mathematical models of distribution the flows and calculations of the arms levels (one-dimensional model) and calculation of the speed plan and distribution of mass flow in the area of branching (two-dimensional model) showed that owing to the laying of the opening in the river sand- bar at the head water some redistribution of the water flow takes place in favor of Bystryy arm mainly due to the water flow decrease in Ochakov arm – less than 4 %, while the water flow of Starostambulskiy arm will practically remain unchanged.

In the period of technical decisions on creation of DWNC the monitoring of geological medium is provided. At disclosing the changes in its conditions fraught with

negative consequences the proper protective measures will be carried out. In particularly, in Technical-Economic Ground the creation of the wing dam is provided in Starostambulskiy arm at the water head of Bystryy arm with the purpose of regulating distribution of the water flows between these arms as well as throughout the whole system of Kiliya arm delta. Its construction is referred to the second step of DWCS creation. At the very first step of the construction the cleaning of the Starostambulskiy arm bed will be made down the water head of Bystryy arm owing to which a redistribution of the water flow will take place as well as the drawn sediment between these arms in favor of Starostambulskiy arm.

Stability of the Ptichya spit banks may also be maintained with engineering measures , in particularly, with appropriate configuration of the protective dams along the sea approach channel which construction will be continued at the second stage of DWNC creation.

The passing ships waves can influence negative impact on the in-shore territories along the Bystryy arm at the period of operation of DWCS. First of all such impact will subject the most valuable in ecological relation the along-shore strip of the near-riverbed swells being the ecotone at the border of water and water-bog biotopes. However the similar impact subjects this strip due to passing over the fishing vessels and motor boats, which waves at fair speed, as it was established with experimental simulation by IMG NASU, is higher than from the large vessels which passing over in the DWNC will be realized at speed limitation to the speed of 7 knots per hour. Besides there is strong development of drive away-positive setup phenomena under which periodic raise of the water level sufficiently exceed the height of waves due to passing of ships.

According to the data of IMG calculations [51] of depth of the ships waves near the shore being the result of superposition of transverse and divergent waves, the calculated value of the wave depth is 15 cm less under the speed of 8 knots per hour near the bank of the calculated cross-section. Height of uprush will significantly depend on roughness of the shore.

In view of uniqueness and importance of the alongshore banks from ecological point of view as well as the complexity of the wave-forming processes under conditions of narrow

fairway, that requires thorough experimental research on the models and environmental tests for the certain parameters entering in calculation proportions the IMG recommends to limit the vessels speed by 7 knots an hour at the initial stage of operation. After receiving information of actual processes (wave height at different distances from the vessels, de-leveling of surface), the speed magnitude can be revised.

Calculations performed and real stability of near- riverbed swells of the Bystryy arm to the up-to-date wave loading (in particularly, from high speed small- size vessels) gives the ground to count on keeping these swells at the period of their operation of DWNC. Permanent supervision of near-riverbed swells is included into monitoring program. In accordance with its results an additional speed limitation for vessels traffic in the Bystryy arm can be introduced on necessity.

4.1.3 Hydrogeologic conditions

Concerning hydrologic conditions the delta of the Danube is attached to the western part of artesian basin of the Black sea adjacent area. The most intense water exchange is noticed up to the depth of 100-300 m in the underground water developing zone attached to Quaternary and neogenic – medium-upper Pliocene, Pontos, Meotis and Sarmatic depositions [55, 56].

The peculiarity of forming the behavior of underground waters (their interconnection, feeding, discharge, chemical composition) is a considerable changeability of lithologic composition, frequent interchange of water-containing and waterproof rocks, unevenness if depositions in cross-section and in extension facilitating the formation of large number of water-bearing floors and layers which are typical for the mouth areas of large rivers.

Possible impact of creation ship passage on the hydrologic conditions within the considered mouth area of the Danube can spread only to the Quaternary zone of active water exchange of 20-30 m in thickness and partially on neogenic zone laying to the depths of 30-120 м. Confining layer to form the water-bearing complex of this thickness is the clay strata of neogenic age i.e. Miocene and early Pliocene.

Water-bearing complex in Quaternary depositions is spread everywhere and facies attached to alluvial , alluvial-dealluvial, sea, estuary and aeoline-dealluvial sands, clay sand and loams.

Water-bearing level in up-to-date alluvial and alluvial-dealluvial depositions spreads within flood-plains of the Danube, its inflows and in gully thalwegs. Depth of underground water beddings is from 0-2 m in coastal areas of the sea (in flood-plains) up to 5-8 m in upper and medium parts of the Danube estuary area.

Feeding of the bedding is mainly at the period of river floods, infiltration of atmospheric precipitation, more rarely (at low water periods) at the expense of onflow from underlying water-bearing levels. Level is free flow, thickness of watered depositions are 0,5-10 m, general direction of water flow at low water is to the riverbed however there are flows directed from the river to the flood-plains and islands.

Chemical composition of the water is very diversified and is characterized with natural increase of mineralization from the upper to the estuary parts. On the most of the flood-plains the value of mineralization makes 1 up to 4 g/dm^3. In near-riverbed areas the mineralization drops to 1 g/dm^3 and less.

In the bottoms of largest gullies the water-bearing soils are dealluvial loams, loam sand, sands. Thickness of watered zone is not large and makes 1m up to 3-4 m. Depth to the water level is 2-3 to 5-8 m. Mineralization is high, exceeding 4 g/dm^3. Confining layer of this level are Quaternary foxy clays or clay Meotis depositions of Pliocene terraces.

Water-bearing level in the sea and the estuary-sea depositions is developed only along seashore and the estuaries and is attached to the sand forms of relief i.e. beaches, sand areas, spits, peninsulas, ridges. Width of these elements is from 2 m to 100 m. Waters have free surface and the lying depth from 0m to 2-3 m.

Chemical composition of these waters is diversified depending on a number of factors: number of atmospheric precipitation per year, fluctuations of water level in rivers and estuaries as well as storm and set-down -run-up activity of the sea. Under the influence of these factors the fresh water lenses with mineralization of 0,6–2,9 g/l^3 can form on the sea salt waters.

Thickness of the level is 10-15 m, the feeding is due to the infiltration of atmospheric precipitations, filtration of water from the sea and estuaries and overflow from underlying water-bearing levels.

Water-bearing horizon in ancient alluvial depositions of above-flood-plains terraces is well developed in the valley of the Danube and in its large inflows. Water-bearing soils are

of sand-gravel-shingle depositions. Depth of the level lying fluctuates from 5 m within the 1st over flood-land terrace to 35-50 m on ancient Quaternary terraces. Thickness of watered soils is from 1-3 to 17 m, but in some cases may reach 30 m.

This level normally presents in itself a few hydraulically interconnected levels being formed within terraces. Loess loams are the roofs of water-bearing complex; the bottom is the clay of Meotis. As a rule the waters are free-flow and only in adjacent riverbed area, where quick sinking of the terrace basis below up-to-date shore line is observed, the head pressure reaches 20-30 m. The main feeding of the level is due to atmospheric precipitation infiltration. Mineralization of water is up to 2 g/l^3. By its type the waters apply to sulphate-carbonate natrium-magnesium waters. In lower course of the Danube this level is often used for everyday-economic water supply.

Water-bearing level in aeoline-dealluvial (loess) depositions is developed on watershed spaces where it is formed on waterproof foxy clays. Its continuous spread is observed only in southeast part where they spread in band of 8-12 km along the estuary area of the Danube between the lakes of China and Sasyk along the Black sea between the lakes of Sasyk and Burnas.

Water-bearing layer is the lower part of loess thickness. Depth of the deposit is 10-20 m, Thickness of watered zone is from 1-3 m to 10 m. The level is free-flow. The feeding of water-bearing level is due to atmospheric precipitations.

Water-bearing capability of the level is insignificant. Prevailing mineralization values of underground waters is 5-7 g/l^3 are observed at the slopes of watersheds, at the watersheds itself the values are 1-3 g/l^3. In the coastal part there are underground waters noticed with mineralization over10 g/l^3.

Besides increase in mineralization of underground waters from a watershed to a slope it is a tendency of its increase from north to south. Chemical composition of the water is diversified. Thus in the area of developing slope between the lake of Sasyk and the lake of Burnas a mineralization fluctuates within the limits 1-4 g/l^3, to the west of the lake of Sasyk it is over 4 g/l^3. Saltish waters are mainly hydrocarbonate-potassium and salt ones are Chloride- natrium.

Analyses of water-bearing floors of the zone of active water exchange of the region under consideration shows hypsometric highest position of the subsoil waters in quaternary

aeoline-dealluvial loams regarding the others floors. This creates conditions for descending overflow of water through separate layers of clays and areal feeding in watershed spaces of underlying water-bearing floors.

Quaternary complex of water-containing grounds of thickness up to 30 m stretches under to the depth of about 150 m thickness of neogenic formation containing water-bearing roofs: in Pliocene laydowns, Pontos and Meotis laydowns. Some of them having low mineralization of water (up to 1 g/l^3) are used for economy-potable water supply (Izmail town).

The indicated above water-bearing complexes represent upper hydrodynamic zone with rather intensive water exchange. The common for all complexes is the move of the subsoil water to the discharge areas from north to south, to the Black sea with deviations of the current to the main riverbed of the Danube and its largest confluents.

4.1.4 Analysis of impact of planned activities on geological conditions

Possible impact on geological conditions while building DWCS can be influenced by measures related with deepening of the Danube riverbed and its arms in the places of forming the rifts and sand- bars. However this impact will be rather positive tendency since the water exchange between surface and underground waters will be intensified.

Deepening and clearing of the riverbed will not effect hydrodynamic conditions of underground waters – change of the water levels bedding – within the limits of water collecting basin of the Danube, as the set conditions of feeding sources and discharge of hydraulically interconnected surface and underground waters is not changed, and possible insignificant deviations assimilate within the limits of seasonal magnitude fluctuations of water levels in the river and underground waters.

Shore dumps of sand-silt bottom sediment formed as a result of dredging in flood-plain of the river along its riverbed, during the floods will be washed, however the carryover of the pollutants from them will not influence significantly the quality of the surface and underground water owing to increasing the diluting capability of the river and under riverbed underground flow at these periods.

4.2 Air environment

4.2.1. Discharge to atmosphere

The institute of Rechtransproekt has carried out calculations of the volumes and dispersal of the pollutants discharge into atmosphere in riverbed part of DWCS at the period of construction [36].

In calculations of the pollutants dispersal the discharge sources, working in the places of the ship passage, riverbed part and the sand-bar part at a definite period of time are considered.

Maximal sporadic pollutants discharge is determined proceeding from the fuel consumption per hour and their specific discharge subject to a capacity factor of Internal Combustion Engine at various loads.

Basic data for calculation of pollutants discharge to the ambient air are presented in the table 4.2.1.

Calculations were made for 5 types of pollution: nitrogen dioxide, soot, sulfurous anhydride, carbonic oxide and carbohydrates. In dispersal calculation the discharges from Internal Combustion Engines of boats, scows and towboats were not considered, as the above-mentioned floating vehicles work occasionally throughout the territory. Magnitudes of single maximal and gross pollutants discharge into ambient air in the riverbed and sand-bar part of the DWCS route while floating vehicles operation are presented in the table 4.2.2.

Table 4.2.1 – Input data for calculation of the pollutants discharge into ambient air while dredging

	Type of floating vehicles

Activities	dredge ship (Ист№ 1)	chain-bucket dredge (Ист№2; 3)	Self-propelled scow (Ист№7)	Lighter (Ист№ 6)	Floating crane lifting capacity 16т (Ист№4)	towboat (Ист.№ 5)
Fuel consumption, кg/hour	126,5	67,5	20,5	10,0	67,5	20,5
Specific discharge, g/kg of fuel:	63,0	83,9	75,1	65,1	83,9	75,1
Nitrogen dioxide	9,4	10,2	7,2	7,9	10,2	7,2
Soot	6,0	6,0	6,0	6,0	6,0	6,0
Sulfurous anhydride	7,0	7,6	42,0	29,4	7,6	42,0
Carbonic oxide	12,0	12,0	12,0	12,0	12,0	12,0
Carbohydrates						

Results of calculations on dispersal pollutants in the surface air made on personal computer by «Rechtransproekt» showed that while operating on the rifts the Maximum Allowable Concentration will be exceeded on the source site only for nitrogen dioxide and soot. Pollutants dispersal in ambient air results in decrease of nitrogen dioxide in sum with sulfurous anhydride concentration to the Maximum Allowable Concentration at the distances up to 1300 m**,** for soot up to 300 m.

At the sites of the ship sea-Vilkovo passage and the sea approach channel the excess above Maximum Allowable Concentration in the area of source is also observed only for nitrogen dioxide and soot. The level of Maximum Allowable Concentration for nitrogen dioxide reaches at the distance of 1240 м (ship passage) и 1400 м (approach channel), for soot – 300 m и 400 m (accordingly). Concentrations of other pollutants do not exceed the level of Maximum Allowable Concentration in zone of the source.

Analyses of charts of dispersal pollutants, while making protecting dams, showed that by nitrogen dioxide the index of Maximum Allowable Concentration is reached at the distance from 1300 m to 1500 m; by soot it is up to 400 m. Discharges of sulfurous anhydride, carbonic oxide, ангидрида, hydrocarbon are sufficiently below Maximum Allowable Concentration.

Amount of payment for pollution of the ambient air for the whole period of the first stage of construction is estimated at 8,5 thousand UAH (Ukrainian hryvnas).

Proceeding from the temporary nature of hydroengineering works, absence of stationary sources of emissions there is no need for sanitary-hygienic zone for the objects of DWCS.

To decrease the surface concentration of the “priority” ingredient of nitrogen dioxide the project provides to disperse the mechanization means and regulate its power as well as vary the demand factor for mechanisms. In case of unfavorable meteorological conditions (UMC) it is recommended to stop the work in full and shut down the engines.

During operation of a dredge ship, floating crane, support fleet in the water area the personnel should have a permanent control (monitoring) of GOST 24585-81 and GOST 24028-80 observance on contents of exhaust gases of the ships’ power installations.

4.2.2 Noise

Calculations of the noise effect during the construction period was made by Rechtransproekt [36].

Main source of noise during the channel construction period is the diesel plants of a dredge ship and a towboat.

Noise characteristics of these sources are taken from the table 1.12 from the «Reference book on the protection from noise and vibration of residential constructions and public buildings», Kiev, 1989.

Equivalent level of noise from dredge ship at the distance of 25 m from its side makes LA equiv. = 59 dBA, towboat - LA equiv = 57 dBA.

During operation of the technical means with different noise characteristics, the equivalent noise levels are added by energy (СниП *(SniP)* 11-12-77).

Difference in the levels is equal to: 59 - 57 = 2 (dBA).

Coming from this difference, the addition is to the higher level of 2 dBA:

$$59 + 2 = 61 \text{ (dBA)}$$

It means the calculated equivalent noise level generated by two sources equals 61 dBA.

Decrease of the noise level subject to the increase of the distance to the source is determined by the formula:

$$\Delta LA = 10 \lg / r_o, \text{ dBA}$$

Where r – the minimal distance between calculated point and acoustic center of sound streaming from the technical means, m; r_o – distance of 25 m, where equivalent noise level is 61 dBA.

For the riverbed part: $\Delta LA = 10\lg 50/25 - 10 \times 0{,}301 = 3$ (dBA).

For a sand-bar: $\Delta LA = 10\lg 2000/25 = 10 \times 1{,}903 = 19$ (dBA).

Decrease in noise level through its absorption by atmospheric air is determined by formula:

$$\Delta L_в\text{-}5r/1000, \text{ dBA}$$

For the riverbed part: $\Delta L_в = 5 \times 50 /1000 = 0{,}25$ dBA.

For a sand-bar: $\Delta L_в = 5 \times 2000 /1000 = 10$ dBA.

Total decrease of the noise equals:

For the riverbed part - 3,25 dBA,

For a sand-bar -19 + 10 = 29 dBA

Level of acoustic pressure on the shore subject to a decrease equals:

For the riverbed part: 61 – 3,25 = 56,75 dBA,

For a sand-bar: 61 - 29 = 32 dBA

Taking into consideration that in the calculations the distance to a shore is accepted minimal (50 m), in fact it makes 50 - 100 m, one can regard that in a riverbed part the level of acoustic pressure corresponds to the normal index for a residential areas in day time (55 dBA), and will be far less for a sand-bar.

There will be two cargo ships per hour passing through the channel at the period of operation. Similarly to the previous calculations a level of acoustic pressure is determined for a ship through-passing.

Equivalent noise level - LA = 55 dBA, subject to correction - 58 dBA.

Decrease in noise level is:

ΔДА – 10 1g 50/25 = 10 x 0,301= 3 (dBA).

$\Delta L_{в} = 5 \times 50 / 1000 = 0,25$ dBA.

Level of acoustic pressure:

LA = 58 - 3,25 = 54,75 (dBA), i.e. it is within a norm value.

In accordance with normative requirements of ДБН 360-92, on the territory of DBR (DBR), adjacent to the route of the DWCS, the equivalent noise level should not exceed 25 dBA at day time and 20 dBA at night. Calculations, made at the stage of Technical-Economic Ground (TEG) [54], showed that subject to sound-absorbing characteristics of riverside vegetation of the Bystryy arm the normative noise level in this case is achieved at the distance of 50–60 m off the shore edge during a ship passing.

4.2.3 Summary on the effect of a ship navigation passage alternatives on air environment

- Execution of hydroengineering works during creation of DWCS will not cause the steady supernormal pollution of atmosphere.
- Emissions from mobile sources will have short-term and local nature; stationary sources of air pollution both during the construction and operation of the DWCS are missing.
- At half-width of the channel and watercourses equaling 50 m the acoustic pressure at riverside while executing the construction works and ships passing through not exceeds normative value of 55 dBA for residential areas and achieves normative values for reserved territories (25 dBA) at the distance of 50-60 m off the shore edge.
- The factors of impact on biological objects like:
  - Electromagnetic fields of production facilities;
  - Very high frequency emission from the ship's communication facilities;
  - Heat pollution of water and air medium (contours of water cooling of engines, exhaust gases);
  - Vibration, high frequency and ionizing radiation;
  - Radioactive pollution is missing completely or, due to the small amount, are not capable to have a material effect on the environment.
- Under conditions of passing the route of DWCS on the territory of DBR a special significance has a disturbance and deterrence factor for fauna by discharge into ambient air (smells), noise and light, in this connection the regulations of passing the ships on the territory of DBR will provide the ban on applying the ships hooters, music broadcast on deck, especially for passenger ships and limitation of ship speed that will decrease negative impact of the above factors on fauna of the reserve and will influence positively in ecological education of tourists.

4.3 Water environment

4.3.1 Hydrologic conditions of DWCS route

Kiliya arm, where riverbed of DWCS goes, has a sizeable depth with relatively small width of riverbed: in the area of Reni town the width makes 800-900 m, average depth reaches 10 m and maximal – 17m-19 m, near Izmail town the width of the arm makes 500 m;

The arm has very low banks due to this practically at the whole length of the left bank of the Danubeя the protective dams have been built. By the data of Goswodhoz the length of the dams makes 212 km. Some parts of the dams are located at the safe length from the arm, however some of them are subjected to a wash-out impact of river current.

The arm of Bystry is branched off to the left from Stambylskiy 7,2 km below its source and flows between the islands of Stambylskiy and Kubanskiy, flowing to the Black sea. The total length of the arm is 9 km, the width is 100-200 m, the depths change from 6 m to 13,1 m. Average water content of the arm of Bystryy makes 36 km^2/year, and outflow share is 18 % of the total outflow of the Danube.

4.3.2 Description of water quality of the Danube river in the mouth

4.3.2.1 Suspended substances

Suspended substances (SS) are the key ecological-hydrologic element of the Danube mouth [19]. Such assessment of SS is defined, first due to great turbidity of The Danube water and the second due to high ability of SS to absorb the polluting substances (PS).

As a result of hydroengineering construction in mid river current the turbidity of water in the Danube delta gradually decreased for the last decades. For 20 years since 1959 to 1979 the decrease was by one third (from 325 to 200-205 g/m3). Annual average characteristics of turbidity for this period fluctuated within the limits 93-242 g/m3; monthly average from 16,6 g/m3 (XI. 1969) to 801 g/m3 (X. 1972), and daily average made from a few grams up to 2-3 кg/m3. In 1995-1997 [37] average contents of SS made 93 g/m3 at the fluctuation range of 15 - 215 g/m3. This naturally affected growth of water clarity. Nevertheless in some years of floods the SS can be quite considerable. Thus in May of 2000 the maximal concentration of SS made 528 г/ $м^3$.

In the delta arms in connection with decrease of the current speed the dredge begins transition to the bottom sediment. At seaside in the zone of mixing river and seawaters in the saltiness range of 2 – 6 ‰ a coagulation of organic and mineral substances on the dredge particles occurs. It facilitates further sedimentation of suspended matter in a zone of so-called avalanche sedimentation spreading for a few kilometers from the delta margin. In this zone up to 90% of suspended substances settle. [38].

Suspended substances have a key role in ecology of the river and the seaside because on the one part SS restrict development of phyto and bacteria plankton, on the other hand they facilitate absorption of up to 80-90% of total pollutants contents (heavy metals, oil products, synthetic Surface Active Substances and other) [39]. Dredge is a factor of concentration of toxic substances.

4.3.2.2 Mineralization.

The most important characteristic of fresh waters quality is believed their general mineralization, which for the last 50 years increased by 1,5 times [40] (table 4.3.1).

Table 4.3.1 – Dynamics of general mineralization of water on Ukrainian part of the Danube

Years	Mineralization, mg/l^3	
	Limits of fluctuation	Average value
1948-1950	226-397	287
1958-1959	253-344	289
1963-1965	235-334	296
1976-1978	275-475	374
1985-1989	295-506	372
1990-1994	297-521	409

Such increase can have only anthropogenic nature: discharge of raw waters or not enough clean waters from industrial enterprises, fields, collecting systems of towns.

By records of the Danube Hydro-Meteorological Observatory the average mineralization of the Danube water in the area of Reni -Vilkovo for the period of 1995-2000 decreased fluently from 403 to 362 mg/l^3.

By ionic composition the water of Ukrainian section refers to hydrocarbonate class of calcium.

4.3.2.3 Biogenic substances and oxygen conditions.

The most important ecological factor for north-west part of Black sea, is run-off of biogenic elements mainly from the Danube. The table 4.3.2 shows that in 70 – 80th of XX century the concentration of substances, containing nitrogen and phosphorus, sharply increased by a few times, and in 90th came back to the values of 50 – 60th. Beginning from 90th, a noticeable decrease of concentration of mineral and increase of concentration of organic forms of nitrogen and phosphorus in the Danube run-off as well as disruption of ratio between them, which existed prior to the beginning of anthropogenic eutrophication [41;.42; 43;].

Table 4.3.2 – Multiyear changes of concentrations of biogenic substances in water of Kiliya deltas of the Danube

period	Volume of run-off, km^3/yea	NH_4	$N0_2$	NO_3	Nmin.	Norga	N total	$P0_4$	Porga	P_{total}
		mg/l^3								
1958-1960	179.4	0,25	0,012	0,53	0,79	0,63	1.42	0.071	0,031	0,102
1977-1985	227,7	0,62	0.044	1,00	1,66	0,90	2,56	0,165	0.071	0,238
1986-1988	204,7	0,57	0,160	1,26	1,86	3,07	4,93	0,281	0,100	0,380
1989-1992	169,7	0,44	0,118	1.63	2,19	5,07	7.25	0,233	0,113	0,336
1993-1996	195,1	0,13	0,074	1,18	1,38	3,74	5,12	0,091	0,096	0,187
1997-1998	222.8	0,05	0,016	0,56	0,63	6,97	7,60	0,078	0,048	0,126

Change in ecological situation in delta of the Danube is evidenced as well by retrospective analysis of quantity of dissolved oxygen. In middle of XX century its contents varied from 8 to 12 mg/l^3, a degree of saturation was from 80 to 95 %. In 90th a variability range sufficiently expanded, making 5,8 -12,8 mg/l^3 and 60-120 %, accordingly. Behind the high levels of oxygen concentration there is a sharp (by 2-5 times) increase in biomass of plankton that accounts by increase in clarity

there is an abrupt (by 2-5 times) increase in biomass of plankton, that accounts for increase in clarity of water due to a decrease in the run-off of the suspended substance. Low levels of oxygen concentration are connected with its consumption for oxidizing of organic substance,

being generated mainly when phytoplankton is dying off. Seasonal dynamics of the quality index of water connected with vital activity of biota are presented in graphs (fig. 4.1).

Monitoring of hydrochemical conditions of the seaside, starting from 1977 and comparing with the data in literature [42; 43] let one to establish that antropogenic eutrophication of the Danube waters showed also in increase of contents of mineral and organic biogenic substances in a zone of influence of its waters. At the seaside of the Danube in 90^{th} it was marked a sharp increase of organic nitrogen against a background of a slight increase in concentrations of its mineral forms. Contents of mineral and organic forms of phosphorus, being another most important element of hydrochemical conditions changed slightly since 80^{th}.

It was established that on the seaside of the Danube as a result of physical-chemical and dynamic processes a maximal transition of a substance from water into bottom depositions occurs in a zone of avalanche sedimentation (saltiness 2-6 ‰). Development of biological processes (vital activity of phito, zooplankton) at seaside also influences dynamics of biogenic substances. Mineral and organic compounds of nitrogen and phosphorus together with the suspended substance are accumulated in the soils of seaside. The soils of seaside at present in itself is a «depot» of biogenic substances. A specific character of hydrologic conditions on the seaside is such that in summer season the near-bottom stratum is isolated from the overlying strata of the sea by abrupt thermo- halocline. On absence of inflow of oxygen and destruction of organic substance the hypoxia and anoxia becomes usual phenomena on the seaside resulting in a rise of restoring conditions. At that the biogenic substances come to the near-bottom stratum of the sea from the bottom sediment, which in this case is a secondary source of eutrophication.

4.3.2.4 Polluting substances of toxic action

Water of the Danube in Ukrainian sector is persistently polluted with heavy metals (HM), oil products (OP), phenol and other polluting substances of toxic action (PS) due to coming in of industrial, communal and agricultural effluents [44]. Average contents of HM and OP by materials of Second International “Blue the Danube” expedition is presented in table 4.3.3.

Table 4.3.3 – Average contents of OP and HM in water of Ukrainian section of the Danube (September-October 1990)

Forms	OP Mic g/l^3	Fe	Mn	Zn	Cu	Pb	Ni	Co	Cd
		Mic g/l^3							
soluted	75	76,0	8,0	55,0	15,0	4,1	5,2	1,5	1,0
suspended	-	394.0	25.4	20.8	2.9	100	10.6	3.1	1.0

Nature of distribution of PS in the delta is connected with the particulars of hydrologic conditions and anthropogenic impact (economic activity, navigation, functioning of ports and so on) on the ecological system. Delta of the Danube can be attributed to the regions permanently foul with copper, zinc and cadmium (table 4.3.4). Concentration of these metals in undercurrent and middle current of the river is much lower than in the delta. This is connected with active application of plants protection means containing these metals in water-accumulating area and area of the delta in viticulture and horticulture [45].

Table 4.3.4 – Contents of pollutants в Kiliya delta of the Danube in 1993-1997

conditions	OP мg/m3	Cu	Zn	Ni	Cd	Cu	Zn	Ni	Cd
		Soluted form (mg/l^3)				Suspended form (mg/l^3)			
Surface stratum									
Min	0.01	0	0	0	0	0	0.004	0	0
Max	0.48	0.005	0.067	0.003	0.001	0.016	0.060	0.013	0.002
Average	0.09	0.003	0.011	0.001	0	0.005	0.021	0.004	0.001
Near-bottom stratum									
Min	0.01	0	0	0.001	0	0.001	0.008	0.001	0
Max	0.25	0.007	0.058	0.014	0.001	0.026	0.070	0.016	0.002
Average	0.07	0.003	0.014	0.003	0.001	0.008	0.027	0.005	0.001
AMBIENT AIR STAND	0,05	0,001	0,010	0.010	0,010	-	-	-	-

Generalized description of HM contents in water of the delta, shown in the table 4.3.5.

For Kiliya part of the Danube delta the high concentrations of phenols are specific: 0,013 – 0,120 mg/l^3 under Maximum Allowable Concentration of 0,001mg/l^3. Such concentrations to a considerable degree are conditioned by incoming of products of natural destruction of air-water vegetation (reed, cat-tail and other) into water.

Distribution of pollutants on the seaside of the Danube (table.4.3.6) is defined by peculiarities of their hydrologic conditions. On the seashore there is enrichment of near-bottom stratum with HM and OP due to the active absorption processes on the suspended substances and sedimentation in a zone of blending sea and fresh waters.

Table 4.3.5 – Contents of some heavy metals ratio of its suspended and soluted forms in waters of Kiliya delta of the Danube [9]

Metal	Fish economic. Maximum Allowable Concen-tration, mic.g/l^3	index	Total contents in water	Contents of suspended forms		Contents of solluted forms	
				mic.g/l^3	% of total	mic.g/l^3	% of total
Kiliya delta of the Danube							
Mn	10	Min. Max. Average.	32,8 720,0 117,3	13,4 660,0 92,0	40,7 99,2 76,4	4,5 168,0 25,3	0,8 59,3 23,6
Cu	1,0 (5,0)	Min. Max. Average	4,0 190,0 47,9	1,2 80,0 17,2	2,2 66,3 33,7	2,0 187,5 30,7	33,7 97,8 66,3
Zn	10,0	Min. Max. Average.	10,2 173,0 59,8	3,9 100,7 29,5	6,0 88,7 46,9	3,5 160,0 30,3	11,3 94,0 53,1
Pb	100,0	Min. Max. Average.	6,0 57,0 30,8	0,9 46,0 23,8	19,3 100 79,0	0,8 29,7 7,0	0,0 80,7 21,0
Cr	-	Min. Max. Average.	14,0 168,0 86,0	2,4 137,0 52,0	5,7 87,7 56,2	8,0 81,5 34,0	12,3 94,3 43,8
Bystryy arm							
Mn	10,0	Min. Max. Average.	21,6 218,0 76,5	12,8 190,0 50,7	32,6 81,5 65,8	6,8 75,0 25,8	18,5 67,4 34,2
Cu	1,0 (5,0)	Min. Max. Average.	4,5 86,5 37,6	2,7 58,7 14,3	7,5 79,2 37,6	2,3 80,0 23,3	20,8 92,5 62,4
Zn	10,0	Min. Max. Average.	18,3 92,5 50,8	5,5 47,8 22,0	16,7 83,6 42,8	3,0 50,0 28,8	16,4 85,0 57,2
Pb	100,0	Min. Max. Average.	10,3 130,0 35,8	7,5 80,0 22,3	48,5 100,0 72,0	0,0 50,0 13,5	0,0 65,6 28,0
Cr	-	Min. Max. Average.	23,6 135,7 80,9	9,6 83,2 37,9	40,7 61,3 46,9	14,0 64,0 43,0	38,7 59,3 53,1

Table 4.3.6 – Contents of pollutants on the seaside of the Danube in 1993-1997

conditions	OP mg/l^3	Cu	Zn	Ni	Cd	Cu	Zn	Ni	Cd
		Solluted form (mg/l^3)				Suspended form (mg/l^3)			
Surface stratum									
Min	0.04	0.068	0	0.56	0	0	1.88	0	0
Max	0.34	3.62	50.13	2.65	1.22	4.45	63.37	3.08	0.93
Average	0,10	2,28	11,34	1,39	0,31	1,37	13.09	1,06	0,29
Near-bottom stratum									
Min	0.03	0.35	0	0.61	0	0	0.13	0	0
Max	0.39	6.12	65.12	11.44	12.37	12.83	40.67	10.44	0.91
Average	0,10	2,51	12,70	2,62	0,57	2.12	9.37	1.52	0.25
Maximum Allowable Concentrat	0,05	0,005	0,050	0,010	0,005	-	-	-	-

Water masses of the Danube seaside is characterized with increased contents of phenols: in surface stratum (0,012 - 0,018 mg/l) for the whole period of observations in 1994-1999 (the same value of Maximum Allowable Concentration of 0,001 mg/l).

According to the approved procedures of ecological assessment of the surface waters quality by corresponding categories the waters of Ukrainian sector of the Danube in the middle of XX century were referred to II class and only in the worst cases to III. By the end of the century the usual condition of the water quality was class III and the worst one was the class IV. According to the verbal description the II class is good, quite clean, in average it is the eutrophic water; III class is at best the satisfactory, weakly foul and at worst the water is mediocre, moderately foul, PS-polytrophic; IV class water is bad, foul, polytrophic [40].

4.3.3 Description of bottom sediments

Bottom sediment is active enough component of the ecological system. This is because the basic part of pollutants are adsorbed by medium-sized silt particles (0,015-0,05 mm),as they have absorption capacity more than the larger ones and their share in dredge predominates at all seasons of the year. On the other hand it is known that the particles of such size and less do not settle on a bottom at the current speed over 0,6 м/с. Temporary silt sediment, being formed during low-water are carried away during the floods. According to some data over 80% of main current bottoms of Ukrainian sector of the delta are covered

with sand sediment, which in addition migrates and are of little use for the development of bottom organisms [39].

During construction of DWCS there will be the various kind of bottoms developed which are polluted in this region with heavy metals (HM), oil products (OP), phenols and other polluting substances.

Contents of metals in the bottom sediment in Kiliya - Reni section according to the Second International expedition «Blue the Danube» [44] is presented in the table 4.3.7.

A range of polluting agents' concentration in bottom sediment of Kiliya delta and the seaside of the Danube [45] is presented in table. 4.3.8.

Grounds of sand-bar section of the projectile DWCS are saturated with mineral and organic compounds of nitrogen, phosphorus, silicon. Concentration of these compounds in the grounds and interstitial waters exceeds by two orders the concentration in the near-bottom stratum.

Table 4.3.7 – Contents of HM in bottom sediment of the Danube in the section of Oily-Rein (September-October 1990)

River section	pH	Mn	Zn	Cu	Pb	Ni	Co	Cd
	mg/g of dry weight							
Kiliya, 32	33,20	0,92	0,188	0,110	0,066	0,062	0,022	0,002
Down Izmail,	50,03	1,20	0,120	0,034	0,050	0,088	0,026	0,002
Above Izmail,	25,00	0,80	0,160	0,028	0,034	0,046	0,016	0,001
Down Reni 182 Km	7.6	0,44	0,060	0,018	0,012	0,042	0,022	0,001

Table 4.3.8 – Level of pollution in bottom sediment of delta and seaside of the Danube for the period 1993-1997

Range	OP	Cu	Zn	Ni	Cd
	mg/g of dry soil	mg/g of dry weight			
Delta					
Min	0.1	2.0	25.2	23.0	0
Max	4.5	102.8	242.8	396.0	13.2
average	0.9	46.2	129.6	62.8	6.6
Seaside					
Min	0.1	0	50.8	20.2	0
Max	5.2	201.6	516.2	144.4	17.0
average	1.8	48,9	138,5	50,8	6,2

According to the results of microbiological research of bottom sedimentation in the arms of Kiliya delta (Starostambulskiy, Vostochny, Bystry, Prorva) and the seaside, which included qualitative and quantitative characteristics of saprophytic bacteria and quantitative characteristics of colibacillus bacteria (CB) [1], the highest index of saprophytic bacteria in bottom sedimentation was registered in the delta arms. At all stations the evident tendency was traced of increasing in the number of benthos bacteria from springtime to a summer-autumn period. In summer-autumn period the number both saprophytic bacteria and CB in bottom sediment in the seaside area was 1,5-2 times lower than in the arms of delta. This has not to do with spring period when saprophytic bacteria in the arms soil were 2,7 times less than at seaside. On average, on seasons the quantitative characteristics of benthos bacteria changed insignificantly however, the changes in the number of benthos bacteria can be too big.

4.3.4 Analyses of navigation passage impact on surface waters

Factors of impact of construction and operation of DWCS on the water medium are enumerated in section 3.4. In this subsection the processes caused by these factors and the possible consequences on separate sections of the delta, through which the route of DWCS passes.

Section of Reni -Vilkovo

In this section where navigation is carried out during long time the main factor of impact on the water ecological system is dredging, which periodically is made here. The main process of the impact-taking place while dredging is an increase of water turbidity, inflow of biogenic and polluting substances from bottom sedimentation in solluted form and absorbed on the silt particles. Secondary pollution of this kind takes place regularly in delta of the Danube in natural conditions at the periods of increased consumption of water going with increased content of suspended and drawn alluvions.

Deterioration of water quality of a number of evaluative and normative indexes as a result of dredging, disruption of oxygen conditions and enhancement of eutrophication processes only partially are synchronously connected with operation of dredging equipment.

It is also conditioned by coming in pollutants from temporarary bank dumps (mainly under heavy atmospheric precipitation) and direct destruction of benthos organizms in the sections of bottom being deepened, that results in slowing down the processes of self-cleaning for a long period. More long impact is made by changes in morphometry and orthography of bottom surface, qualitative and granulometric structure of bottom grounds, which in turn brings in the change in hydrodynamic and lithodynamic conditions. All the described processes lead to the change of water life biotope, their partial destruction, failure of ichthyofauna reproduction conditions.

Comparison of the bottom areas, damaged at dredging in the section of Reni - Vilkovo (1,129 km^2), total area of the riverbed in this section (about 80 km^2) shows that at the period of construction there will be totally about 1,4 % of bottom biocenosis damaged and this can't affect appreciable influence on the water ecological system of the section. Hence, main impact on the water quality at the construction period will render the coming in water the pollutants from bottom sediments, which main source is a loss of ground during dredging, which according to the active norms make 2–5 % of the ground extracted (depending on the type of a hydraulic dredge). The major role in pollution of the water is for small fractions taking on average about 5 % of the sedimentation volume. Their predictable volumes for the time of construction and at the period of operation are shown in table 4.3.9.

Table 4.3.9 – Predictable volumes of soil losses at dredging works

Name of a section	Construction				Operation on cleaning by Technical Economic Ground	
	Volume of losses, thousand m^3		Volume of discharge of small fractions, thousand m^3		Volume of losses, thousand m^3 / year	Volume of discharge of small fractions, thousand m^3/year
	in delta	On seaside	in delta	On seaside		
Reni -Vilkovo	43,84	-	2,19	-	16,0	0,8
Vilkovo-Bystryy	8,5	107,8	0,42	13,64	8,8	0,4

Permanent physical-chemical impact on water ecological system of the delta as a whole can be estimated by comparing predictable total mass of incoming admixture per year of construction with yearly river flow-off and determining of average value of increase in concentration of polluting ingredients in water as it was done in a report of Institute of Hydrobiology [9].

Not less important is to estimate maximal predictable gain of polluting admixtures at the section of executing dredging at the period of the hydraulic dredges work.

Such calculation was done for the work at one section of two dredges with nameplate capacity 1000 m^3 of soil per hour for each hydraulic dredge. The volume of simultaneously extracted soil was accepted 1200 m^3/hour subject to their non-synchronous operation and wear and tear. Calculated consumption of water is accepted as a minimal yearly consumption at 95 % provision equaling 1350 $м^3$/sec in section line of Kiliya and minimal consumption of 850 m^3/sec observed at this section of riverbed. Content of calculated substances in extractive ground is accepted in accordance with the data in the report of Institute of Hydrobiology [9]. Alternatively the most pessimistic assumption is that all polluting and biogenic substances, which were in the mass of soil lost during loading, remain in the water thickness. In calculations the density of preliminary loosened soil is accepted 1,6 g/cm^3.

Results of the calculation made regarding the change in contents of pollutants on average throughout the whole cross-section of water flow in Kiliya arm are presented in table 4.3.10–4.3.12. They are the evidence that out of the biogenic substances the greatest relative gain (by 16,2 % at consumption of the river water at 1350 m^3/sec) can be reached for gross content of phosphorus compounds in water. In case of permanent action the given factor can lead to a corresponding increase in eutrophication degree eutrophication of water objects of the Danube delta, however calculated increase of concentration could occur only for a short duration. For duration, corresponding to the cycles of biological productive processes (24 hours and more), average increase of phosphorus concentration in water is predicted a one order lower received during the calculation and can’t essentially influence the level of trophicity of the below sections of the delta. Increase in concentration of total nitrogen in water will make slightly over 0,1 % in calculations and can’t influence the processes of eutrophication.

Total content of organic substance during execution of dredging (by indexes of Biochemical Oxygen Demand$_5$ and Chemical Oxygen Demand) can increase for a short time by 5–6 %, concentration of oil products by 9 %.

The greatest growth of heavy metals concentration predicted for manganese is up to 11,5 %. Increases in concentration of other metals and toxic organic substances will not exceed 2,5 %. From this analysis one can conclude that increase of the polluting concentration in water at the construction period can only result in short-time and local impacts on the water quality, not changing on the whole the existing sanitary-toxicological situation in Kiliya delta of the Danube and in its separate arms.

Regarding the suspended substances themselves the predictable calculation shows that near the working hydraulic dredge their addition can reach a few tens of mg/l^3, however, as the cloud of dredge throughout the whole width of the flow as far as it is spreading and sedimentation of large fractions the content of the suspended substance in water drops abruptly.

If to take that the loss dredge coming in to a water consists only out of small fractions making 5% of the bottom sediment and does not further go for sedimentation, then at the consumption of 1350 m^3/s the addition to a background content of the suspended substances will make 0,4 mg/l^3 on average in a cross-section of the flow and at the consumption of 800 m^3/c it will be 0,68 mg/l^3. At that even in the case when the background of the suspended substances will turn out to be less than 30 mg/l^3, the requirements of Sanitary Project and Norms (СанПиН (SanPiN) 4630-88) are observed according to which the content of the suspended substances in the points of cultural-everyday water use should not increase more than by 0,75 mg/l^3.

Increse in concentration of polluting admixtures on average cross section of the current can characterize impact of dredging on quality of water current in the case, when the source of impact is located at considerable distance from the control section line. From the viewpoint of protection of water medium on the territory of DBR the most important control section lines are the ones before the forks of arms Ochakov-Starostambulskiy and Bystryy – Starostambulskiy, as the spreading of pollutants throughout the system of watercourses of Kiliya arm delta depends on distribution of pollutants throughout the width of watercourse in the given section lines.

For the case of carrying out dredging on the rift, being at the least distance from these section lines the calculation of pollutants distribution in the current for the most unfavorable conditions was done: at the calculated consumption in Kiliya arm at the level of yearly consumption of 95% provision in the section line of the town of Kiliya (**Q**=1350 m^3/s) and working of bottom sediment at the distance of 50 m from the left bank of Kiliya arm. Technological conditions and amount of losses corresponded to the mentioned above, all polluting substances coming into the water of the Danube was considered as conservative and the possibility of re-sedimentation of small fractions of suspended substance was not taken into account. Consumption of water in the arms per the year for 95% provision is presented in the table 4.3.13.

Table.4.3.13 – Consumption in the arms of the Danube river for a year with 95% provision

Arm	Outflow portion, % of **Q**	Consumption of water, m^3/s
Kiliya (town of Kiliya)	100	1350,0
Solomonov	50,9	687,2
Ochakov	27,4	369,9
Bystryy	33,2	448,2

Diagram of location of the check section lines (CSL) is presented on the fig.4.2. In fig.4.3 the graphs of concentration areas for suspended substances along the check section lines №1 и №2 are presented. (For visualization the abscissa axis are presented as a percentage of water consumption in CLS Q_{CSL} from left bank to the right one). As the process of blending the river water and dredge is identical for all substances, the presented graphs characterize the picture of pollution for all indexes.

Background concentrations of pollutants in the Danube river and in the bottom sediment are presented in table.4.3.14.

Table.4.3.14 – Background concentration of pollutants in the Danube river and in bottom sediment

№	Index	Background concentration,mg/l^3	Average content in bottom sediment, mic g/g	Volume concentration in bottom sediment, mg/l^3	Maximum Allowable Concentration p/x, mg/l^3
1.	Suspended substances (small fractions)	30	50000	80000	background+ 0,75
2.	Nitrogen general	7,6	1200	1920,0	–
3.	Phosphorus general	0,126	2600	4160,0	–
4.	Manganese	0,1173	1770	2832,0	0,01
5.	Zinc	0,0598	225	360,0	0,01
6.	Copper	0,0479	128	204,8	background+ 0,001
7.	Lead	0,0308	108	172,8	0,1
8.	Cadmium	0,002	3,3	5,3	0,0033
9.	Chrome	0,086	176	281,6	0,001
10.	Oil products	0,08	920	1472,0	0,05
11.	ПАУ (Surface Active У.)	0,00037	1	1,6	–
12.	DDT	0,000051	0,032	0,051	–
13.	hexachlorocyclo hexane	0,00017	0,01	0,016	–

While determining the concentration and polluting substance in CSL №1 it was taken into account that left section of the current (from Solomon arm) and right one (not foul from main riverbed) have background water quality. As the ratio q/Q=0,07/1350=0,000005 <0,0025, then , according to [52], quality of water in of the foul part of the current was calculated by ТПИ/TPI method [53], based on analytical solution of the equation of turbulent diffusion. As the consumption of the foul part of the current in CSL №1 is commensurable with total consumption in the river the calculation of concentration fields in CSL №2 was performed by method of Karaushev (flat problem) subject to the transverse circulation in current and kinematics heterogeneity [53].

In view of laminarity of the current in Kiliya and Starostambulskiy arms of the Danube river (enclosure 2), it was supposed that the left part of the current (27,4% от Q) is

supplied to Ochakov arm. So the average concentration in the given section of the current characterizes the water quality at the water head of Ochakov arm. In the rest part of the current the concentration fields were calculated in CSL №3 (fig.4.4) in similar way and in accordance with them the water quality at the water head in Bystryy arm was calculated.

As it can be seen from fig. 4.3 and 4.4, the pollution does not cover the part of the streamflow in CSL №2, which comes in Ochakov arm (27,4% of the total outflow of the Kiliya arm). Main part of the foul current comes in the arm of Bystryy, which outflow portion makes 45,7% of the total outflow in CSL №3. Hence the dredging in this case renders a man-caused influence predominantly on the quality of water in Bystryy arm. Calculated values of the water quality are presented in table.4.3.15.

Table.4.3.15 – Calculated quality of water in Bystryy arm

№	Index	Concentration in water arm, mg/l^3	Maximum Allowable Concentrationp/x, mg/l^3	Background. concentration, mg/l^3	Exceeding in background	
					absolute, mg/l^3	relative,%
1.	Suspended substances (small fractions)	31,10	background+0,75	30	1,1	3,67
2.	Nitrogen general	7,63	–	7,6	0,03	0,39
3.	Phosphorus general	0,183	–	0,126	0,057	45,24
4.	Manganese	0,156	0,01	0,1173	0,0387	32,99
5.	Zinc	0,064	0,01	0,0598	0,0042	7,02
6.	Copper	0,051	background+0,001	0,0479	0,0031	6,47
7.	Lead	0,033	0,1	0,0308	0,0022	7,14
8.	Cadmium	0,002	0,0033	0,002	0	0,00
9.	Chrome	0,090	0,001	0,086	0,004	4,65
10.	Oil products	0,100	0,05	0,08	0,02	25,00
11.	ПАУ (Surface Active У.)	0,00039	–	0,00037	0,00002	5,41
12.	DDT	0,000052	–	0,000051	0,000001	1,96
13.	hexachlorocyclohexane	0,00017	–	0,00017	0	0,00

As on can see from table. 4.3.15, the calculated values of concentrations for those indexes which background quality of the Danube river water meets the required norms the calculated values of concentrations also do not exceed Maximum Allowable Concentration (cadmium and copper). For the rest of water indexes the conclusion on the degree of man-caused impact on the basis of relative exceeding of background level of the pollution. The maximum relative exceeding is for phosphorus, manganese and oil products (45,24%, 32,99%, 25,00% accordingly).

Results of the calculations show that in case of carrying out dredging at the closest rift to the territory of DBR the main mass of pollutants comes in to the sea through the system of Starostambul arm and practically does not influence on the water quality in the current of the system of Ochakov arm.

While operating of a hydraulic dredge near the Shore of Ermakov Island the main portion of pollutants will be brought to the Bystryy arm, at that in low waters period the deterioration of the water quality in it by a number of indexes will be noticeable (5-45% regarding to their background values. In order to avoid this the cleaning of this section of the riverbed is carried out at the periods of the increased waters by using no more than one hydraulic dredge.

As place of dredging moves away from the delta of Kiliya arm the polluting substances will be distributed more evenly in the system of the currents of Kiliya delta, at that as it was shown above the impact on the quality of the water will be insignificant.

Besides direct coming in of polluting admixtures from bottom sedimentation due to the losses during a hydraulic dredges operations the dredging is connected with the process of pollution of river waters by seepage waters and outflow of atmospheric precipitation from the places of storage of extracted bottom sedimentation. The most significant contribution to the man-caused pollution of the river water is expected with rain showers. According to the calculations a 10 mm atmospheric precipitation during an hour on the whole territory of dumps with 100% filling with soil the total runoff of rain showers foul waters reformed in the settling-basins will not exceed 1 m^3/s from this territory, and a total transport of pollutants with this drainage will be sufficiently less than at direct losses of the extracted soil.

So the processes of impact on the environment, occurring during dredging, are controlled and their consequences under proper organization of the works can be restricted to the acceptable level.

First of all it refers to determining of the conditions of the works performed, choice of the storage places and working out measures to avoid pollution of river waters with return waters from dumps. In the project the suspension of the works is provided during fish sprawning and young fish motion for one month. The restrictions can also be brought in on dredging at extremely low flow rate waters and on the basis of result of monitoring the water quality.

The mentioned restrictions refers both the dredging at the period of construction and at the maintenance operations of cleaning the bottom, which smaller volumes in comparison with the works of the construction period enable to take into consideration the ecological requirements in greater extent and on necessity to reduce intensity of the ground extraction.

Section of Vilkovo – sea edge of the delta

Riverbed deepening work in this section will be carried out in Starostambulskiy arm and the suspended substances, produced during this work can only partially be brought in Bystryy arm. **At the same time the protection of this section from negative impact of construction works are especially important, because below the site of the works both the banks of Bystryy arm and left bank of Starostambulskiy arm are adjacent to the zone of the strict reservation conditions of DBR. Strict observation of all ecological restrictions provided for carrying out such works on the above sections is compulsory for this area. The additional restriction like the one on the carrying out the works in the section of a sand-bar is a suspension of the work during the birds nesting.**

Besides impact of dredging, carried out in the area of the riverhead of Bystryy arm its ecological system can experience the impacts connected with making the sea approach channel through the area of the sand-bar.

Enhancement of set-down – positive setup phenomena predictable after opening the sand-bar can facilitate to some extent the improvement of water exchange in water-meadow rendering the positive impact on biota of DBR, and under excessive influence result in gradual destruction of the formed complex of waterно-marsh grounds.

Results of quantitative modeling of the positive set-ups carried out by Institute of hydromechanics of National Academy of Science of Ukraine presented in the report of Institute of hydrobiology [9], are the evidence that the influence of changing parameters of the positive setup wave will be insignificant and spreads within the limits of a few tens of meters inside of waterside of Bystryy arm.

Process of penetration of salt water of the seaside deep to the current mouth zone was researched for the Ochakov arm for which a critical speed of the current impeding this process was determined. There are evidences [9] that the salt waters could as well at the positive setups spread before in the near-bottom stratum at all length of Bystryy arm.

Preliminary calculations for penetrating of salt field during organization of the sea approach channel, carried out by Institute of hydromechanics of National Academy of Science of Ukraine showed that creation of the opening will exceed the saltiness at the inlet into arm and result in increase by about 1,5-2 times the length of salt field. However, at all values of a differential of saltiness the salt field will not penetrate into arm at the flow rate over 800 - 900 m^3/s.

Impact of waves from the passing ships at the period of operation of DWCS is considered in the present Report of Impact on Environment in the section 4.1.2 in the aspect of possible wash-outs of near-riverbed swells of Bystryy arm i.e. the direct impact on the processes of relief forming of the delta. However in case of extensive wash-outs the consequences of such impact are predicted in the form of disrupt of water and hydrochemical conditions of large massifs of water-meadow, separated by riverbed swells from river current, degradation of vegetation and animal life of riverbed swells and adjacent territories. Therefore returning to the earlier produced analysis of the given impact we shall once more notice that according to the preliminary calculations carried out by IMG the limitation of a ship 7 knots speed while passing Bystryy arm accepted in the project is sufficient to preserve riverbed swells in steady state. Additional restriction of speed may be

accepted on necessity on the basis of the results of monitoring at the period of experimental operation of DWCS.

So the results of modeling research enable to estimate a possible change of a level, wave and salt conditions in Bystryy arm while building and operation of DWCS as those which subject to operational restrictions of speed for the passing ships provided in the project does not go beyond the existing values of main characterizing parameters and can be accepted as allowable.

The final conclusions and prognosis will be made on the results of hydrologic and hydrochemical monitoring at the period of operation of experimental passage by a ship.

4.3.5 Analysis of impact of the ship passage on coastal areas of the sea

Section of a sand-bar of the Bystryy arm

The main negative impacts on water quality of the seaside at construction period are effected by making sea approach channel through sand- bar of Bystryy arm and creation of protective dam. The source of pollution in the area of the sand-bar will exist only at the period of operating the equipment and then will quickly be dispersed by the current of Bystryy arm and the sea streams. At this the main damage will be inflicted to benthos organisms both due to worsening of water quality as well as damaging of considerable areas of bottom. However benthos in this area is accommodated to the active processes of reforming of the bottom relief, permanent carrying away of pollutants and alluvions due to it being capable to restore quickly after termination of man-caused factors, which in this case are similar to the natural ones.

Section of the sea dump of ground

Main volume of the ground extracted is subject to a burial in the sea dump. The area of this dump is approved by the decision of Odessa region authorities and coordinated with the organs of sanitary supervision and inspection of the Black sea protection.

The grounds to be extracted at the first stage of construction by status on October 2003 refer mainly to the class A and **I**, not needing special precautions while shifting and dumping.

The planned capacity of the dump while filling the ground of 3 m thickness is determined as 5361 thousand m^3. At even distribution within the limits of the selected dump circle the masses of the shifted grounds at the first stage will be laid in a layer thickness of 0,6 – 0,7 m.

In the area of dumping ground a local long-term pollution of the bottom and water mass is predicted. The consequences of the dumping are predicted by way of destruction of the bottom biocenosis, worsening of oxygen conditions, increase in trophic structures and toxic action on hydrobiotones.

As a result of complex hydroecological examination of the water area of the Danube seaside, adjacent to the mouth of Bystryy arm, the area has been chosen to organize the sea underwater dump of the ground with the center coordinates **45°19′13″ north and 29°51′58″ east and** depths of 22 – 23 m. The ground dumping is located south from the entry to the sea approach channel at the axis of fresh water runoff and at the period of flooding it gets into a zone of maximal removal of the suspended substance. It is extremely important for the process of natural burial of the storing ground and prevention of the pollutants outflow from the stored grounds into the water thickness. At the same time the discharged ground does not get onto the zone of driven alluvions formed by general along-shore carrying over and so will not shift to the zone of channel. Territory of the dump is over 5 km away from the seashore excluding spreading of tail area of foul water into coastal zone.

This area is also characterized for the grounds close by the degree of pollution to the grounds in the area of the opening, relative scarcity of the bottom and deep-sea biocenosis. Judging by temperature characteristics and oxygen conditions in near-bottom stratum, the recommended place of the ground dump subject to short-time spring –summer hypoxia (no longer than 2 - 3 weeks). This means that during the last 30 years as a result of oxygen shortage in near-bottom stratum there was a definite depression of benthos. According to the results of research of the Danube seaside for many years it was determined that the recommended place of ground dumping has not to do with permanent and long hypoxia. So the hydrologic conditions and

hydrobiologic characteristics of the selected place of underwater dump of the ground provide minimization of impact of the dumping on biota.

According to the project the area intended for the dumping of grounds presents in itself a circle of 1 sea mile in diameter. A segmentation and subsequent filling of the parts of the dumping area is provided for the purpose of its even use. Such organization of the works on the dump will enable to observe restoration of the bottom fauna in the filled sections.

Calculation made during the working out the Report of Impact on Environment of the sea dump by the methodic of ChernomorNiyiproject and the State Oceanographic Institute showed that beyond the check section lines the concentration of turbidity will remain within the limits of natural changeability of turbidity [50].

4.3.6 Ships passage impact on quality of the water. Emergency situation

Impact of the passing ships on quality of the water in normal operation conditions is predicted as insignificant. Ballast and sewage waters according to the shipping rules are to be delivered to special ships. Heated waters of the engine cooling systems relates to the category of “conditional clean” and in the existing discharged volumes can’t sufficiently influence the river water quality.

The most serious negative impacts at all sections of DWCS can be caused by the accidents with the passing ships. According to the estimates available the probability of the emergency situations in the ship passage, which meets international requirements for navigation, is extremely low. It’s important that the riverbed of Bystryy arm is separated from the adjacent territories of water-meadows with near-riverbed swells acting as the sand-bars. So a source of pollution arisen as a result of a shipwreck firstly would have affected the coastal area of the seaside and only from there the polluting substances can spread in the water-meadows.

At the same time, even in case of building ship passage in Ukrainian section of the Danube delta, the dangerous consequences of the shipwrecks in the above navigable sections of the Danube will be able to appear in full on the territory of DBR, because the pollution if occurred as a result of a shipwreck will inevitably spread to the boundaries of the reserve.

4.3.7 Conclusions on impact of the ship passage on the water medium

Analysis of impact of DWCS on the water medium indicated that the main factor of impact is dredging, which is provided in the area of sand-bar of Bystryy arm and in the sections of Kiliya and Starostambulskiy arms used for navigation earlier. In the Bystryy arm itself no construction work is provided in the project.

Main negative impact is effected by opening of the sand-bar of Bystryy arm. At that the negative consequences arise for the processes of forming the quality of water in the arm itself (due to spreading of the salt water field) and in the area of the sand-bar. Under conditions of great flowage of the arm and unconfined water exchange in the adjacent water area of the seaside the changes of water quality will be short-run.

Results of the modeling research allows to estimate a possible change of the level, wave and salt conditions in Bystryy arm during building and operation of DWCS as ones being subject to operational speed restrictions provided by the project while ships are passing are within the existing values of main characteristic parameters and can be considered allowable**.**

Opening of the sand- bar can result in redistribution of water flow in Kiliya delta, however at the next stage of construction the necessary measures of protection are provided on necessity which are capable to make the process controlled not to allow the negative consequences for water conditions of the delta.

4.4 Soils. Ground

Conditions of soil forming in the delta are conditioned mainly, by hydrologic conditions and the relief pattern. Depending on the Danube water level and its duration the various areas of delta are subjected to flooding for short or long time.

Very changeable conditions of surface and subsoil water give rise to the change in the soil forming processes. So, along with well-developed soil cover there are young and undeveloped soils. Vast areas in the delta are constantly covered with water so practically

there are no soils there. Luxuriant vegetation of the delta serves a source of enriching the soils with humus and organic substance.

The most favorable conditions to form the soils are on the riverside ridges so the soil cover there is most developed.

By a degree of spreading and forming the soils in the delta one can mark out 5 classes of soils: juncaceous water-meadows and Lucopodiales, lake-marsh, sand, alluvial, saline chestnut chernozems.

Taking into consideration the kind of construction and operation of DWCS, the impact on the soil cover in the area from Reni to the arm of Bystryy will be limited by separate areas along the channel route where alluvial soils are predominant. These soils are formed on the near-riverbed ridges and from economic viewpoint present the greatest value. They are rich in mineral salts (in river alluvions) and humus, very fertile, they are weakly saline in high-level places. Alluvial soils are distinguished in structure and the degree of development. Alluvial-turf soils are exposed to short-term flooding, the depth of subsoil waters is 1 - 1,8 m, oxidizing processes are predominant. These soils have gray tints with rusty inclusions, lumpy and laminated structure.

The complex of dredging planned during the construction of DWCS is connected with delivery of the soils worked by the hydraulic dredges to the banks specially equipped with inwash chart places. Territories of inwash charts are excluded from economic activity and are specially intended for storage of the soils during the dredging. On these charts there were a great volumes of soils stored earlier so the formed soil cover on them is man-made and not a natural one. The inwash is intended to be carried out with the settling basin arranged along the dam as the sections of dams of 1,1–2,5 km long provide such conditions.

Organization of temporary dumps on the bank is timed to the places of diking dams needing a repair. Width of the dumps is about 500-600 m. Recommended mark of the inwash is 2,2 - 2,5 m BS (Baltic System). Under such restrictions of the dump one can secure storing of sand and silt, having a high degree of clarification of the discharged waters. For this a lay-out of all territory for inwash sections is necessary with their alternate filling. With sand grounds availability one can reach fractionation of indelible grounds i.e. separation of sand for further use in construction of minor structures. Main mass of the

ground from dumps will be used in the works on restoration of destructible sections of protective dams.

Vacated territory of the inwash charts later on can be returned to the economic activity i.e. after reclamation the newly formed not flooded territory can be used in agriculture.

With purpose to prevent negative impact on the soils and vegetable cover of the near-riverbed banks along the arm of Bystryy a decision in the work project was accepted to reject the arrangement of permanent and temporary signs of navigation on the banks of the arm limiting it to the installation of floating signs which maintenance will be realized with vehicle-assisted means.

4.5 Flora and Fauna, the nature reserve objects

As the navigation in Kiliya arm and above section of Starostambulskiy arm was effected earlier and for storing of the bottom sedimentation the territories are provided to be used which have been already exposed to the man-caused heavy duty and this territories do not represent botanic and zoological value then the description of biota and estimation of DWCS impact mainly have to do with the sections of DBR adjacent to the arm of Bystryy. The presented below description of vegetation and animal life on the territories, located in the area of DWCS route is based on the report of Institute of Hydrobiology [9], which is the main part of Technical Economic Ground and the data of the directors board of DBR, placed in the materials of the institutes which participated in working up Technical Economic Ground materials on investments and working draft on construction of DWCS [1; 46].

4.5.1 Description of DBNR (the Danube Biosphere Nature Reserve).

The route of DWCS below Vilkovo crosses territory of DBR which is a part of Ukrainian delta of the Danube, which biota is the most valuable and at the same time most vulnerable. Just this case attracts fixed attention of ecology experts of various specializations to the analysis of nature and expected impact of construction and operation of DWCS on the vegetation and animal life.

The President of Ukraine in a Decree No 861/98 founded DBR of National Academy of Science of Ukraine (NAS) on August 10, 1998 on the basis of natural reserve "the Danube water-meadow" of the Academy of Sciences of Ukraine, which existed as self-supporting organization since 1981. Before this (since 1976) the territory was a branch of Chernomorskiy reserve. Area of DBR was fixed at the rate of 46402,90 hectares together with channels, interior ponds and 2 km strip of water area of Black sea adjacent to the delta. At that 23740,9 hectares are included to its makeup without taking away from the land users.

By decision of UNESCO of 02.02.99 the reserve has received the appropriate international certificate of biosphere reservation. By the same decision of UNESCO an integrated Rumania-Ukraine bio terraneous «Biosphere of the Danube Delta» reservation was created that is one of the five bio terraneous reservations in the world. Water-bog grounds of the Danube delta are included in 200 of most valuable and high in bio variety of the grounds in the world, which constitutes the planetary network known as Global 200 (WWW International).

At present the territory of DBR has the following structure:

- **Reserved zone (the zone of strict conditions of reserve)** – territory of the former natural reserve "the Danube water-meadows" of 14851 hectares fig. 4.2, in which there are *prohibited*: presence of the persons without respective permits, hunting, catching of animals, cattle pasturing on the seaside spits; *allowed are*: Normalized pasturing of cattle along riverbeds, extraction of water nuts, provision of reed, cleaning of channels to restore fish yield and conservation of the lakes productivity, traditional burning–out of juncaceous bush, regulation of number of separate kinds of animals, forest recreation, scientific and ecology-educational tourism, strictly controlled traditional commercial fishing, which can be temporary limited during nesting and forming of big aggregation of birds.

- **zone of regulated reserve conditions** – territory of Stentsovskiy-Zhebriyanskiy water-meadows of total area 7811 ra, where *it is allowed*: limited pasturing of cattle, commercial and sports fishing,, prey of musk-rats, green frogs, sports fishing, provision of reed, organization of tourist activity;

- **Buffer zone** – a territory of 19687 hectares in total (south section of Ermakov island and water-meadow lands between Zhebriyanskiy ridge and western boundary of the reserve

zone of 13000,8 hectares as well as a strip of Black sea and its Zhebriyanskiy bay of 6686,2 hectares), on which in order to avoid negative effect on the reserve area the economic activity is realized mainly within the framework of its traditional way; *it is prohibited* to change the type and features of the natural landscapes.

- **Zone of anthropogenic landscapes** is the territory of total area 4053,9 hectares (north section of Ermakov island, Zhebryyanskaya ridge, vegetable gardens and pastures near Vilkovo along the arms of Belgorodskiy, Ochakov, Ankudinov, Starostambulskiy), which economic use is realized with restricted application of harmful technologies, use of biological resources, type and volumes of insecticides, pesticides and herbicides are coordinated with administration of the reserve.

By the Decree of the President of Ukraine No117/2004 dated of 02.02.2004г in order to make better the natural state of unique natural complexes in delta of the Danube , protect water-bog lands of international value, other valuable natural complexes of Ukrainian near-the Danube lands, execution of zoning of the territory of DBR and optimization of its control subject to the interests of the region development, transport and other national needs, as well as aactivation of international cooperation, scientific research and monitoring of the environment the scheme of temporary zoning of DBR territory was approved concurrently with expansion of its territory (Annex 4). In accordance with this scheme in order to restore navigation in Ukrainian section of the Danube river delta the lands of coastal protective strip of the Danube channels i.e. the arms of Bystryy and Ochakovskiy and adjacent section of the Black sea defined water area within the limits of DBR territory are referred to the zone of anthropogenic landscapes (Annex 5).

So the decree introduced a creation of deep-water ship passage in Ukrainian section of the Danube delta according to a version of route through-passing the arm of Bystryy into the legal sphere of Ukraine and eliminated fundamental legal obstacles for a possibility to receive an affirmative conclusion of integrated official commission of experts on the working draft of the first stage of construction.

Assignment of DBR is to achieve long-term ecological purposes in everyday activities, which in the report [9] are determined in the following way.

The most general purposes:

- Provision of maximal naturally running processes in the delta and conservation of the biologic variety at the ecological, organism and genetic levels under the conditions of steady development of the region;
- Execution and provision of long-term regular observations (ecology monitoring) with up-to-date methods (including remote ones by space instruments), processes of succession (self development and deformation of structural-functional organization) of water and ground-based systems of the Danube delta on impact of natural factors of regional and planet scales under conditions of minimization of anthropogenic activity.

Purposes for separate territories:

Secondary delta of Kiliya arm of the Danube:

- Conservation of the biologic variety, maximal naturalness of delta forming processes, ecological and economic potential of the grounds under conditions of partial and rational use of natural resources.

Stentsevsko-Zhebryyanskiy water-meadows (SZW):

- Renewal and maintenance of SZW as a stable and mosaic flood-plain ground with shallow water grounds and currents relying as much as possible on the natural processes of the water-meadows functioning, preserving their natural and economic potential at the same time.

Zhebryyanskaya ridge:

- Provision of stable functioning of natural and anthropogenic systems of the ridge while preserving and renewing their biologic variety under conditions of running forestry and rational use of natural resources.

Ermakov island:

- Provision of stable functioning of the island ecological system with maximal preservation of biologic variety, ecologic capacity and economic potential of the territory under conditions of partially regulated water conditions and rational use of natural resources.

Ecological systems of DBR make in aggregate very diverse and peculiar complex due to variety of its landscapes and transient (ecotone) location between large river and the Black sea.

Main part of Kiliya delta, Stentsevsko-Zhebryyanskiye water-meadows and partially the island of Ermakov are occupied by water-meadow ecological systems represented mainly with weak mosaic grounds with slight flowage. Vegetation groups of reed, cat-tail, lake tule, sharp sedge are predominant here. Small spots of ash-gray willow bushes are distinguished.

Forest and bush ecological systems of water-meadow landscapes are represented both by natural groupings and man-made planting. Along the currents there are strips of 5 to 200 meters bushes of white three-staminal willows stretching and along the seashore there are loeaster, amorpha, tamarisk, sea-buckthorn.

Grass ecological systems in Kiliya delta are located on elevation areas, near-riverbed ridges as well as in outlying areas of water-meadow, adjacent to the seaside ridges. They are formed on the bog places and coastal water groupings, which disappear in the relief elevations caused by yearly accumulation of alluvium. Mainly spread are large-cereal and small cereal, large cane, juncaceous as well as motley grass salty grasslands. There are appreciable areas of grasslands on Ermakov island.

By natural-geological reasons and due to anthropogenic interference the ecological system of Zhebryyanskiy ridge formed on sands of CSL complex between the leavings of sand steppe and man-made forest of Crimean pines distinguishes itself with great diversity.

Ecological system of Zhebryyanskiy spit can be characterized as sand-littoral.

There is great diversity in water ecological systems of DBR. There are fresh water systems and in fore delta of Kiliya arm there are salt-water ecological systems, which develop in the water flows, estuaries and numerous lakes. Specific ecological system of the seaside is a contact zone of the Danube and Black sea. Along with great water masses of the Danube the suspended substances and soluted biogenic substances, 100-200 thousand tons of fresh water plankton and other organisms are carried away here yearly to the sea and settle on the bottom forming a store of organic substance. This phenomenon is vital for the processes of forming biological productivity in northwest part of Black sea and the Danube

itself with spawning reproduction of population (in particularly sturgeons and the Danube herring).

Building of deep-water ship passage affects the interests of DBR to a certain extent.

Dredging in the area of the sand-bar can affect as a long-term outlook the natural development of the delta while the long-run task of building the reserve is to provide at the most the natural course of the processes in the delta.

Analyses of the situation in the other possible routes of DWCS concerning the territory of DBR shows that the acceptance of any choice affects in some ways the functioning of the reserve and the requirement of National Academy of Sciences about the choice of a variant not affecting the interests of DBR is impracticable.

During realization of the project solutions on building DWCS the purposes of the construction and economic activity restrictions fixed for different zones, which are crossed by the route of ship passing must be taken into consideration.

4.5.2 Description of vegetation and analyses of impact on the project activities

Vegetation cover of the reserve as well as the whole Kiliya delta of the Danube differs from the deltas of other rivers of the northwest regions near the Black sea with more water-bog communities by composition, which occupies about 80% of the area. 10 % of the territory is occupied with near-riverbed water-meadow woods and seaside bushy aggregations. Fewer areas are occupied with psammophyton, halophyton and grassy land aggregations, which share is about 10%.

Flora of DBR numbers 950 sorts of vascular plants, which belongs to 379 kinds and 100 classes. 134 kinds of plants refers to the different categories of rare and disappearing ones (14,1%), out of which the 16 are put into Red book of Ukraine and 3 put into European Red List.

In the area of building the navigable channel about a half of the reserve flora grows in the arm of Bystryy. However here the alien acclimatized kinds practically do not occur except for cosmopolite kinds (bush amorpha, Canadian fleabane, flagroot common and others.)

Bog vegetation in the area of the ship channel as well as all the secondary delta of Kiliya mouth of the Danube, distinguishes with great share of communities: cuspate sedge, sedge-pseudogalingale, reed-cuspatesedge, narrow-leaved reed-mace, reed-mace-large sedge class. Diagnostic kinds of the class are common reed, buckhome plantain celandine, narrow-leaved reed mace, broad-leaved reed mace, river equisetum, bog bedstraw, European Lycopus, amphibiotic knotweed, coastal dock, bell-like Scutellaria, broad-leaved Sium, bog woundwort, bog iris and others. This vegetation develops under conditions of fluctuation of water level during vegetation period that influences morphology of community. The most valuable of the sorts resources and number of rare sorts is a cuspate sedge community (altogether 48, 15 of them are rare), the following is reed-cuspatesedge one (altogether 87, 6 of them are rare).

In the analyzable area of pure community there is practically no common reed. This is conditioned by natural hydrologic conditions (spring floods carrying considerable amount of alluvium on one part and not so large water level fall on the other hand).

Water vegetation is presented with duckweeds and pondweeds integrating community of free-floating and bottom-fixed plants with the leaves immersed in water. Diagnostic kinds are: frogbit, small duckweed, three-lobate duckweed, common multiply root, Canadian Elodea, dark-green Ceratophyllum, eared Muriophyllum, whorled Muriophyllum, flattened pondweed, shiny pondweed, perfoliate pondweed, compact pondweed, straight bur-reed and others. Among them there are kinds put into Red book of Ukraine,– floating water nut, floating Salvinia, floating heart, white spatterdock, yellow spatterdock. Vegetation of these kinds develops in not stagnant ponds and gullies of fore delta under conditions of insignificant fluctuation of water level during vegetation period, conditioned by hydrologic peculiarities of the Danubея. Only in the delta of the Danube among the rivers of northwest territories near the Black sea there are cenosis of duckweed-azole, grass-azole, as well as the community of water nut, floating heart types, spatterdogs, put into Green book of Ukraine.

Communities of pilot vegetation of the seaside integrate Cakile maritime forming on upper boundary of land wash. Diagnostic kinds are Black sea Sinapis, sea knotweed, spurge water-purslain-like, spear-shaped orache, Russian thistle soda-bearing, perforated camomile, which the succession families of littoral vegetation start with. They are followed with kinds of Khonkenio class (water-purslain-like) - sand leumus integrating community of seaside

bank. Its diagnostic kinds are represented by Black sea leumus, sand leumus, seaside fever-weed, Siberian Tourneforcia, sand sagebrush, Russian thistle soda-bearing, Colchis sedge, white melilot.

Wood growth is represented with willow and integrates flood-lands wood and bush community of white willow, ashy willow, fragile willow, black poplar, white poplar, high ash-tree and others, timed to the near-riverbed ridges of estuary-adjoining row of geocomplexes as well as narrow-leaved loeaste, silver loeaste, sea buckthorn, scattered tamarisk entering in frutescent community of low-salt sand soils of estuary geocomplexes.

Meadow vegetation of large-grass bogs class is represented with shoot forming bent, giant bent, azov bent, meadow foxtail, reed foxtail, couch-grass, azov couch-grass and others. It is typical mainly for estuary-adjoining and partially formed estuary geocomplexes. Halophytic vegetation of statice of Meyer, South-Bug statice, cauline galimione, spread puccinellia is typical for the same geocomplexes like the preceding group, however for the areas of the secondary salinity. This type of vegetation has the least popularity in the area of the projectible navigable channel.

According to skeleton maps there are 3 types from the Red book noticed in the area of Bystryy arm (fig 4.2) and two grouping of the Green book (fig 4.3), moreover the places of their growing are widely spread throughout the territory of the reserve main body.

The impact of the navigable channel on biocenoses, populations and individual plant species will be of a double character: on the one hand, wave-breaking effects during ships' movement may result in changes of vegetative cover in the riverside of the Bystry distributary and falling out of many species and communities, including rare ones, and on the other hand, navigation will contribute to saturation of flora with newly arrived species, including quarantine ones.

Of rare communities of mars type vegetation the most sensitive to man-caused influence are the Carex acutiformis and Phragmites australis, species-poor reed communities will be formed, in the place of their possible falling out. Possible reduction of tree and bush vegetation areas of channel banks under the influence of wave activity is fraught with serious consequences, which will require artificial reforestation for coast protection.

In consequence of dredging and hydraulic engineering operations in the sand-bar of the Bystry distributary and passage of ships along the approach channel, it is possible to

damage coastal sand ecosystems of the Ptychya spit and the adjacent area of the Kubansky island, as well as communities the Red Book species of floating water-chestnut and floating-moss, that began to develop in the newly-formed freshwater reservoir – the Bystry kut.

It is necessary to take into consideration the impact of runoff redistribution, that may occur as a result of dredging operations, on the flora and vegetation of ecosystems of the whole reserve, not just the area of the ships' navigation. In case of hydraulicity reduction of the other distributaries overgrowth of internal reservoirs– kuts will quicken, as well as withering away of small narrow straits, general prairification of grass vegetative cover.

At the same time, the danger of damaging even the most vulnerable and valuable vegetative groupings growing on channel and coastal banks in the zone of ships' navigation track influence is not imminent. When installing navigation equipment in a floating version direct intrusion into these territories is eliminated. Wave impact on channel banks under speed restriction of the vessels' movement along the distributary is reduced effectively. It is also considered workable to restrict the use of mosquito-fleet during the ships' navigation operating period at the level close to the modern one. If these conditions are met and the existing water discharge rates along the Bystry distributary, creation of ships' navigation on vegetation of the adjacent areas will not pose a threat to preservation of species diversity of vegetable kingdom and the places where valuable plant associations grow.

To detect possible negative consequences of creating a navigation channel along the Bystry distributary, additional research and constant ecosystem monitoring, first of all in the channel affected zone, are necessary.

All this permits to consider the probability of preserving vegetation kingdom of the Bystry distributary area high enough to regard the impact on the DBR vegetable kingdom acceptable.

4.5.3 Characteristic of fauna and analysis of the activities under project impact on it

4.5.3.1 Insect fauna

According to the data [9], insects (about 3,500 species) that belong to 23 kinds predominate among land and amphibia invertebrates in the DNC construction and operation zone of impact (ZI). Most of them (90 pct.) belong to 6 kinds: hymenoptera, diptera, beetles, Lepidoptera, homoptera and bugs. Of 8 types of the DBR entomocomplexes 7 occur in ZI (the steppe one is missing. Of them 5 are represented very well – juncaceous, grass, psammophytic, fruticose and forest flood-plain ones. The fruticose entomocomplex occupies the largest area. The grass and fruticose complexes are notable for the greatest specific diversity. Brackish and anthropogenic ethnomocomplexes occupy a very small area and are characterized by the lowest specific diversity. Of insects found in the ZI, 23 species (56 pct. of all protected species, found in the DBR) are inserted in protection lists; they belong to 7 classes: butterflies (8 species), hymenoptera (7), beetles (3), dragonflies (2), day-flies (1), orthopterans (1) and diptera (1). Of 23 species of protected insects found in the ZI, the species entered into the Red Book of Ukraine (RBU) constitute the biggest number (15). One specimen each is entered into the European Red List (ERL) and the Bern Convention (BC) list, two species are included simultaneously into the RBU and the ERL, another two – into the ERL and the BC, 1 specimen is entered into the RBU, the ERL, one more – into the ERL, the BC and the IUCN list.

Hence, by insect fauna composition, the areas that are included in ZI belong to highly valuable in ecological and scientific respects. The scale of the DNC impact on insect fauna is determined by impact on vegetation and landscapes that are a habitat of insects and, therefore, will be insignificant.

4.5.3.2 Hydrofauna

The DBR hydrofauna is represented by fish and water invertebrates.

Ichthyofauna **is a very important component of the Danube biological diversity. Fish play a key role in trophic chains. Besides, no other group of wild animals has such an important economic significance as fish.**

A great diversity and considerable sizes of natural grounds – habitats of fish, from fresh to sea water areas, as well as a specific geographical location, cause a great biological diversity and density of the Danube ichthyofauna.

In the Ukrainian delta of the Danube According to the data [9], there are 95 species of fish that belong to 31 families, of freshwater species representatives of the families of carp, perch and goby predominate.

This number includes all fishes from the European red list. Of sturgeons, these are spiny sturgeon and Atlantic sturgeon; of salmons, these are Black Sea salmon and Danube salmon, of perches these are big chop and little chop, as well as umbra. (In the DBR 15 fish species out of the 32, entered into the Red Book of Ukraine, are found. Besides the mentioned ones, these are beluga, sterlet, Rutilus frisii, light weakfish, red goby, Danube shemaya, striped ruff, gurnard).

The annual catches of fish in the river range between 500 up to 1,500 tons. The base of the catch in the Danube is made of Danube herring and crucian carp that make up on average 49.2 pct and 32.6 pct respectively. The share of bream in the total catch makes up on average 10.3 pct, of sazan – 8.0 pct, of pike-perch – 2.7 pct. During last years the share of herbivorous fish in the catches and, first of all, silver carps – 2.5 pct, has increased significantly. The share of sturgeons in the catches during last years makes up about 5 pct. Silurus, vimba, pike, zherekh and other commercial fish are also caught in the river. Altogether 43 fishing organizations do fishery in the Danube.

Of food species the most interesting are sturgeons, but the most important in the economic aspect is Danube herring.

At present one of the main ecological factors that affect the size of the main fish species are the conditions of their reproduction. As a result of a large-scale diking of

the flood-plain carried out in 1960-70s, about 30,000 hectares of most valuable spawning grounds were cut off. The main factor affecting reproduction conditions of the fish directly in the lower part of the river is the water level state (terms, height and duration of the flood).

It is a sharp decrease of the number of sturgeon species that not only were of great industrial importance, but also played a significant role in the Black Sea ecosystem that gives maximum concern. It should be noted that spiny sturgeon (Acipenser nudiventris) and Atlantic sturgeon (Acipenser sturio) have always been rare species here. At the same time sterlet (Acipenser ruthenus) was a usual food fish formerly, but in 1964 already it ceased to be noted by fishing statistics, though the number of its migratory young fish is sometimes the greatest among all sturgeon species.

The number of three other species of anadromous food species of sturgeons – beluga (Huso huso), Russian sturgeon (Acipenser guldenstadti colchicus) and stellate sturgeon (Acipenser stellatus) has decreased sharply. In 1994, as beluga was included in the Red list of Ukraine, its catch was forbidden. That same year Ukraine unilaterally imposed a ban on catching sturgeons; and from 1995 only its scientific and experimental catch is carried out. The Danube is the last Black Sea river where natural spawning of anadromous sturgeons still takes place.

A small number of spawning grounds are located in the lower course of the river, their bulk is outside the country. Accordingly, the Ukrainian section of the river is mainly a spawning route of the sires and migratory route for the fry, the delta front also serves as finishing area for sturgeon whitebait.

According to the data [49], the total finishing area of anadromous sturgeons of the Ukrainian delta of the Danube within 5 km coastal zone makes up 16,250 hect. The mean annual concentrations of sturgeon whitebait makes up: beluga – 0.05 spec./hect., sturgeon – 0.35 spec./hect., stellate sturgeon – 0.75 spec./hect.,

Spawning migrations of sturgeons and downstream migration of the whitebait down the Danube are extended in time. The main run of sires takes place in March –

June and the first whitebait are found in the Starostambulskoye estuary and in the adjacent seashore sections in the beginning of May.

Average fry sizes are 6-9 mm; the downstream migration takes place during 3-4 month from the end of April till the beginning of August. The main downstream migration takes place mostly along the main riverbed 4-10 m beneath the surface. The whitebait downstream migration from the late spawning sires may be delayed.

After turning to active feeding, the predominating part of sturgeon, beluga, stellate sturgeon whitebait migrates to estuary part of the river where they feed till September-October. 95 pct of sturgeon whitebait migrates downstream to the sea not gaining the mass of 2 g, while specimens with the mass not less than 1 g make up 72 pct.

Beluga whitebait, having reached 3-6 cm in length, moves to seashore sandbanks to delta front where it is kept throughout summer. Till September beluga young-of-the-year reach 26-30 cm in length and 40-65 in weight. Beluga whitebait grows 2 times faster, thus it passes to predatory way of living in the first decade of active feeding already.

The second subject in significance and the first one in catches is Azov-Black Sea (Danube) herring. Annual catches in the 80s reached as high as 350-400 t. In 1994-1997 – 210-290 t. Since 1990 an abrupt decrease of catch (18.0 t in 1999, 78.9 in 2000) is observed.

The official fishing statistics of late already reflects little the real variations of fish population size. Still, the analysis of dynamics of fish catch in the lower Ukrainian part of the river, where its major part is caught, provides information about species balance and general tendencies of size changes. More than a half of commercial fish catch (56,1pct) is made up of Danube herring – a typical anadrom that spawns outside the Ukrainian part of the river. Because of pelagic caviar it proved less sensitive to an abrupt decrease of spawning ground area. The mean annual herring number is relatively stable and natural annual number variations are a characteristic peculiar feature of the family. The catch decrease in recent years is explained, first of all, by lesser quantity of herring delivered to fish receiving centers. Besides, for reasons unknown, spawning migration of herring in 1999 was 12.4 times less the average rate of ten years. Now the vast majority of herring migrates very early, and its main catch takes place in March-April, before the ban to catch it takes effect.

Spawning migration of herring sires takes place from the end of March till the first half of June, depending on hydrometeorological and other conditions. Downstream migration of sires after spawning begins in May. The main spawning grounds are located outside the borders of Ukraine, 500-600 km from the Danube estuary. Because of pelagic caviar, the decrease of spawning ground areas during the river diking did not affect the herring reproduction.

Herring caviar and its fry migrate downstream passively with the average speed of about 80 km a day. Intensive downstream migration of whitebait is observed from the end of May till the beginning of June.

The drift takes place only in the upper two-meter layer (most of them drifts in the water layer from the surface to the depth of 1 m – 90 pct). Herring fry are found any deeper sporadically. The downstream migration period of herring whitebait in the Danube lower course may take as long as 4 months, the mean annual downstream migration of whitebait in the Ukrainian section makes up 200-250 million specimens. [49]

The degree of water transparency determines the fry distribution in the water mass: the increased suspended matter content in water keeps the fry closer to the surface of 0 – 50 cm), cleaner water allows to keep deeper 50-150 cm).

The whitebait downstream migration is at its most intensive in daytime. In the riverside the whitebait is usually found during the morning or evening hours.

In case food is available the fry start to feed during the downstream migration, which affects their development and survival on approaching the feeding grounds. Most fry migrate downstream to desalinated sections of the sea where their further development takes place, but a certain part of them is detained in the river and enters (is brought) in the lakes.

Rare endemic fish species, such as little chop (Zinger streber), big chop (Z. zingel), striped ruff (Gymnocephalus schraectcer) and some other small fish species almost never get caught into fishing instruments. That is why, no special measures are necessary to preserve these and other specimen of small fish, other than preservation of the existing biological types.

During the last decades the golden carp that occupied the vacated econiche of valuable fish species sharply predominates among nonmigratory fish species. As an active

detritophage, the crucian carp avoids food competition; it is undemanding to the spawning substratum, matures early and has an extended spawning period

Sea fish (grey mullets, silverside, Platichthys flesus luscus and others) under favorable conditions enter estuary sections of the Kyliya delta of the Danube, they are constantly found in shallow waters of estuarine seashore of the river delta.

The distinctive feature of the Bystry distributary with its increased current velocity is that reophilic rare fish species, such as little and big chops, striped ruff, gudgeons, madder, sturgeons, etc. are found here more often than elsewhere. Here a significant downstream migration of sturgeons' whitebait – stellate sturgeon, Russian sturgeon, beluga and starlet takes place. Because of the greater estuary hydraulicity, it is one of the main ones along which passively drifting Danube herring fry migrate downstream.

Great water masses carried by this distributary attract Danube herring there during its spawning migration. Wide river banks in the narrow strait and a greater depth are favorable for its successful catching. That is why in the nineties the average annual catches of herring in the Bystry distributary made up 16.7 pct to 51.1 pct [49] (according to the DBR data – up to 21.1 pct) of all herring catches in the delta of Kyliya distributary of the Danube.

Because of considerable depths, cat-fish and sazan are successfully caught there, in winter time wintering gatherings of many fish species are observed there. In that season starlet is caught there more often than in other narrow straits.

An interesting distinctive feature is that the greatest concentration of crayfish, as compared to other distributaries, is observed there.

During the last five years, big catches of red-finned mullet have been registered in the area of the sand-bar, adjacent to the Bystry distributary. Shallow waters of this narrow strait are traditionally noted for good catches of рыбца. Because of spacious shallow waters the sand-bar zone, blocking the entrance to the Kyliya bay in the form of a reef, is of great significance for all hydrobionts. These are excellent feeding grounds both for whitebait and mature fish of many food species.

In other fishery aspects the Bystry distributary is similar to other Kyliya bay distributaries of the Danube.

Qualitative composition of **water invertebrates** in the water areas of the Danube biospherical reserve is notable for species affluence of the so-called punto-Caspian relic

fauna. These hydrobionts came into existence and evolutionary formed 1.5 million years ago in the ancient sarmatian saltish lake-sea, on the place of which the Aral Sea, the Caspian Sea, the Sea of Azov and the Black Sea appeared later. In the Caspian Sea, as well as in certain sections of the Sea of Azov and the Black Sea, this ancient unique faunistical complex of hydrobionts stands out for its specific affluence, singularity and an important significance in forming a nutritive base for the fish.

In the Ukrainian delta of the Danube, in particular in the Danube biospherical reserve, Caspian relic species of water invertebrates are mass forms. They form the base of plankton and benthos biotic communities (cenoses). 96 species of punto-Caspian relics are present within water faunistical complexes of the reserve. Among them there are 3 hydroids' species, 9 Oligochaetes species, 1 leech species, 22 mollusks' (shellfish) species, 2 Cladocera Crustacea species, 9 Ostracoda species, 4 copepods species, 1 Isopoda species, 33 amphipoda species, 9 cumacean species, 8 opossum shrimps species, 1 Decapoda species, 1 tick species.

Three mollusk species, 4 Rotifera species and 1 infusoria species, as well as some species of amphipoda, opossum shrimps and two Decapoda crayfish subspecies belong to endemics of the Danube delta.

Along with freshwater hydrobionts, saltish water ecosystems occur in the Kyliya distributary delta front.

The Danube and the Black Sea contact area is a specific seashore ecosystem. Aside from suspended substances and dissolved biogenic elements, 100 to 200 thousand tons of fresh water plankton and other organisms that die there and sink to the bottom, forming stocks of organic substance, get to she sea each year with the river runoff. This phenomenon is of great importance for the processes of forming biological productivity in the northwestern part of the Black Sea.

Because of its physico-geographical and ecologo-hydrological conditions, the Bystry distributary plays a significant role in the Kyliya delta of the Danube in whole and is of great importance for the territory and water area. That applies to biological diversity of water and land plants and animals, as well as to important ecological processes, in particular to passing of spawning migrations, feeding and wintering of water organisms. Under conditions of reserve system and a normal synoptic situation, water in the Bystry estuary remains fresh

from surface to bottom. On the one hand, this results from a constant current towards the sea, and on the other hand, by existence of a shoal in the sea in front of the estuary. That is why zooplankton and zoobenthos in the Bystry distributary are mainly of freshwater nature from surface to bottom.

Negative impact on hydrobionts at the DNC creation results first of all from carrying out construction work to remove bottom sediment that result in changing ecological situation in the pond.

The work of excavation equipment results in upsetting ecological situation in the pond: the density of suspended mineral substances in the water mass increases, color and transparency change.

During the work of excavation equipment the suspension density increases 20 times and more as compared to the natural one. This results in decrease of feed organisms' quantity and biomass, death of spawn, fry and whitebait; besides, death of plankton organisms happens in the volume of water-soil compound when water jet is used.

The increased content of suspended particles also has a negative effect on **phytoplankton**: its quantitative indicators decrease, the change of dominant types takes place. Suspension particles break large cells and colonies of water-plants, increase the speed of plankton forms settling, cover **the submerged macrophytes**. Due to the particles' small sizes, the rivers' self-cleaning happens too slowly, phytoplankton partial renovation takes place at a considerable distance from the work site. In the work sections with the increased content of suspended particles is much poorer in a quantitative and qualitative sense.

The decrease of quantity, biomass and the depletion of **zooplankton and benthos** specific composition results from direct influence of suspension on search functions and breathing conditions of the organisms in the work zone. Topsoil removal or earth backfilling results in biocenoses reformation, disrupts the benthos structure, and makes organisms unstable to survival.

The impact of carrying out construction work on ponds **ichthyofauna** may be expressed in death of fish whitebait, feed organisms, disruption of spawning grounds, crossing of fish migration and downstream migration routes. In the first place, the increase of suspended particles negatively affects the fry and the whitebait, whose organisms are weaker as compared to the grown up fish. In the increased turbidity area sexually mature

fish undergo morphometric changes in the organism, in particular, body weight and size, fertility, which affect the quantity and the quality of the progeny.

While carrying out construction work, the pond water areas lose their fishery significance, which results from the absence of feed organisms, the increased noise during the mechanisms' work, the increased turbidity. Adverse factors scare away fish, block the routes of spawning migrations and the whitebait downstream migration.

When carrying out phase I of the work, the nutritive base in the places of dredging will be terminated temporarily. Also, the water area in the zone of protective dam construction is forever withdrawn from fishery use. Besides, the change of environment state as a result of deepening the sand-bar part will result in the loss of these areas for feeding conditions of whitebait of the most valuable ichthyofauna representatives – sturgeons.

Carrying out the work, stipulated by the project, by phase I during nonspawning period rules out the impact on spawning migrations and downstream migration of anadromous fish whitebait.

For the purpose of reducing the negative impact of construction work on biocenoses of the ponds, it is necessary to carry them out only in accordance with the project and only in coordination with fishery protection bodies.

4.5.3.3 Amphibious and land vertebrates

According to the IGB [Institute of Hydrobiology] data [9], in the zone of projected construction of the navigable channel along the Bystry distributary live 10 species of amphibious, 2 species of reptiles, 29 species of mammals, that makes up 91 pct, 40 pct and 74 pct of species composition of the corresponding groups of vertebrates in the Danube biospherical reserve (DBR) fauna. Of them, 10 species of mammals are entered into the Red Book of Ukraine; 3 species of amphibious, 1 species of reptiles, 5 species of mammals are entered into the IUCN Red list; 3 species of mammals are entered into the European Red List; 9 species of amphibious, 2 species of reptiles and 19 species of mammals are entered into the Bern Convention supplement lists.

All in all, 32 species of amphibious, reptiles and mammals (fig. 4.4.) are subject to protection on national and international levels. In particular, of the mammals living in that section, 78 pct are entered into national and international protection lists.

Such species as the Danube triton (Triturus dobrogicus), red-bellied toad (Bombina bombina), common tree-frog (Hyla arborea), common spade-footed toad ((Pelobates fuscus), swamp tortoise (Emus orbicularis), ermine (Mustela erminea), European mink (M. lutreola), European otter (Lutra lutra) have in the DBR, including the area of the Bystry distributary, a very high or a considerable population size, while in many countries of Europe they are threatened with extermination. The importance of the DBR for preservation of these species on an all-European .scale is very great. T. dobrogicus triton lives only in the lower course of the Danube, i.e. it is a narrow endemic; and the species itself is an endemic of the Danube basin. Rana lessonae frog in the DBR is known for certain for three points only; two of them are located in the Bystry distributary zone. The wood cat (Felis sylvestris) and the monk seal (Monachus monachus) are very rare animals; the territory and the water area of the DBR, and, in particular, the Bystry distributary zone, are extremely important for their preservation.

The zone wetlands have considerable resources of fishing and game species – green frogs (first of all, lake frog Rana ridibunda), musk-rat (Ondatra zibethicus), common fox (Vulpes vulpes), raccoon dog (Nyctereutes procyonoides), boar (Sus scrofa).

The predominant majority of amphibious', reptiles' and mammals' species that live in the Bystry distributary zone give preference to channel banks, littoral ridges and lakes-kuts. It is these natural elevated territories and water stretches that act as centers of biodiversity under conditions of large areas of continuous undergrowth of reeds, reed maces, sedges in the Danube delta.

Creation of the navigable channel will not cause direct damage to amphibious and land vertebrates, as it will not disturb their habitat territories. At the same time, to a greater or lesser extent, an aposematic effect caused by construction machinery and transit of ships will be revealed, despite the measures taken in the project to decrease such effects. This will result in a certain decrease in the size of the vertebrates' fauna in the riverside of the Bystry distributary, and in migration of a certain number of

animals to similar biotopes of other distributaries. An impact like that in the zone of anthropogenic landscapes should be considered acceptable.

4.5.3.4 Birds

Wetland grounds of the Kyliya delta of the Danube are of international importance, mainly as places of water birds reproduction and mass gatherings. About 257 species of birds (that makes up about 62 pct of ornithofauna of Ukraine) can be found here, of them 124 species nest in the Danube delta. Birds of passage make up the most numerous group – 196 species. A significant number is known hibernating – 129 species. 41 species are recorded as summering, 3 – as migrant, 8 – as straying. 42 species are entered into the Red Book of Ukraine and into the European Red List [9]. Wetland grounds of the Kyliya delta of the Danube were entered into the List of wetland grounds of international significance as early as 1975. This high status of wetland grounds of the Kyliya delta of the Danube was confirmed in 1996 by the Convention on wetland grounds of international significance on the basis of Ramsar convention of 1971. The uniqueness and nature-conservative value of many Danube delta ornithocomplexes on a European or a global scale, as well as key importance of the Danube delta for preservation and reproduction of a number of globally vulnerable bird species, are generally known.

An absolute majority of ornithocomplexes known for the DBR have one or another nature-conservative status, they fall under the force of some or other international nature-conservative conventions and agreements. 42 species (about 16 pct) among which 11 are known as nesting, 31 – as flying past, 22 – as wintering, 16 – as summering, 2 – as straying, are entered into the Red Book of Ukraine (1994) and into the European Red List (1991). Dalmatin pelican (Pelecanus crispus), pigmy cormorant (Phalacrocorax pigmaeus), Red-breasted goose (Rufibrenta ruficollis), erne and others are entered into the Red book of International Union for Conservation of Nature and Natural Resources (IUCN).

Water birds and circum-water birds, especially anseriformes (swans, geese, ducks), totipalmate birds (pelicans and gannets), Ciconiiformes (herons and guaras), charadriiformes (sandpipers and seagulls) have a leading place in the reserve ornithofauna. Among them are white pelican (Pelecanus onocrotalus), spoon-bill (Platalea leucorodia), glory ibis (Plegadis

falcinellus), yellow heron (Ardeola ralloides), white-eyed pochard (Aythya nyroca), big and medium sandpiper and others, entered into the Red Book of Ukraine [9].

For some of them, such as pigmy cormorant, the Danube delta is a key ground on a global scale, for Dalmatin pelican – on a European scale.

Of four main reserve sections, the greatest diversity of birds' species is typical of the secondary delta of the Kyliya distributary. Next in this line are the Stentsovsko-Zhebriyanskiye plavni, the Zhebriyanskaya ridge and the island of Yermakov.

In the secondary delta of the Kyliya distributary of the Danube (the former natural reserve territory) the main colonies of cormorants, herons and ibis are located. The vast shallow waters of the Kyliya delta front of the Danube, where the birds' seasonal gatherings boast as many as 50 thousand specimens, are of special significance for water and circum-water birds. Here the majority of migratory ducks amass. In certain seasons the number of wild duck alone reaches 16-20 thousand specimens, there are as many bald-coots. Other species are less numerous. Almost annually from 500 to 5,000 mute swans shed feathers in the southern sludgy section of the delta front.

Almost all birds' species of the reserve meet in the area of the prospective construction of navigable channel along the Bystry distributary with one or another degree of regularity.

Along the channel track within the Danube biospherical reserve the following main ornithocomplexes are allotted:

- of littoral low islands and spits;
- of desalinated littoral shallow waters;
- of bush undergrowth on littoral on sand-sludgy dunes;
- of reed-sedge undergrowth;
- of flood-plain willow woods.

The most valuable of them – ornithocomplexes of littoral low islands and spits and of desalinated littoral shallow waters are located in the sand-bar part of the navigable channel. It is right there where one of the two most important colonies of charadriiformes birds in the reserve is located at present. Oyster catcher (the Red Book of Ukraine), snowy plover (the Red Book of Ukraine), common tern and sandwich tern, herring gull, avocet nest here.

At present time man-made impact on birds' populations in the reserved DBR zone is quite insignificant. Among man-made factors two main groups stand out: direct action factors (commercial fishing, partial recreation burden, pyrogenic (fire) factor, regulated pasturing) and indirect action factors (man-made changes of the river and delta hydrological regime, the impact on delta formation processes, deterioration of water quality, general deterioration of air basin quality and global environment pollution). According to ornithologists [9], all of them are not a determining factor for birds populations functioning on this territory.

Ornithologists consider one of the most essential negative consequences of construction work on the Bystry distributary sand-bar to be a prospective merger of the Ptichya spit with the sea boundary of the delta, that will result in loss of safe places for wintering and nesting of protected birds' species [9]. The spit washing away, they believe, will lead to even greater negative consequences.

A general assessment of possible consequences of the construction for ornithofauna, made by experts of NAS [National Academy of Sciences] of Ukraine, is presented in table 4.5.1.

Such assessment corresponds to the most pessimistic forecasts of the impact of the navigable channel creation on the landscape of the zone of its impact and, besides, it does not take into account ornithofauna's high mobility and adaptability. Assessments of man-caused wave factor, made by Hydromechanics Institute of NAS of Ukraine does not give reasons to forecast significant changes in configuration of the Ptichya spit in connection with the DNC creation. At the same time, natural instability of the delta sea boundary does not give reasons to count on long-term existence of the Ptichya and other temporary formations of the sand-bar zone of the Bystry distributary with or without the navigable channel. On the other hand, further designing protective engineering structures in the sand-bar zone taking into account the tendencies of the spit configuration changes, revealed during the experimental operating period, permits to increase stability of its state.

Under such conditions, a sufficiently slow evolution of the existing habitats, close to normal one, may be forecast, and on the strength of this assess the navigable channel impact on ornithofauna as acceptable, provided that ecological restrictions

on carrying out construction work, stipulated by the project, are observed. ***Particularly important for preserving ornithofauna is the ban to carry out work in the sand-bar zone during the period of birds' nesting.***

Table 4.5.1 – Characteristic of impact of the DNC construction and operation on birds

INDICES	Values
The total number of birds' species in the zone of the direct impact of the construction	245
The number of species from the European Red list	5
The number of species from the Red Book of Ukraine	36
The size of nesting complex in the direct risk zone, couples	up to 5600
The total number of birds from the Red Book of Ukraine on nesting in the direct risk zone, specimens	up to 10
The number of autumn gatherings in the direct risk zone, specimens	up to 3200
The total number of birds from the European Red List in autumn gatherings, couples	45
The total number of birds from the Red Book of Ukraine in autumn gatherings in the direct risk zone, specimens	up to 450
The size of wintering complex in the direct risk zone, specimens	up to 750
The total number of birds from the European Red List on wintering in the direct risk zone, specimens	up to 25
The total number of birds from the Red Book of Ukraine on wintering in the direct risk zone, specimens	up to 270
The probability of violation of aboriginal ornithocomplexes structure	High
The probability of violations ecosystemic character	Very high
The practical possibility of compensating the predicted losses	Very low

4.5.3.5. Conclusions on part 4.5

The assessment of the DNC creation on separate environment components testifies that, taking into account the measures to ensure normative condition of environment and ecological safety, stipulated by the project, residual effects are limited in scale to the territories, directly adjacent to the track, which are attributed to the zone of man-made landscapes. This is acceptable according to the existing environmental legislation.

Construction and operation of the navigable channel will not lead to changes in number and species composition of the DBR biota.

Biotic groupings of the Bystry distributary area, including rarity species and aggregations, are not unique for the DBR, they are widespread within the boundaries of its territory. That is why certain local successions of vegetative aggregations and partial migration of animals from the distributary itself and its riverside, that may happen in connection with the DNC creation, do not pose a threat to preservation of the reserve biodiversity, to existence of rare and especially valuable representatives of plant and animal kingdom on its territory, in particular.

5. Description of social environment and assessment of impacts on it

In connection with the absence of a navigable channel along the Ukrainian part of the river, the sea and river complex of the Danube region and the sections of the national economy connected with it suffer huge losses, that results in slowdown in the development of a whole region, the population's standards of living descend.

Restoration of a continuous navigable channel along the Danube will result in substantial positive changes in social sphere of the region and will considerably increase the general level of well-being.

First of all, it will happen due to increase of employment and wages level in the most promising and dynamic sectors of economy. For instance, additional jobs must appear in the fleet of UDSC [Ukrainian Danube Shipping Company], in ports, in railway and motor transport, in service organizations, industrial shipbuilding and ship repair enterprises, etc. Increase of investment not only in transportation complex, but also in other sectors of economy and the region's infrastructure can be confidently predicted. The conditions of passenger traffic for people from the Danube towns and villages will improve considerably. Good prospects for developing water tourism, including international, appear.

The positive effect for economy and social life of the region from the project realization exceeds many times over the possible negative consequences for a part of population of the town of Vilkovo. For instance, the terms of fishing for fishermen working at "Bystroye" fishery, temporary loss of jobs by people working in the port of Ust-Dunaysk with their consequent employment at the installations, related to the deep-water navigable channel operation, is also possible,

On the whole, restoration of the Danube navigable channel will have not only a great economic and transportation significance, but also political and strategic one, which is absolutely necessary in the present situation for development of both the Danube region and Ukraine as a whole.

The public opinion on the question of creation of the deep-water navigable channel in the Danube delta is ambiguous. A number of articles for and against creation of the deep-water navigable channel is published in the press. The population of the Danube region

favors it. The resolution adopted at a public hearing held in Vilkovo with participation of elected representatives of local population of the region (supplements 6, 7) proves it.

The Academy of Sciences of Ukraine, in whose jurisdiction the reserve is, and several public environmental groups that function, as a rule, in regions distant from of the Danube region («Pechenyegui, «Sibirsky Ecologichesky Tsentr», «Front», «Novaya Volna», «Zelyonaya Dubna», «MAMA-86», «Ecopravo-Lvov», Social-ecological union and others) speak against it.

The impact on social environment, despite negative attitude to the project from a part of the population, should, by objective criteria, be considered as positive.

6. Assessment of the planned activity impact on the man-caused environment

The economic installations that pose a potential ecological threat in connection with realization of the deep-water navigable channel project are, for the most part, linear installations of man-caused infrastructure, namely: 750 kW and 500 kW power lines, gas pipeline, communication cables that traverse the Danube at Reni – Isakcha segment. Taking into account the fact that navigation in this section of the river is carried out without restrictions at present (the Sulinsky narrow strait – the Tulchinsky narrow strait – the Danube) and that the project makes no provisions to carry out dredging and other work here, there will be no deterioration of man-caused situation here and the likehood of man-caused disasters risk will not increase.

In Vilkovo – Bystroye – seashore section man-caused infrastructure is practically nonexistent and no negative impact may be had on it.

Indirect negative impact may be had on installations of the port of Ust-Dunaysk if they lose their economic significance in connection with the DNC creation. But its technical base is of insignificant material value. At present, berths as hydraulic works are absent in the port and three buoy anchorages are used for mooring the handled ships. Office and residential buildings in the port area are also absent, the administration is located at Vilkovo. All operating mechanisms are mobile and may easily be relocated to another port area.

7. Measures to ensure normative environmental condition and ecological safety

7.1 Protective measures

7.1.1 Organizational measures

On the grounds of the Decree of the President of Ukraine No. 502/2003 of June 10, 2003, for the purpose of preventing negative ecological consequences as well as obtaining funds, necessary for the project realization, the first stage of DNC designing and construction, singled out in the investments feasibility study, is stipulated in the given working draft as experimental. Such status of the object will permit to carry out integrated surveillance (monitoring) during the construction and operating period and to prevent arising of negative ecological consequences. This is especially important in the present conditions, as the navigable channel passes through the territory of the Danube Biospherical Reserve.

By the decree of the President of Ukraine No. 117/2004 of February 02, 2004, for the purpose of improving preservation of the unique natural complexes in the Danube delta in its natural state, protecting wetlands of international importance, other valuable natural complexes of the Ukrainian Danube region , carrying out zonation of the Danube Biospherical Reserve (DBR) territory and optimizing control of them, taking into account the interests of the region development, transportation and other state requirements, as well as stirring up international cooperation and environment monitoring; along with expansion of the DBR territory the scheme of temporary zonation of its territory is approved (supplement 2). According to that scheme, for the purpose of renewal navigation in the Ukrainian part of the Danube delta, the lands of the littoral protective strip of its channels – the Bystry and the Ochakovsky distributaries – and the adjacent part of the Black Sea water area within the DBR territory are allotted to the man-made landscapes zone (supplement 2).

Thus, the decree incorporates creation of the deep-water navigable channel in the Ukrainian part of the Danube delta into according to the variant of the track, passing along the Bystry distributary into the legal sphere of Ukraine and eliminates the principal

legal obstacles to the chance of receiving a positive opinion of integrated State expertise on the examination state on the working draft of the first stage of its construction.

7.1.2 Monitoring natural environment of the deep-water navigable channel zones of impact

The program of integrated natural environment monitoring in the DNC zone of impact for the period of the first stage of it creation and experimental operation makes one complex with the materials of the given working draft.

The main purposes of organizing and carrying out the integrated monitoring are:

- acquiring objective information, necessary to further design the deep-water navigable channel;
- effective control of the natural environment state by key indices;
- determining the actual changes of the natural environment state related to the DNC construction and operation;
- detecting the tendencies of natural and man-made changes of environment conditions and characteristics and devising the forecast of these changes at preserving the conditions of experimental operation and at full DNC development;
- developing, on the basis of the monitoring results, recommendations to minimize the negative impacts of the DNC construction and operation on the natural environment and to improve its state.

Implementation of the monitoring program during the first stage of the DNC construction and operation will result in accumulation and integration of information that will be used to accomplish the following tasks:

- to support taking decisions at completing the DNC creation and passing to its permanent operation;
- to substantiate the measures to prevent potentially possible negative consequences of the DNC operation;
- to prepare accounting data for controlling units and information for the interested organizations and the public;

- to work out the program of a permanent environment monitoring in the zone of the DNC impact as a component of the system of supporting steady operation of the navigable channel itself and, at the same time, as one of the measures to preserve the integrity and uniqueness of the delta natural environment.

The elements of the monitoring program, aimed at improving the DNC steady operation, are incorporated by the notion "engineering analysis", though the greater part of the monitoring results has both engineering and environmental significance.

The natural environment components that experience a substantial impact during the DNC construction and operation and, in their term, affect the conditions of the DNC operation, namely: geological environment, air environment, surface waters, soil, plant and animal kingdom, are subject to the monitoring within the program limits.

In accordance with this list, the following monitoring directions in the DNC zone of impact are determined:

- geo- and hydromorphodynamics;
- hydrodynamic conditions, hydrological regime and sediment regime;
- hydrometeorological conditions and atmospheric pollution;
- hydroecological and sanitary and hygienic state of water bodies;
- the state of soils;
- the state of ichthyofauna;
- the state of plant and animal populations of the shore zone and plavni, the dynamics of biogeocenoses' composition.

The monitoring system, that meets the above-stated goals and objectives, includes

1. Carrying out regular observations under standard programs at the network of operating meteorological stations, hydrological posts and sites, as well as at the points of controlling natural environment pollution.

2. Organizing additional points of standard observations of hydrometeorological, hydrochemical and sanitary and hygienic regime elements.

3. Organizing and carrying out more detailed observations and special research, including field research, to study natural and man-made changeability of

hydrometeorological, morphological, hydrodynamic, hydrochemical and biological processes and phenomena.

All hydrometeorological and hydrochemical observations, carried out in the Ukrainian part of the Danube delta, may be divided into standard ones and special ones.

Standard observations are carried out at the network of meteorological stations and hydrological posts, as well as at hydrosites of the Danube delta and in the pollution control points. Standard observations and processing of the data received are carried out according to the uniform procedures of Hydremeteorological service.

Observations of the complete complex of meteoelements are carried out at Izmail, Vilkovo and Ust-Dunaysk meteorological stations.

The work program of Reni, Izmail, Kislitsa, Kiliya, Liski, Vilkovo, Prorva, Ust-Dunaysk and Primorskoye hydrological posts includes observations of water level and temperature, as well as roughness and ice phenomena. Besides, at Reni, Izmail, Vilkovo, and Prorva posts, observations of water turbidity are carried out.

Measuring water discharge rates and suspended sediment discharge rates are carried out in 24 hydraulic sections, eight of which are boundary. Measurements, carried out in different phases of water regime, embrace the main river-bed of the Danube and all distributaries in the Ukrainian part of the delta.

Regular hydrochemical observations are organized along the entire length of the Ukrainian part of the Danube, in the estuaries of the Kyliya delta distributaries and in the estuary coastal waters.

The standard observations results are the basis for studying the most important characteristics of natural environment, such as:

- the delta climate and its perennial changes;
- the level, the thermal and the ice regime;
- the delta water balance;
- perennial and seasonable water and sediment runoff variation in the delta top;
- distribution and redistribution of water and sediment runoff over the delta distributaries;

- hydraulic and morphometric parameters of runoff and river-bed;

-the total washout of water, heat, solid and soluble substances to the sea and their distribution over the coastal waters area;

- the chemical composition, the pollution state of the Danube waters and their perennial and seasonable variations.

In connection with the DNC creation, provisions are made to resume observations at hydrological posts that used to exist in the source of the Bystry distributary and in the estuary of the Starostambulsky distributary, as well as to open a specialized hydrometeorological station.

No less important is studying responses of the biotic constituent of the delta ecosystem to changes of conditions of its existence. The Danube delta is distinguished by its unique biological diversity and richness of nature. That is why protection of natural complexes of the Danube region is one of the priorities in reserve business of Ukraine. This priority is secured by creation of the Danube biospherical reserve in the lower course of the Ukrainian part of the delta.

Preserving plant and animal kingdom of the Danube lower course goes beyond the scope of natural interests, as unique wetland grounds of the second-largest delta in Europe is of acknowledged international significance.

The DBR scientists, with the participation of profile institutes of NAS of Ukraine, have accumulated extensive data of species diversity, availability and size of populations of rare and valuable representatives of fauna and vegetable groupings, research data of the delta territory, maps of animal and vegetable kingdom. The DBR has contacts with similar foreign establishments of natural-reserve fund that have experience in navigation in reserve area.

In the monograph [24], written by a group of researchers on various directions (botany, zoology, hydrobiology, parasitology), the results of already conducted research of animal and vegetable kingdom are given, it also contains data on organizing hydroecological monitoring at the modern stage of the DBR development.

All this attests the possibility to carry out the biota monitoring in the DBR zone of impact at a high scientific level.

Special observations are organized to accomplish specific research and practical tasks and are carried out according to separate programs.

One of the main lines of these observations and research is obtaining quantitative assessment of experimental-operational slot and the estuary part of the DNC on natural **abiotic** processes that take place in the delta.

The most important here are considered the observations of dynamics of:

- estuary sand-bar where the navigable channel path will pass;
- all sea boundary of the delta;
- hydrographic network of the Danube delta as a whole;
- distribution of water and sediment runoff over the delta distributaries;
- suspended and drawn sediment runoff;
- alongshore sediment runoff;
- penetration of sea waters into the artificially deepened distributary.

In respect of studying the DNC impact on the ***biotic*** constituent of the delta ecosystem, the most important are the research of:

- reaction of hydrobionts communities of the DNC estuary part and the sand-bar area of the Bystry distributary to carrying out construction work, navigation, as well as the possible changes of water saline composition and trophicity;
- changing of fish migration routes in connection with creation of hydraulic structures;
- changing of land animals' population size and floristic complexes' composition on channel banks, littoral sections of plavni and the territory of the Ptichya spit in connection with creation a slit through the sand-bar and wave load from passing ships;
- succession of biotic groupings of the delta in case the DNC creation results in redistribution of river runoff among the delta distributaries and in changing of the плавней water regime.

To accomplish the listed tasks, subdivisions and individual experts of the below-listed institutions and organizations are recruited to organizing and carrying out of the monitoring:

- the Danube hydrometeorological observatory (the town of Izmail, Odessa region);
- Odessa YUDNIRO center of the Ministry of Agropolicy of Ukraine;

- UkrNIIMF [Ukrainian Marine Scientific Research Institute] of the Ministry of Transportation of Ukraine;
- UkrNTSEM [Ukrainian Scientific Center of Ecological Monitoring] of the Ministry of Ecological Resources of Ukraine;
- ChernomorNIIproekt;
- Odessarybvod central directorate;
- Odessa branch of Institute of the southern seas biology of NAS of Ukraine;
- Odessa state ecological institute;
- The Danube biospherical reserve of NAS of Ukraine;

To give scientific and normative-legal advice, experts from State Inspection of the Black Sea Protection and UkrNIIEP [Ukrainian Scientific Research Institute of Ecological Projects] of the Ministry of Ecological Resources of Ukraine are recruited.

Hydrographical work concerning the navigable channel, including drawing up pilot charts, river-bed survey of complicated sections (sand-bars and rifts), building bottom grade lines along the axis of the ship's motion (bottom and water level) must be done by the organization that operates the channel. In this case, it is state enterprise "Delta-Pilot».

Control of sanitary and hygienic regime of water bodies in the DNC zone of influence is prerogative of sanitary bodies of Ministry of Health of Ukraine. Epidemiological monitoring and control, related to passing of foreign ships, must be placed upon customs service and its lower organizations.

The DNC zone of impact is the zone of a special monitoring, at the same time the main attention is paid to the DBR territories adjacent to the navigable channel.

The main objects of a special monitoring are:

- the Danube distributaries, along which the channel track passes, including channel banks, earth deposits and the territories adjacent to them;
- the coastal waters section in the area of the DNC approach channel, including the area of the sea earth deposit and the area of the Bystry distributary with the DSE [delta sea edge] sections and the Ptichya spit, adjacent to it;
- sections of plavni on the DBR territory, that have hydraulic connection with the Bystry distributary and its sand-bar area.

The volume of special research and observation on each direction is restricted by those key indices and the number of control points (stations) that permit to reliably attest the presence or absence of significant changes in natural environment state with regard to initial one at the moment of the construction beginning. Besides that, within the bounds of the monitoring, analysis and integration of the data from the existing network of standard hydrometeorological, hydrologic and hydrochemical observations in the Ukrainian part of the Danube delta that must be preserved and modernized. It is also suggested that observations at hydrologic posts, that used to exist in the estuary of the Bystry distributary and in the estuary of the Starostabbulsky distributary, be resumed and that a specialized hydrometeorological station be opened.

It is advisably to effect coordination of research and observations, carried out within the bounds of monitoring of the DNC zone of impact, with the planned scientific work, executed by institutes of NAS of Ukraine and the DBR management on the reserve territory, with the subsequent exchange of the obtained results.

The order and periodicity of control, methods of assessing natural environment state indices and of data processing are determined in accordance with the demands and recommendations of the current normative base.

The intended composition of research on the main monitoring directions is given in table 7.1.

Table 7.1 – The composition of research intended within the bounds of natural environment monitoring program during the first stage of the DNC creation

No.	The environment element, The controlled parameter	Control places
1	**Geo- and hydromorphodynamics**	
1.1	Morphometric parameters of flow and estuary	Along the entire DNC track
1.2	Morphometric parameters of estuary sand-bar of the Bystry distributary and the Ptichya spit	The sand-bar area of the Bystry distributary
1.3	Position of boundaries of sea boundary of the delta	Within the bounds of the Kubansky and the Stambulsky islands
1.4	The state of channel banks	Along the Bystry distributary
2	**Hydrodynamic conditions, hydraulic regime and sediment regime**	
2.1	Ice conditions	Along the entire DNC track and in the adjacent sections of the adjoining distributaries
2.2	Water levels	The same
2.3	Water discharge rates	The same
2.4	River stream speeds	The same
2.5	River runoff parameters	The same
2.6	Sediment runoff parameters	The same
2.7	Parameters of wind-induced waves, onset waves and waves from passing ships	In the area of sand-bar and estuary of the Bystry distributary
2.8	Speeds of sea currents	In the area of sand-bar of the Bystry distributary and in the sea waste dump area
3	**Meteorological condition and atmospheric pollution**	
3.1	Air temperature	At the points of constant meteorological observations and in the places of carrying out dredging operations
3.2	**Precipitation**	The same

No.	The environment element, The controlled parameter	Control places
3.3	**Wind direction**	The same
3.4	**Wind speed**	The same
3.5	Carbon monoxide (CO) content	The same
3.6	Ammonia content	The same
3.7	Nitric oxides content	The same
3.8	Sulphur oxide content	The same
3.9	Inorganic dust content	The same
3.10	Soot content	The same
4	**Hydroecological and sanitary and hygienic state of water bodies**	
4.1	**River and sea waters**	
4.1.1	***Hydrophysical and organoleptic indices***	
4.1.1.1	The presence of floating admixtures and stains on the water surface (visual observations)	Along the entire track length
4.1.1.2	Temperature	The same
4.1.1.3	Smell	The same
4.1.1.4	Transparency (by print and by Secchi disc)	The same
4.1.1.5	Chromaticity	The same
4.1.1.6	pH value	The same
4.1.1.7	Suspended matters	The same
4.1.2	***SALINE CONTENT INDICES***	
4.1.2.1	Total mineralization (the sum of ions)	Along the length of the Bystry distributary, in the sand-bar area and in communicating sections of plavni
4.1.2.2	Chlorides	The same
4.1.2.3	Sulphates	The same
4.1.2.4	Silicates	The same
4.1.2.5	Hydrocarbonates	The same
4.1.2.6	Carbonates	The same

No.	The environment element, The controlled parameter	Control places
4.1.2.7	Calcium	The same
4.1.2.8	Magnesium	The same
4.1.3	***HYDROCHEMICAL THROPO-SAPROBIOLOGICAL INDICES***	
4.1.3.1	Ammonia nitrogen	All objects of monitoring
4.1.3.2	Nitrite nitrogen	The same
4.1.3.3	Nitrate nitrogen	The same
4.1.3.4	Phosphate phosphorus	The same
4.1.3.5	General iron	The same
4.1.3.6	dissolved oxygen	The same
4.1.3.7	Biological oxygen consumption -5	The same
4.1.3.8	Dichromatic oxidability	The same
4.1.4	***HYDROCHEMICAL TOXICOLOGICAL INDICES***	
4.1.4.1	Manganese	All objects of monitoring
4.1.4.2	Cobalt	The same
4.1.4.3	Copper	The same
4.1.4.4	Zinc	The same
4.1.4.5	Cadmium	The same
4.1.4.6	Mercury	The same
4.1.4.7	Lead	The same
4.1.4.8	Chromium	The same
4.1.4.9	Petroleum products	The same
4.1.4.10	Pesticides (DDT and its derivatives, hexachlorocyclohexane – (α- and γ-isomers)	The same
4.1.4.11	General phenols	The same
4.1.4.12	Synthetic surface-active materials	The same
4.1.5	***Microbiological and parasitological indices***	
4.1.5.1	The number of coli-phages	Along the entire track length
4.1.5.2	The number of colon bacillus group bacteria (coli index)	The same
4.1.5.3	The number of bacterial plankton	The same
4.1.5.4	The number of saprophytic bacteria	The same

No.	The environment element, The controlled parameter	Control places
4.1.5.5	The presence of elementary pathogenic intestinal protozoa – lamblia, cryptosporidia, eggs and larvae of helminthes	The same
4.2	**Bottom sediment**	
4.2.1	Granulometric composition	In places of dredging operations and in dumps
4.2.2	Organic matters (total content)	The same
4.2.3	Manganese	The same
4.2.4	Cobalt	The same
4.2.5	Copper	The same
4.2.6	Zinc	The same
4.2.7	Cadmium	The same
4.2.8	Mercury	The same
4.2.9	Lead	The same
4.2.10	Chromium	The same
4.2.11	Petroleum products	The same
4.2.12	Pesticides (DDT and its derivatives, hexachlorocyclohexane – (α- and γ-isomers)	The same
	Synthetic surface-active materials	The same
4.3	**Hydrobiological indices**	
4.3.1	Composition and biomass of phytoplankton	Along the entire track length
4.3.2	Composition and biomass of zooplankton	The same
4.3.3	Saprobity indices by Pantle-Bukk	The same
4.3.4	Water toxicity for test objects	The same
4.3.5	Composition and biomass of water macrophytes	The same
4.3.6	Composition and biomass of zoobenthos	The same
4.3.7	Toxicity bottom sediment for test objects	The same
5	STATE OF SOILS	
5.1	**Toxic substance content in surface layer of soils**	
5.1.1	Manganese	In the places of bottom sediment storage
5.1.2	Cobalt	The same
5.1.3	Copper	The same
5.1.4	Zinc	The same
5.1.5	Cadmium	The same
5.1.6	Mercury	The same
5.1.7	Lead	The same
5.1.8	Chromium	The same

No.	The environment element, The controlled parameter	Control places
5.1.9	Pesticides (DDT and its derivatives, hexachlorocyclohexane – (α- and γ-isomers)	The same
5.2	**Indices of soil value**	The same
6	**State of ichthyofauna**	
6.1	Species composition of fish with separation of rare and endangered species	In the Bystry distributary, in the area of sand-bar and in the sea waste dump area
6.2	The number and productive properties of fish populations	The same
6.3	Growth and development of fish and their whitebait	The same
6.4	Distribution and migrations of fish and their whitebait	The same
7	**The state of plant and animal populations of the shore zone and plavni, the dynamics of biogeocenoses' composition**	
7.1	Rarity florofund	On reserve territories adjacent to the DNC track
7.2	Natural floristic complexes	The same
7.3	Adventive plants	The same
7.4	Synanthropic floristic complexes	The same
7.5	Species composition of animals of land ecosystems	The same
7.6	Species, entered into the Red Book of Ukraine. Occurrence and size of the populations.	The same
7.7	Insects. Occurrence and size of the populations, development conditions.	The same
7.8	Amphibian. Species composition, occurrence and size of the populations, spawning places and tadpole development conditions.	The same
7.9	Reptiles. Occurrence and size of the populations, development conditions.	The same
7.10	Wetland birds. Species composition, occurrence and size of the populations, reproduction conditions, the size of wintering species.	The same
7.11	Mammals. Occurrence and size of the populations.	The same

7.2 Reconstructive measures

As it was stated in Chapter 2, last century saw gradual runoff redistribution of the Danube among two main distributaries of the delta – the Kyliya and the Tulchinsky ones– in favor of the latter. This resulted in watering reduction of the Kyliya distributary delta during that period, which contributed to deterioration of natural conditions in its northern dying part. A number of scientists believe that one of the reasons of the Danube runoff redistribution that happened is carrying out by Romania hydraulic engineering work to ensure navigation along the Sulinsky and the Georgievsky distributaries.

Under these conditions, ***deepening the bed of the Kyliya distributary***, stipulated by the working draft of the first stage of the DNC creation, may be regarded as a reconstructive measure that enables to partially reconstruct the water regime of the Kyliya distributary delta, disrupted as a result of the man-made impact, made on the Romanian part of the Danube delta. The efficiency of this measure at the second stage of the DNC construction will be increased by means of further deepening of the bed of the Kyliya distributary along with restriction of runoff entrance into the Bystry distributary by flanking dike, that is being created in the Starostambulsky distributary near the source of the Bystry distributary, which will permit to preserve, maybe even increase, water discharge rates in distributaries of the northern part of the Kyliya delta.

7.3 Protective measures

Hydraulic engineering measures

The hydraulic engineering measures listed below, whose primary objective is providing navigation along the created navigable channel, are also environmental, as they prevent banks erosion and decrease the volume of dredging operations that have a negative impact upon water quality and conditions of water organisms living.

Clearing the bed of the Starostambulsky distributary in the area of T-junction of the Starostambulsky and the Bystry distributaries. Below the source of the Bystry distributary, partial clearing of the left-bank rift up to the mark minus 7.26 mBS is foreseen,

which will ensure turning water and sediment runoff away from the navigable channel, preventing banks erosion of the Bystry distributary and reducing sediment accumulation in the slot through its sand-bar. The length of cleaning section is 550 m. At present the said rift works as a natural obstacle, directing water and sediment runoff to the Bystry distributary. The efficiency of the given technical measure is confirmed by conclusions of NASU Institute of Hydromechanics.

Creation of a flanking dike in the Starostambulsky distributary forward to the source of the Bystry distributary. It is foreseen by the investments feasibility study of the DNC creation for the purpose of regulated distribution of water discharge rates between these distributaries, prevention of banks erosion of the Bystry distributary and sediment accumulation in the slot through its sand-bar. In the process of designing the working draft is scheduled to the second stage of construction, as determining optimal parameters of the structure is only possible on the basis of the results of observing the runoff hydrodynamic parameters in the course of the work of the first stage of construction.

Creation of a levee along the sea approach channel. It is foreseen by the feasibility study of the DNC creation for the purpose of reducing sediment accumulation in the slot through the sand-bar of the Bystry distributary at storm roughness. Constructively the levee is designed of trapezoidal profile with the slope base of 1:3 and the ridge breadth of 3 m at the 0.52 mBS mark. The enrockment is foreseen of unsorted rock mass with the content equal to 50 pct of rocks 300 mm in diameter. On the outer slope, in the broken wave section subjected to wave impact, a train dump of the same rock, from 2 to 15 m in breadth, 0.90 m in height, is previewed. Estimated wave height in the given section, according to the data of NAS Hydromechanics Institute, makes up 3.2…1.5 m. section 1 of the levee 1,040 m in length (310+730), is planned at the first stage as a temporary structure, construction of which must continue non-stop till full-face and projected length of the levee as a whole with the corresponding estimated values.

Apart from the main purpose, the levee will prevent bank erosion of the Ptichya spit with storm waves at strong northern winds.

Core pools, created on the territories of bank charts of dredging soils inwash, enable to substantially decrease pollution of the Danube water by surface run-off from the places of bottom sediment land storage. Estimated path of pulp clarification in the core pools

depends on grading of stored soils, the pool breadth and depth and ranges from 40 m to 140 m. Projected length of the pools ensures that the following condition is met.

Planning measures

Location of banking dumps of dredged earth is previewed on inconvenient and degraded lands, previously used in similar purposes. These lands, according to acts of sites choice, are allotted for temporary use, as the excavated soil, after consolidation and carrying out the necessary qualitative analyses, will be used in construction of earth protecting structures. Location of sludge ponds is confined to the places of repairing the existing reclamation protecting construction and to places of lands inconvenient in use.

After the lands taken for dumps are free their reclamation is foreseen.

For the purpose of decreasing the area of temporary land requisitioning for banking dumps, the working draft also foresees также ***the possibility of storing dredged material in bed dumps in places previously allotted and currently used for disposal dumps*** – at the 35.5th and at the 89th kilometers of Kyliya distributary river-bed. The depth of the river-bed in the places of bed dumps is 12.80-18.00 m at the 35.5th km and 20.20 m at the 89th km. Such decision ensures ecologically safe storage of bottom sediment with small content of silts and pollutants.

Location of sea disposal dump in accordance with environmental impact statement.

Placement of navigational situation marks in floating version, foreseen in the working draft, permitted to reject allocating for these purposes sections of riverside territories along the Bystry distributary.

Bioreinforcement of channel banks along the Bystry distributary by means of reforestation with the Danube flora species – common willow, abele, black poplar, high ash-tree; of planting river bank slopes with local wave-absorbing aero-aquatic plants.

Exercising the measure is foreseen on the basis of the DBR staff recommendations according to the results of carrying out monitoring of the channel banks state during the period of construction and operation of experimental navigable channel.

Technological measures

Termination of all construction and repair-and-renewal operations on the DNC track during spawning period and downstream migration of fish whitebait is the main measure of decreasing the negative influence on ichthyofauna. While carrying it out, it is necessary to take into account that maximum downstream migration of ordinary fish fry takes place some time after the ban starts. This fry, that hatched upstream of the Danube, reaches the delta sections 10-15 days after the ban starts, sometimes later, for example, in 1984 in the first – second decades of June 96.2 pct of the total number of herring fry migrated downstream to the sea.

Termination of construction and repair-and-renewal operations in the section of the sea approach channel and in the area of the Bystry distributary source during birds' nesting period is the most important measure that ensures minimizing the DNC impact on the DBR ornithofauna, which at that period is the most sensitive to disturbance factor, related to the work of construction equipment.

Speed reduction of the vessels' passage along the Bystry distributary to 7 knots an hour is a necessary condition for preventing the negative wave impact on channel banks and providing the normative noise levels in the DBR reserve zone.

Dispersal of mechanization means, adjustment of their power, variation of their work simultaneity coefficient is a complex of measures directed at providing the normative quality of atmospheric air (in particular, to lower surface concentration of "priority" ingredient – nitrogen dioxide) in inhabited localities and reserve territories, adjacent to the areas of carrying out construction work. In case of adverse meteorological conditions (AMC) complete termination of hydraulic work and engines shutdown is previewed.

The ban to sound vessels' blasts, the ban to transmit music to the deck during the vessels' passage along the DBR territory, restriction, when possible, for the vessels passage along the Bystry distributary to day-time is a complex of measures directed at minimization of disturbance factors for the DBR fauna and reduction of damage for fish industry from catches loss.

7.4 Compensation measures

7.4.1 Reinbursment for irreparable damage by taking measures on equivalent improvement of natural environment state

The most essential irreparable damage resulting from the DNC construction and operation may be inflicted on ichthyo- and ornithofauna.

Damage to ichthyofauna resulting from deterioration of nutritive base, reproductive conditions and migration may be compensated by constructing a fish-farming installation in the given region. Such an installation just on the Danube may become a sturgeon factory on the Ochakovsky distributary (downstream of the town of Vilkovo), the feasibility study for which was devised by "Odessarybvod" (former ZapCherrybvod).

The damage associated with disturbance factors for birds in the sand-bar area during the period of carrying out construction work and during vessels' passage along the Bystry distributary may be compensated by means of implementing measures to increase capacity of the adjoining areas of the reserve for this group of animals by a well thought of hydro- and phytomelioration of the most degraded grounds.

In the opinion of the DBR staff, taking into account a high mobility of birds and movement of many colonial species within large territorial bounds, it would be advisable to direct the bulk of compensation funds at ecological reconstruction of the Steptsovsko-Zhebrianovsliye plavni, namely:

- at clearing the existing water ducts and building new ones for the purpose of increasing watering degraded grounds of plavni;
- at mosaic withdrawal of excessively accumulated organic mass of reed with a view to improve water cycle conditions and prevent the development of putrescent processes.

The funds deducted during the DNC construction and operation for nature-conservative measures in accordance with the calculations of irreparable damages restitution given below, according to the pessimistic prediction of the consequences of the DNC creation for vegetable and animal kingdom, may be directed for the designated purpose of carrying out compensation measures.

If natural conditions of the adjacent territories are preserved due to protective measures, it would be advisedly to carry out the above-mentioned compensation measures as reconstructive ones, directed at compensation of the damage inflicted on the environment by the previously executed economical activity.

7.4.2 Cast of financial reimbursment of eventual irreparable damage to environment

Calculation of damage to aquatic environment

Assessment of damage to aquatic environment from water quality deterioration during carrying out dredging operations was made only by "suspended matters" index, accepting that by their chemical composition (pollutants) soils belong to class II (Classification of soils of the Sea of Azov – the Black Sea basin dredging by the degree of their pollution). While carrying out the monitoring program, a complex of granulometric and chemical composition research of excavated bottom sediment will be conducted. In case of an increased soils pollution, an additional compensation of damage for aquatic environment pollution will be made.

Calculations are made by the procedure described in the report of OF INBYuM [Odessa Branch of Impact assessment Institute of the Southern Seas Biology] [1], in accordance with the requirements of the following normative document: "The order of setting the normals of environment pollution duty and of collecting this duty", approved by Regulation of the Cabinet of Ministers of Ukraine No. 303 of March 1, 1999, and "Instruction on the order of calculation and payment of environment pollution duty" No. 162/379 of July 19, 1999.

The amounts of payment for discharging pollutants into surface waters, territorial and internal sea waters were determined by the formula:

$$\Pi_{В} = \sum_{i}^{N} [(H_{\delta i} \times M_{\lambda i}) + (K_{n} \times H_{\delta i} \times M_{ni})] \times K_{T} \times K_{ind} \quad (1)$$

, where:

I=1

Пв – amount of payment, UAH;

$H_{\delta}i$ – base payment rate for discharge of 1 т of i-го pollutant within the limit range, UAH/t;

$M_{\lambda i}$ – the mass of yearly discharge of i-го pollutant within the limit range. For dredging operations $M_{\lambda i}$ =0.

In this case the formula will acquire the following look:

N

$П_В = \Sigma \; K_N \times H_{\delta i} \times M_{ni} \times K_T \times K_{ind}$ (2), where:

I=1

$К_N$ – multiplicity coefficient of payment for over-the-limit discharges of pollutants;

$К_т$ – regional coefficient, that takes into account territorial ecological peculiarities. $К_т$ for the Black Sea and the Sea of Azov basins equals to 2.0; of the Danube – to 2.2;

M_{Ni} – the mass over-the-limit yearly discharge of i-го pollutant, t;

$К_{ind}$ - indexing ratio, K_{ind} =1.

Izmailsky Chatal – Vilkovo section

Soils excavation is planned to be done by "Dnieprovsky-5" type suction dredger of 1,000 m^3/h productivity. In-process loss may do as high as 2 pct. In the given section it is necessary to excavate 2,192,200 m^3 of soils that are characterized by the following averaged physico-chemical properties: consistency of the soil – 1.6 t/m^3; turbidity-causing fraction – 5.0 pct (according to Rechtransproekt data).

Calculation of impact on aquatic environment is made by suspended matters on the basis of following:

Soil excavation will result in ingress of the following quantity of suspended matters to aquatic environment:

Мвзв = 2,192,200 m^3 x 1.6 t/m^3 x 0.02 x 0.05 = 3,508 t

The amount of damage to aquatic environment as a result of suspended matters ingress during soils excavation, according to the formula (3) will make up:

П взв = 3,507 т x 1 UAH/t x 2.2 = **7,718 UAH**.

In Izmailsky Chatal – Vilkovo section the planned annual operating excavation makes up 800,000 m^3. in this case, correspondingly, the annual payment amount will make up **2,816 UAH**.

Vilkovo – Bystry section

It is planned to carry out soils excavation in Vilkovo – Bystry section by "Skadovsk" type hydraulic dredge of 750 m^3/h productivity. In-process loss according to Building Regulations 3.02.01-87 make up 5 pct. In the given section it is necessary to excavate 170,000 m^3 of soils that are characterized by the following averaged physico-chemical properties: consistency of the soil – 1.6 t/m^3; turbidity-causing fraction – 5.0 pct (according to Rechtransproekt data).

Soil excavation will result in ingress of the following quantity of suspended matters to aquatic environment:

Мвзв = 170,000 m^3 x 1.6 t/m^3 x 0.05 x 0.05 = 680 t

The amount of damage to aquatic environment as a result of suspended matters ingress during soils excavation, according to the formula (3) will make up:

П взв = 680 t x 1 UAH/t x 2.2 = **1,496 UAH**.

In Vilkovo – Bystry section the planned annual operating excavation makes up 100,000 m^3 which will result in pollution of aquatic environment with suspended matters. In this case, correspondingly, the annual payment amount will make up **880 UAH**.

The sand-bar part

It is planned to carry out soils excavation on the sand-bar part by "Skadovsk" type chain-bucket hydraulic dredge. In-process loss during the work of a chain-bucket hydraulic dredge make up 5 pct.

In the littoral section it is necessary to excavate 2,155.6 m^3 of sandy and sludgy soil, in which the stable suspension-forming fraction makes up, correspondingly, 2.1 pct and 23.2 pct (according to Rechtransproekt data). As ratio of the given types of soils is estimated close to 1:1, we accept in the calculation the average content of suspension-forming fraction of 12.65 pct. The soil density is 1.6 t/m^3.

Soil excavation will result in ingress of the following quantity of suspended matters to aquatic environment:

$M_{взв}$ = 2,155,600 m^3 x 1.6 t/m^3 x 0.05 x 0.1265 = 21,815 t;

The amount of damage to aquatic environment as a result of suspended matters ingress during soils excavation, according to the formula (3) will make up:

П взв = 21,815 t x 1 UAH/t x 2.0 = **43,630 UAH.**

In the sand-bar section the planned annual operating excavation makes up 300,000 m^3 which will result in pollution of aquatic environment with suspended matters. In this case, correspondingly, the annual payment amount will make up **6,071 UAH**.

Thus, the amount of pecuniary compensation for polluting water with suspended matters during carrying out works of the first stage is valued at 52,844 UAH. Annual payments for similar pollution during the operating period – at 9,767 UAH.

Assessment of damage to vegetable and animal kingdom

Assessment of damage was made in accordance with the technical approach used in the report [1].

Preliminary amount of pecuniary compensation of the possible damage to plant communities is calculated at the existing rates for natural-reserve fund of Ukraine (Regulation of the Cabinet of Ministers of Ukraine No. 521 of April 21, 1998 "On adoption of rates for calculating the amount of compensating damage, inflicted by violating environmental legislation within the borders of territories and objects of natural-reserve fund of Ukraine"). Taking into account the uniqueness of estuary plavni forest and its unrecoverability in future, the damage for exterminating wood-and-brush vegetation must be calculated for each tree, bush or subshrub. In a section with the area of 0.1 hect. the average of 5-6 trees grow with trunk diameter from 60 to 120 cm, 90 cm on average (19,800 UAH) and 12-15 trees with trunk diameter from 25 to 50 cm, 37.5 cm on average (11,840 UAH) and up to 20 bushes (900 UAH).

In case estuary forest in such section dries as a result of its partial damaging by wave breakage from vessels' passage, calculations must be made by the above-stated rates on the basis of 30 thousand UAH for 1 hect. of the damaged grounds. For estuary part of the Bystry distributary (1/3 is occupied by estuary forest) it may makeup **810 thousand UAH**.

Damage for disturbing grass cover, related to the change of hydrological regime, as well as with other actions, resulting in land erosion, is calculated on the basis of 20 thousand UAH for 1 hect. of the damaged grounds.

If, under impact of wave effect, in estuary sections of the Bystry distributary herbaceous plants species, unsteady to long-term underflooding, fall out on 2/3 of the territory, the damage to reserve ecosystems may make up **1,133 thousand UAH.**

Thus, in case of degrading of plant communities of the Bystry distributary channel banks, the damage in the long term may be valued in money terms at 1,943 thousand UAH. But, to assess ii specifically, annual monitoring of probable degrading of plant communities along the Bystry distributary is necessary.

The main damage to ornithofauna of the reserve at the first stage of the DNC creation will be inflicted in the sand-bar part. Direct damage may be inflicted in case of by

washing away a part of the Ptichya spit – the place of mass nesting charadriiformes birds, which may result in the following species (in couples) losing habitual places of nesting:

- Sandwich tern – 2,600;
- Common tern – 1,850;
- Herring gull – 65;
- Avocet – 12;
- Oyster catcher (the Red Book of Ukraine, further – RBU) – 1;
- Snowy plover (RBU) – 1.

If impossibility of the given species' nesting is accepted as equivalent to destruction of their nests, according to the current legislation the amount of pecuniary compensation of the damage will make up (in UAH):

- Sandwich tern – 2,600 x (48 x 2) = 249,600
- Common tern – 1,850 x (48 x 2) = 177,600
- Herring gull – 65 x (48 x 2) = 6,240
- Avocet – 12 x (95 x 2) = 2,280
- Oyster catcher (RBU) – 1 x (90 x 2) = 180
- Snowy plover (RBU) – 1 x (90 x 2) = 180
- **TOTAL** **= 436,080**

The rates of compensating damage to birds species, not entered into the Red Book of Ukraine, are calculated on the basis of Regulation of the Cabinet of Ministers of Ukraine No. 521 of April 21, 1998 "On adoption of rates for calculating the amount of compensating damage, inflicted by violating environmental legislation within the borders of territories and objects of natural-reserve fund of Ukraine".

The rates of damage to birds species, entered into the Red Book of Ukraine, are calculated on the basis of Regulation of the Cabinet of Ministers of Ukraine No. 398 of March 16, 1999 "On introducing alterations to Regulation of the Cabinet of Ministers of Ukraine of June 1, 1999 No. 399".

Besides that, the following species (in specimens) will lose places of rest, feeding and wintering:

- Dalmatin pelican (European Red List, further ERL, RBU) – 5;
- White pelican (RBU) – 45;
- Spoon-bill (RBU) – 5;
- Big curlew (RBU) – 4;
- Wild duck – 230;
- Herring gull – 120;
- Common teal – 60;
- Pintail – 45;
- Black-headed gull – 45;
- Widgeon – 35;
- Gadwall – 15;
- Little gull – 15;
- Black tern – 10;

And others.

The procedure of calculating damage to birds resulting from loss of places of rest, feeding and wintering. However, the damage undoubtedly exists. Expertly, in report [2] the amount of damage from loss of places of rest, feeding and wintering by the given species was accepted as equal to half that from their death. Then, by current legislation, the amount of pecuniary compensation of the damage will make up (in UAH):

- Dalmatin pelican (ЕКК, RBU) – 5 x (1,000 x 0,5) = 2,500
- White pelican (RBU) – 45 x (1,000 x 0,5) = 22,500
- Spoon-bill (RBU) – 5 x (500 x 0,5) = 1,250
- Big curlew (RBU) – 4 (100 x0,5) = 200
- Wild duck – 230 x (90 x 0,5) = 10,350
- Herring gull – 120 x (48 x 0,5) = 2,880
- Common teal – 60 x (90 x 0,5) = 2,700
- Pintail – 45 x (90 x 0,5) = 2,025
- Black-headed gull – 45 x (48 x 0,5) = 1,080
- Widgeon – 35 x (90 x 0,5) = 1,575
- Gadwall – 15 x (90 x 0,5) = 675

- Little gull – 15 x (48 x 0,5)	=	360
- Black tern – 10 x (48 x 0,5)	=	240
TOTAL:	**= 48,335**	

Altogether, according to the given preliminary calculations, in case of partial washing away of the Ptichya spit, the direct damage to ornithofauna from the navigable channel construction and operation in money terms may be evaluated at 523,805 UAH.

To assess the actual damage to ornithofauna, as well as to animals of other groups for whom even a preliminary predicted damage assessment is difficult, special long-term research (monitoring) of the DNC impact on birds and other animals of the given area of delta and of the reserve as a whole, are necessary.

a summary table of pecuniary compensation of the possible irreparable damages to natural environment, according to assessments of associate organizations, is given below. Calculations of the damages amount are placed in the corresponding reports that form part of the working draft.

Table 7.2 – Preliminary evaluation of pecuniary compensation amount of irreparable damage to natural environment at the first stage of the DNC creation

Natural environment component, kind of damage	Amount of compensation payments		Note
	during the construction period, UAH.	during operation, UAH.	
Aquatic environment, water pollution	110,964	31,487 (annually)	During dumping and dredging
Ichthyofauna, damage to fish reserves	1,061,597	280,320 (annually)	During dumping and dredging
Vegetation, disappearance of valuable communities	–	1,943,000	In case of degrading of channel banks communities as a result of navigation. Actual damage is assessed by monitoring
Orhithofauna, disappearance of places of reproduction and wintering	–	523,805	In case of washing away of the Ptichya spit as a result of navigation. Actual damage is assessed by monitoring
Air pollution	10640	5,320 (annually)	During dumping and dredging operations of the craft

8. All round assessment of the activities under project impact on environment

The results of integrated assessment of the impacts on natural environment of the DNC, that goes along the Bystry distributary, taking into account the measures, foreseen by the project, to ensure normative state of natural environment and ecological safety at the first stage of creation during construction and operation, are presented in tables 8.1 and 8.2.

According to the assessments made by main factors of impact and by complex of impacts as a whole, carrying out the projected economical activity is considered acceptable, taking into account that:

- already at the first stage of work the project foresees implementing engineering decisions aimed at prevention of negative impacts on the processes of further delta formation, on territories and water areas that are adjacent to the DNC tract and are of ecological value;
- of work of the first stage, paving the Bystry distributary banks, mounting navigational marks on them and creating engineering structures in the area of its estuary are excluded, besides, the levee erection in the sand-bar area is restricted to one section, which minimizes interference in environment in its most vulnerable sections – ecotones;
- during work organization, during their carrying out and during the DNC experimental operation, meeting ecological safety demands and imposing a series of permanent and seasonal restrictions, aimed at decreasing possible negative ecological consequences of the activity are foreseen.
- a program is developed and financial provision is foreseen of carrying out integrated monitoring of environment state for the purpose of timely exposure of tendencies of possible negative consequences of activity manifestation;
- full pecuniary compensation of negative consequences that are initially irreparable or may show up in future, despite all provided measures to prevent them, is foreseen.

Table 8.1 – Complex evaluation of the influence of the deep-sea navigation channel during its construction

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
1. An excavation and temporary storage of a ground on the plot of the Danube channel from Izmailsky Chatal to Vilkovo in the	Damage of the bottom during the excavation	1.129km^2	Destruction of the benthos biocenoses during the construction period on the area of 1.4% of the bottom of the channel considered plot.	A slight temporary drop of the cleaning capability of the river ecosystem on the considered plot. Convertibility of the process is ensured by non-simultaneous influence along the plot and benthos organism move by tractional loads. **The impact on the aquatic system is permissible.**

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
	Ground losses during the excavation (2 %)	4 3844m^3	Downstream diffusion of a fine-dyspersated suspension with adsorbed pollutants, increase of the water content of biogenic matters, ions of the metals, harmful organic substances, both in dissolved state and as a suspension (see tables 4.3.10 - 4.3.12), radioactive nuclides (in case of their increased content in the ground deposits).	During the low-water flows, in the cross-section of complete mixing, which is situated lower than the plot of the simultaneous operation of two hydraulic dredges, the 95% of the water content of suspended matters will increase on 0.5mg/dm^3. Thus the gross content of separate substances in water would briefly increase: nitrogen - on 0.12% from the background concentrations, phosphorus - on 16.2%, manganese - on 11.5 %, zinc - on 28.6 %, copper - on 2.1 %, cadmium - on 1.0 %, lead - on 2.7 %, chromes - on 1.6 %, organic substances (by biochemical oxygen demand - BOD_5) - on 5.7 %, petroleum - on 9 %, surface-active materials - on 2.2 %, pesticides – on less than 1 %. The growth of concentrations of these substances at chronic contamination during the construction period is estimated as 10-20 times less. The increase of the content of the suspended matters, water body trophisity and deterioration of

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
	Land occupation for temporary dumps	96 hectares	An inwash of a ground layer of 2-3m on the sites between the channel banking dams and near dam channels of polder system by a suction-tube dredger.	The lands, assigned under the sites, are unused and man-caused infringed. Their considerable part was already used for dumps earlier. The ground from dumps will be used for repair and reconstruction of the defective plots of dams. In accordance with reduction of amounts of works on excavation these assigned lands will be reclamated. **The Influence on the land resources is allowable.**
	Return of fluids from the dumps	$\Sigma Qi < 1.0 m^3/s$	The receipt by the channel of pollutants, having the same nature as ones, appeared during dredging. These pollutants come with storm and filtration waters, formed on the sites.	Suspended matters with adsorbed metals, organic substances, radioactive nuclides are detained in core pools. Thus the receipt of the dissolved harmful impurities averages over time. In view of slight flows of return fluids and their watering in near dam channels, **the influences on the quality of the river water are allowable**.

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
	Noise of operating engines and mechanisms	The noise level on a coast is 55dBA	The calculations of the noise nuisance are presented in the source data for environment impact evaluation, given by "Rechtransproject".	According to the calculations **the noise nuisance is permissible in reference to existing regulations.**
	Pollutant emissions in the atmosphere made by operating equipment	16.2t	The calculations of the atmospheric gross blowouts of hazardous substances and their concentrations in the affected zone after dispersion are presented in the source data given by "Rechtransproject".	According to the calculations, taking into consideration the temporary character of the works, **the influence on the air is allowable with reference to existing regulations.**

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
2. An excavation of a ground on the plot from Vilkovo to the sea edge of the delta with following ground transportation to the dump near Izmail Chatal - Vilkovo in quantity of 170 000m^3	A damage of a bottom during the excavation	0.17km^2	Destruction of the benthos biocenoses during the construction period on the area of 2.5% of the bottom of the channel considered plot, **situated outside of the reserve zone.**	A negligible and temporary drop of the cleaning capability of the river ecosystem. **The impact is permissible.**
	Ground losses during the excavation (5%)	8 500m^3	The same pollutants would come in the channels Starostambul and Bystryy as on the plot of Reni-Vilkovo.	The increase of the content of the suspended matters, water body trophisity and deterioration of the oxygen content are estimated as insignificant. The toxic impact on aquatic organisms would be brief and will not change essentially the usual toxicological situation. **Taking into account the compensation and the ban on operation during the certain periods, stipulated by the project, the influence would be allowable.**

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
	Noise of operating engines	The noise level on a coast is 55dBA	The calculations of the noise nuisance are presented in the source data for environment impact evaluation, given by "Rechtransproject".	According to the calculations **the noise nuisance is permissible in reference to existing regulations. The deterrent effect on the fauna is shown out of the reserve zone and has a local character.**
	Pollutant emissions in the atmosphere made by operating engines	1.8t	The calculations of the atmospheric gross blowouts of hazardous substances and their concentrations in the affected zone after dispersion are presented in the source data given by "Rechtransproject".	The emission takes part outside the reserve zone. According to the calculations, taking into consideration the temporary character of the works, **the influence on air is allowable with reference to existing regulations. It is fauna disturbing and has a local character.**

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
3. An excavation of 2 155.6 thousand m^3 of ground and construction of the dam on the sand bar plot, with the length of 1040m. The transportation of 620 thousand m^3 of ground to the coastal dumps on the plot of Izmail Chatal - Vilkovo and 1 535.6 thousand m^3 to the sea dump.	A damage of a bottom during the excavation and dam construction.	0.58km^2	Destruction of the benthos biocenoses on bottom plots at the area of the sand bar of the Bystryy branch.	The effaceable biocenoses are valuable ones. The drop of the cleaning activity would have little impact on the quality of water due to sufficient water change. **The influence on biota is significant. Taking into consideration the compensation of the damage to the fish fodder supplies, provided in the project, it is permissible.**
	Ground losses during the excavation (5%)	116 550m^3	The entrance of the pollutants to the coastal waters.	The water quality worsening because of the pollutants coming in from the ground. **The effect is significant, but has a local character. Taking into account the compensation of the damage to the water fauna which is foreseen in the project.**

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
	Noise of operating engines	The noise level on a coast is 32dBA	The calculations of the noise nuisance are presented in the source data for environment impact evaluation, given by "Rechtransproject".	According to the calculations **the noise nuisance is permissible in reference to existing regulations.** In view of the sufficient distance from the shore **the impact on a fauna will be negligible.** Out of the zone of 50m from the riverside the exceeding of the noise level permissible for reserves is not foreseen.
	Pollutant emissions in the atmosphere made by operating engines	30.2t	The calculations of the atmospheric gross blowouts of hazardous substances and their concentrations in the affected zone after dispersion are presented in the source data given by "Rechtransproject".	According to the calculations **the influence on air is allowable with reference to existing regulations.** In view of the sufficient distance from the shores **the impact on the fauna is insignificant.**

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
	Contact of the ground with water mass and with bottom in the dumping site.	1 535.6 thousand m^3	The composition of the suspended matters, dissolved contaminants and organic matters is the same as the one which would enter the water with the lost ground during the dredging process.	**The influence is strong.** **Taking into account the stipulated in the project compensation of the damage to the fish fauna, the dumping is allowable on the specially assigned water area, allocated at the distance of more than 5 km from the shore.**

Table 8.2 – Complex evaluation of the influence of the deep-sea navigation canal during its operation

Kind of works	**The factor of influence**	**The quantitative characteristics of the factor**	**The characteristics of processes of influence**	**Evaluation of the consequences of the influence, taking into account the measures on their limitation**
1. Repair dredging operations on the riverbed plots of the canal. An excavation of 940 thousand m^3/year of ground (after the dada of the feasibility study).	A damage of a bottom during the excavation	1.2km^2	Destruction of the benthos biocenoses during a year on the area of 1.4% of the bottom of the riverbed.	A slight temporary drop of the cleaning capability of the river ecosystem on the considered plot. Convertibility of the process is ensured by non-simultaneous influence along the plot and benthos organism move by tractional loads. **Taking into consideration the provided compensation of the damage to the fish fodder supplies, it is permissible.**

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
	Ground losses during the excavation (2 %)	1 8400m^3/year	Downstream diffusion of a fine-dyspersated suspension (5% from the value of losses) with adsorbed pollutants, increase of the water content of biogenic matters, ions of the metals, harmful organic substances, both in dissolved state and as a suspension.	The increase of the content of the suspended matters, water body trophisity and deterioration of the oxygen content on the considered part of the riverbed and downstream are estimated as insignificant. The toxic impact on aquatic organisms would appear occasionally, on the local plots and will not change essentially the usual toxicological situation in the Danube delta. **Taking into account the provided compensation of the damage to water fauna, the influence is allowable.**
	Land occupation for temporary dumps	< 96 hectares, are considered in the table 8.1	The use of the lands which were allocated for dumps previously is assumed.	The lands, assigned under the dumps during the period of construction, are used. The liberated sites are reclamated. **The Influence on the land resources is allowable.**

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
	Return of fluids from the dumps	ΣQi <1.0 m^3/s	Suspended matters with adsorbed metals, organic substances and radioactive nuclides are detained in core pools.	Suspended matters with adsorbed metals, organic substances and radioactive nuclides are detained in core pools. Thus the receipt of the dissolved harmful impurities averages over time. In view of slight flows of return fluids and their watering in near dam channels, **the influence on the quality of the river water is insignificant**.
	Noise of operating engines	The noise level on a coast is 55 dBA	The calculations of the noise nuisance are presented in the source data for environment impact evaluation, given by "Rechtransproject".	According to the calculations **the noise nuisance is permissible in reference to existing regulations.**
	Pollutant emissions in the atmosphere by engines	18.8 t/year	The calculations of the atmospheric gross blowouts of hazardous substances and their concentrations in the affected zone due to dispersion are presented in the source data given by "Rechtransproject".	According to the calculations, taking into consideration the temporary character of the works, **the influence on air is allowable with reference to existing regulations.**

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
2. Repair dredging operations on the sand bar plot. An excavation of 232 thousand m^3/year of ground (after the dada of the feasibility study).	A damage of a bottom during the excavation	0.3 km^2	Destruction of the benthos organisms on the plots of the bottom on the area of the sand bar of the Bystryy branch .	Annihilable secondary bottom biocenoses are not valuable. In view of sufficient water exchange the drop of the cleaning activity will have a little effect on the quality of the water. **The impact is permissible.**
	Ground losses during the excavation (5%)	11 600m^3	The entrance of pollutants in the masses of the coastal waters.	The deterioration of the water quality due to inflow of the contaminants from the ground. **The influence is significant, but local one. Taking into account the provided compensation of the damage to water fauna it is allowable.**
	Noise of operating engines	The noise level on a coast is 32 dBA	The calculations of the noise nuisance are presented in the source data for environment impact evaluation, given by "Rechtransproject".	According to the calculations **the noise nuisance is permissible in reference to existing regulations.** In view of the sufficient distance from the shore **the impact on a fauna will be negligible.**

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
	Pollutant emissions in the atmosphere made by operating engines	5.3 t/year	The calculations of the atmospheric gross blowouts of hazardous substances and their concentrations in the affected zone due to dispersion are presented in the source data, given by "Rechtransproject".	According to the calculations, **the influence on air is allowable with reference to existing regulations.** In view of the sufficient distance from the shore **the impact on a fauna will be negligible.**
	Contact of the ground with water mass in the dumping site.	232 thousand m^3	The composition of the suspended matters, dissolved contaminants and organic matters is the same as the one which would enter the water with the lost ground during the dredging process.	**The influence is strong. The dumping is admissible only at the previously allocated and used plot of the sea water area, taking into account the provided compensation of the damage to a fish fauna.**

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
3. The complex of constructions of navigation canal and ships traffic.	The presence of the opening and dams in the region of the sand bar.	3 km	The change of the natural character of the processes of the advancement of the delta marine edge in the area of the sand bar and of the development of the Ptichya spit .	Possibility of the loss of places of safe nesting of guarded birds' species, breaking of alongshore fishes' finishing migration routes and their hatchery areas. **The influence on the fauna is the subject of monitoring. The realization of regulating protective hydraulic engineering measures and money compensation of unavoidable damage is stipulated on necessity.**

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
	Changed parameters of the channels and sand bar area	A complex of factors	Enlarged salted waters intake in the riverbed of the Bystryy branch .	The degradation possibility of the existing benthos organisms' complex and formation of a new one. Disappear of infrequent and endemic fishes' species. **Influence on a fish fauna is the subject of monitoring. Money compensation of unavoidable damage is stipulated on necessity.**

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
			The probability of redistribution of the water flows between the branches of the Kiliya delta. Intensification of positive and negative setup phenomena in the Bystryy branch and its riverside.	Some intensification of the water exchange and water level fluctuations at the riverside of the Bystryy branch will not produce an essential influence on coastal biocenoses. The redistribution of the river flow in the delta due to first-stage works is predicted as slight; on the second stage of construction the engineering regulation of the water flows on the entrance in the Bystryy branch is provided for prevention of the negative changes of water regime in the delta. **The influence is the subject of monitoring. Taking into consideration of the provided regulating hydraulic engineering measures, it is allowable.**

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
	A landwash during the passage of ships	The waves' height is up to 0.7 m		According to the forecasts, at ships speed limitations, assumed in the project, the parameters of man-caused hydrodynamic loads on the banking near the riverbed of the Bystryy branch and on the Ptichya spit do not fall outside the limits of the natural values amplitude and will not produce significant breaches in these biocenoses. **The influence is the subject of monitoring. Taking into consideration the provided restrictive and protective hydraulic engineering measures, including the compensations and bank consolidation, it is allowable.**

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
	An intake of pollutants in water	On the length of the navigation canal, 159.5 km	A water drain of engines' cooling systems, the exhausts in water of boats engines. Drains which are not authorized or emergency ones.	Contamination is insignificant in conditions of normal operation. At failures ecological effects can be very serious, irrespective of the allocation of the initial pollution focus. The probability of failures in the accepted variant is the least in view of a smaller canal length and the best navigating conditions.

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
	Noise of operating engines and other factors, disturbing the fauna of the Danube Biosphere Reserve	The noise level on a coast is 54.75 dBA	Influence of passing by ships on animals' senses in the riverside of the Bystryy branch. The calculations of the noise nuisance are presented in the report of the Open Company "Ecoton".	Difficulties for migration of land animals through the water area of the Bystryy branch, decrease of their number in the riverside of the Bystryy branch are possible. The level of a noise nuisance from engines of cargo and passenger vessels and of motorboats is in permissible limits after the regulations for reserves, which are situated outside the riverside. **The influence is the subject of monitoring. Taking into consideration the provided restrictions of the ships' speeds and sound signal injections, it is permissible.**
	Pollutant emissions in atmosphere made by operating engines		The calculations of the blowouts' dispersion are presented in the report of the Open Company "Ecoton".	**The influence is allowable with reference to existing regulations.**

Kind of works	The factor of influence	The quantitative characteristics of the factor	The characteristics of processes of influence	Evaluation of the consequences of the influence, taking into account the measures on their limitation
	Bringing of new representatives of flora and fauna.	It is probable	During the transit of ships through the Bystryy branch and upstream with possible following spread in the entire delta.	The undesirable change of water biocenoses is possible. The displacement of guarded and valuable species, the deterioration parasitologic state. **The influence is the subject of monitoring and control from the specialized agencies.**

CONCLUSION

1. Natural conditions of the Danube delta permit Ukraine to have on its territory a deep-water navigable channel (DNC) that meets the requirements to the highest international class of waterways. This possibility is ensured by existence of the Kyliya distributary of the Danube with the highest water-level and sufficient stability of the active part of the delta. The existing and forecast for the future trend to decrease of suspended solids washout gives grounds to count on retention of these favorable conditions during, at least, next several decades.

2. Absence of the DNC causes Ukraine a serious economical, strategic and social damage that attests objective necessity of its creation.

3. By now, a big enough number of the DNC tracks variants have been worked over at the feasibility study level, which permits to make a number of fundamental conclusions about the main factors of impact of the navigable channel in the Danube delta on environment.

4. According to all variants, within the territory of Ukraine more than 90 pct of the DNC track are made up of the Kyliya distributary channel, the breadth and prevailing depth of which meet the demands made to waterway of the highest international class. At the same time, the rifts at Izmailsky Chatal – Vilkovo section stipulate the necessity to carry out a significant amount of dredging operations both for the period of the DNC creation, and during the period of its operation. In the present project they are estimated correspondingly in 2,192,200 m^3 of soil excavation.

5. In all variants, before coming to the seashore, the DNC tracks crosses the territory of plavni, that are unique for Ukraine by their vegetable and animal kingdom and are enterer into the international register of wetlands that require special protection. In 1998 here, on the basis of the Danube plavni reserve, the Danube biospherical reserve (DBR) was created. All variants of the DNC track at this section infringe on the reserve's interests and it will require regulation on the state level to accomplish them.

6. Within plavni territory tracks variants differ in direction and in the method of building the navigable channel – along the dug channels with sluices, or along natural distributaries of the delta.

7. Lock channels impact the environment most during the construction period, as the amounts of soil excavation during their creation considerably exceed those for navigable channels that pass along natural river-beds. Besides, such channels artificially divide the delta territory and result in change of water regime on large enough territories. At the same time, at the DNC section supplied with sluices there is no need to constantly carry out dredging operations, the amount of which in navigation channels, passing along natural distributaries, has the tendency to increase constantly that, in the end, sometimes makes further operation of the navigable channel impossible.

9. When coming to the seashore, all variants of the DNC creation foresee building of sea approach channel, which entails the need of a large amount of dredging, during both construction and operating period.

10. Unlike the tracks that pass along lock channels, the DNC tracks that use natural distributaries for exit to coastal waters can influence the natural course of delta formation processes. It should be emphasized that in the process the activity of the main natural delta development factors remains, only the intensity of their manifestation changes.

11. Of all distributaries, along which the DNC can be built, the Bystry distributary is the most optimum alternative both by technico-economical and by ecological criteria. Its breadth, slight sinuosity of its river-bed and, most important, great depth at present practically completely meet the conditions of the DNC opening without dredging operations.

12. Besides that, the given variant of the track has a number of advantages that permit to count on a long-term successful operation of the DNC:

– the slowest, as compared to other sections, advancing of the delta sea boundary in the estuary area of the Bystry distributary;

– a constantly increasing share of the Kyliya delta river runoff passing along the Bystry distributary;

– the washout of the bulk of sediments runoff from the Bystry distributary beyond the bounds of coastal waters (though this factor is not steady: during the last years the process of the sand-bar elongation before the distributary and its extension to the sea has become more intensive, together with the development of the right-bank spit that has acquired the name of Ptichya);

– comparatively rapid increase of sea depths behind the sand-bar area.

13. the impacts of construction and operation of the approach channel through the sand-bar of the Bystry distributary on the delta formation processes are regulated. The possible negative consequences for the DBR flora and fauna can be minimized due to the foreseen technical decisions:

– creation of special engineering structures at the place of the Bystry and the Starostambulsky distributaries T-junction will permit to regulate discharge rates of the water coming to the Bystry and to prevent acceleration of process of the northern delta distributaries dying off;

– the choice of the optimal positions of sea approach channel levees permits to slow down transformation of the newly-formed Ptichya spit south of sand-bar of the Bystry distributary, which is a place of mass nesting of birds;

– speed restriction of passing vessels' movement may prevent washing away of the channel banks along the Bystry distributary.

14. A detailed comparative assessment of impact of the track variant along the Bystry distributary and the suggested alternative variant of the DNC passing along lock channel the Solomonov distributary – the Zhebriyanskaya bay on natural environment, carried out at the stage of investments feasibility study, showed the advantage of the first variant by its impact on the DBR territory, its animal and vegetable kingdom. The advantage of the DNC variant track along the Bystry distributary was also confirmed in the Conclusion of integrated State expertise, on the

strength of which the variant along the Bystry distributary was approved on the government level for further designing.

15. Despite a whole number of advantages, building the navigable channel according to the adopted variant, though to a lesser degree as compared to other variants, is connected with negative impacts on the environment.

The most serious consequences may take place with respect to wetland birds population, that constitute the main wealth of the DBR and include a large number of protected species, in case of transformation of the Ptichya spit and destruction of the channel banks.

The channel banks, as well as the DSE, constitute ecotones on the border of aquatic environment and wetland territories of plavni. Ecotones are characterized by the greatest diversity of animal and vegetable kingdom and are the habitat of many of its rare and endangered specimens, being at that the most vulnerable elements of natural environment. Besides direct big losses for flora and fauna, their destruction may result in disturbance of water cycle on the adjacent territories of plavni.

16. A number of measures are foreseen, directed at preserving ecotones during the DNC creation:

- building a levee in the area of sea approach channel, restricting the area of advance of waves from vessels;

- building a flanking dike in the area of the Bystry and the Starostambulsky distributaries T-junction, as well as deepening of the Starostambulsky distributary river-bed downstream the T-junction, which will enable to prevent washing away of the Bystry sand-bar banks;

– speed restriction of vessels' passing along the approach channel and the Bystry distributary, which will also considerably decrease the negative wave impact.

- artificial reforestation of the channel banks areas exposed to washing away;

- storing soil along the Kyliya distributary only on territories that earlier suffered a man-caused disturbance during its artificial diking with its subsequent use for repairing the dikes and removing the soil remains to the sea waste dump.

At the first stage these measures are planned to be carried out partially, and only on the strength of the monitoring results the final amounts of work and design values of installations will be determined.

17. The negative impact on hydrobionts is related to, first of all, dredging work and dumping of bottom sediments, carrying out of which results in decrease of water quality and destruction of nutritive base of fish.

18. A certain damage during the DNC creation may be inflicted on the fauna in connection with changing of hydromorphological parameters in the area of the Bystry distributary sand-bar, which may result in disrupting fish migration routes and the conditions of its reproduction. Digging across the Bystry distributary sand-bar may also cause penetration of salty seawaters deep into the distributary which will adversely affect living conditions of freshwater ichthyofauna and other hydrobionts.

19. As fishery protection measures the project foresees dispersing hydraulic dredges along the length of the navigable channel track and discontinuing the work during the spawning period; the choice of place for sea waste dump is made taking into account minimizing the damage to hydrobionts, inflicted during dumping.

20. The main factor of impact on fauna of the other vertebrates is the trouble given to them while carrying out construction and dredging work and also during passing of vessels. To decrease this negative impact, imposing a ban on carrying out work in the area of the Bystry distributary sand-bar for the period of birds' nesting is foreseen. During vessels' passage along the Bystry distributary, the rules of navigation will foresee the ban to sound vessels' blasts and to transmit music to the deck.

21. Taking into account the measures, foreseen by the project, to ensure the normative state of the environment and ecological safety, residual effects are confined in scale to the territories directly adjacent to the track, which are attributed to the zone of anthropogenic landscapes. This is permissible according to the current environmental legislation.

22. Construction and operation of the navigable channel will not result in changes in size and species composition of the DBR biota. Biotic groupings of the Bystry distributary area, including rarity species and aggregations, are not unique for the DBR, they are widespread within the boundaries of its territory. That is why certain local successions of vegetative aggregations and partial migration of animals from the distributary itself and its riverside do not pose a threat to preservation of the reserve biodiversity, to existence of rare and especially valuable representatives of plant and animal kingdom on its territory, in particular.

23. The project foresees a considerable pecuniary compensation for the possible damage to land flora and fauna in the amount of 2,467 thousand UAH in case this damage cannot be prevented by carrying out nature-conservative measures. The allocated funds will be directed for supporting the reserved regime and scientific research of the DBR on new territories allotted to it upon expansion.

24. The project also foresees a pecuniary compensation for the damage to fish industry in the places of carrying out construction work in the amount of 720.32 thousand UAH, and in the place of the sea waste dump in the amount of 461.33 thousand UAH. During the operating period, the annual amount of compensating the damage, caused by the sea waste dump, is evaluated in the amount of 280.32 thousand UAH. These funds must be directed in the first place for measures of protection and restoration of natural environment of the Sea of Azov and the Black Sea, including restoration of measures to reproduce fish stocks.

25. Compensation for the damage from decrease of water quality due to increase of turbidity in the places where dredging and dumping are carried out during construction period is foreseen separately in the amount of 52,844 UAH и 58,120 UAH correspondingly. During the operating period, these amounts annually make up 9,767 and 21,720 UAH correspondingly.

26. It should be pointed out specifically that assessments of damage to natural environment, assumed as a basis for calculating compensation payments, are to a great extent hypothetical and correspond to pessimistic forecasts of negative ecological consequences of the DNC creation. Taking into account the foreseen guarding and protective measures, the real damage in many respects may be prevented, but, in any case, the allocated funds may be used for developing the DBR and improving the state of natural environment.

27. The DNC creation should be regarded as a restoration measure with respect to man-caused environment. Increase of vessels turnover in the ports of Izmail and Kyliya will contribute to restoration of work both of the ports themselves and of the infrastructure, created to ensure their work, which will result in revival of all economical activity in the region.

28. The DNC creation will also be a restoration measure for social environment. Aside from direct creation of new jobs for the staff operating the DNC, increase of employment of the region population will also be caused by restoring the infrastructure of the region as a whole. Hence, the impact on social environment, despite a negative attitude to the project from a part of the population (mainly members of separate public organizations) should, by objective criteria, be judged as positive.

29. Taking into account, on the one hand, the insistent need of the DNC creation, and, on the other hand, an exceptional ecological value of the territory, along which its track passes, the decision is taken to create the DNC track in two stages, the first one being experimental. The navigable channel parameters at the first stage foresee restriction of the passing vessels' draft to 5.85 m which decreases the amount of dredging and hydraulic engineering work and, consequently, of impact on natural environment. At that period, in accordance with the program of the environment monitoring, carrying out a large amount of observations and scientific research is foreseen for the purpose of specifying the prognoses of the possible negative ecological

consequences of the DNC construction and operation, and substantiating nature-conservative measures carried out at the stage of its complete development.

30. The EIA [Environmental Impact Assessment] materials of the working draft attest that construction and operation of the deep-water navigable channel according to the project "Creation of the Danube – the Black Sea deep-water navigable channel in the Ukrainian section of the delta. Stage 1" will have no transboundary impact on the neighboring states and will not produce negative ecological consequences on territories adjacent to Ukraine.

31. Integrated assessment of residual effects on natural environment of Stage I of the DNC creation, given in section 8 of the EIA, allows considering them permissible, taking into account attributing the Bystry distributary water area, its sand-bar area and riversides to the zone of anthropogenic landscapes of the DBR.

Переклад з російської мови на англійську мову виконала, зміст його підтверджую, перекладач Куракіна Ірина Василівна. _____

This TRANSLATION should serve as a true document. Translation has been done in the City of Mykolaiv by a qualified official translator IRINA V. KURAKINA, Translation Bureau of Mykolaiv. I DO HEREBY CERTIFY that the above English translation is TRUE AND IDENTICAL to the original, is attached hereto. Certificate of State Registration No. 1951200242 was issued by The Chamber of Registration and Licensing (Mykolaiv) on July 26, 1995. My bureau address: Moskovska 42-59, 54017 Mykolaiv, Ukraine; Tel.: +38-0512-474028; E-mail: ark@mksat.net
IN TESTIMONY WHEREOF, my official seal is hereunto affixed.
Witness my hand this 13th day of July 2006 _____ *Irina V. Kurakina, Translator*