

Appendix to section 3.4.

Description of the strategic project no. 4 “Improving Environmental Safety and Conservation of Natural Systems of Caspian Macroregion”.

The Volga Delta has unique ecosystems, including wetlands, and largely determines biodiversity in the Caspian Sea. The environmental situation in the region is tense. Astrakhan Region participates in seven environmental programs: “Clean Country”, “Integrated Waste Management System”, “Clean Water”, “Restoring the River Volga”, “Conservation of Unique Water Bodies”, “Conservation of Forests”, “Conservation of Biodiversity and Development of Ecological Tourism”.

The volume of contaminated wastewater discharged into Volga basins is 38% of the national total, the pressure on Volga water resources is eight times higher than on average in Russia. Housing and public utilities, in addition to those brought upstream, dump 39 million cubic meters of polluted water per year into the Volga River basin in Astrakhan Region. 5.2 million cubic meters (1/7) of these waters are untreated. Less than 80% of the population is provided with or has access to piped treated water. The pollution of the water basin is transforming natural ecosystems and reducing the biodiversity of the Caspian Sea.

Soil degradation and desertification in the Caspian region (the territories of Iran, Kazakhstan, Azerbaijan, Turkmenistan, Kalmykia, Dagestan, and Astrakhan Region) are causing disastrous consequences, in the form of reduction in arable land and in the form of natural hazards (dust storms). According to the UN, no area currently faces a greater threat from desertification than the region between the Caspian Sea and the Pamir Mountains. 579,900 ha of the total area of deflation-hazardous lands in Astrakhan Region are deflated, 333,800 ha of which are agricultural lands, including 2,000 ha of arable lands. There are 542,700 hectares of mobile sand dunes within the region.

The reduction of biodiversity and pollution of water bodies has depleted the food ration for fish, which is the reason for the lack of global leadership in commercial fisheries in the Caspian Sea.

The strategic project will be implemented through a number of key regional projects:

- Regional project “Conservation of biodiversity and development of ecological tourism (Astrakhan Region)”. Expected results by 2024: establishment of at least 24 new SPNRs with a total area of at least 5 million hectares;

- Regional project “Restoring the River Volga (Astrakhan Region)”. Expected results by 2024: restored water bodies area of the “Lower Volga” will reach 0.01 thousand ha; the polluted wastewater discharged into the Volga River will be reduced to 0.01 km³/year; 2 objects of accumulated environmental damage that threaten Volga River will be eliminated;

- Regional project “Conservation of unique water bodies (Astrakhan Region)”. Expected results by 2024: ecological rehabilitation of at least 33 water bodies; environmental improvement of at least 30 rivers and lakes; clearing of at least 2 water bodies.

Through cooperation between science and business, ASU has developed eco-technologies:

- Together with *Marine Robotic Systems* scientific and engineering company, *LUKOIL-Nizhnevolzhskneft*, we developed robotic technologies for environmental monitoring in the southern area of the Volga-Caspian basin using offshore autonomous surface vessels and robotic complexes;

- Together with *Astrakhanrybhoz* Association, *Rybnyye Korma* (eng. Fish Feed), *Global Catering Service* we developed resource-saving biotechnologies for intensive cultivation of commercial aquaculture products.

The implementation of the project will involve scientific potential and resources of the Consortium “Ecology of the Volga River Basin” (joint implementation of the national project “Improvement of the Volga”, comparative analysis of ecosystems of the lower and middle Volga), a regional Consortium of Educational Institutions of Higher Education, Scientific Organizations of Astrakhan Region and Research Institutes of the Region: Volga-Caspian branch of VNIRO (technologies for monitoring and conservation of biodiversity of fish

fauna), the Caspian branch of P.P. Shirshov Institute of Oceanology (technologies for monitoring of underwater ecosystems, including under conditions of oil fields development in the Caspian Sea), Caspian Marine Research Center (formation of a data bank on environmental parameters, technologies for monitoring natural environment), Federal Agroecology Research Center RAS (technologies for combating desertification and soil degradation), Institute for Biology of Inland Waters RAS (improvement of water bodies), Dagestan Federal Research Center RAS (ecosystem monitoring, technologies for combating desertification), Lomonosov Moscow State University RAS (monitoring of the environment), Kalmyk State University (ecosystem monitoring, technologies to combat desertification), South Federal University (ecosystem monitoring, technologies to combat desertification), etc, University of Guilan, Republic of Iran (biodiversity conservation, technologies to combat desertification); Atyrau University of Oil and Gas, (environmental monitoring of the Caspian Sea); Baku State University, Republic of Azerbaijan (biodiversity conservation of ichthyofauna); Institute of Microbiology, Azerbaijan National Academy of Sciences (water treatment and soil rehabilitation technologies).

The key interested parties in the business sphere are *Aquatrade* fish breed company, *Chinar* company, *Global Catering Service*, *Astrakhan Canning Company*, *Raskat* fish breed and reproductive complex, *Lebed*, *Beluga* charity fund for rescue and protection of sturgeon species, *Neftegazovoye Oborudovanie* (eng. Oil and Gas Equipment), *Gexa-Lotos*, *LUKOIL-Nizhnevolzhskneft*, *Astrakhansky* agro-industrial complex.

The results of the project are aimed at solving a number of urgent problems of the Caspian Sea region:

Problem 1: In 2020 the water quality of the Volga River along the main channel was rated by Class 3 as “very polluted”. Maximum allowable concentration (MAC) for waters of the Volga River along the main channel was celebrated on chemical oxygen demand (COD), biochemical oxygen demand (BOD) – 5-day test, iron, copper, zinc, cadmium, molybdenum, phenols, nitrites,

hydrogen sulfide, and sulfides. Water pollution with copper, zinc, iron compounds, organic substances for COD and BOD, and phenols is defined as “typical”. according to the frequency of cases exceeding the MAC. 19.3% (194,486 people) of the population used water directly from open reservoirs (non-public water supply). In 2020, the discharge of water into natural surface water bodies was 142.84 million cubic meters. The actual volume of wastewater discharge (requiring cleaning) was 33,309.47 thousand m³ (4.3%).

Result: improving water bodies and water quality in the Volga River through new water ecosystem treatment technologies (reduction of the Combined Water Pollution Index by 5% (equal to 58.3 in 2020). The use of microbiological systems for the process and purification of waste and wastewater using combined processes and hybrid bioreactors with controlled oxidative stress. The creation of a new generation of microbiological cultivation systems using combined processes, agents that suppress abiotic reactions and eliminate their adverse effects on microbial cells.

The effect on the Caspian Region: restoration of aquatic ecosystem biodiversity; improvement of epidemiological situation, reduction of acute intestinal infectious diseases.

Problem 2. Drinking water. According to the laboratory tests, there is an increase in the percentage of substandard samples of drinking water from the water supply network in the whole region for microbiological parameters from 1.17 % in 2019 to 1.44 % in 2020 (1.04 % - in 2018, 1.5 % - in 2017) and an increase in the proportion of substandard samples for sanitary and chemical parameters from 3.6 % in 2019 to 6.06 % in 2020 (0.9 % in 2018, 1.2 % in 2017).

In 2020, as compared to 2019, there was a deterioration in the condition of water bodies in places of water use - drinking water supply (category I), according to sanitary and chemical indicators from 2.9 % (2019) to 7.8 % (2020), according to microbiological indicators, there was a decrease in the share of unsatisfactory samples from 0.89% to 0.48%. In 2020, as compared to 2019, the proportion of

water samples that do not meet hygienic standards for sanitary and chemical parameters from surface water sources increased from 4.1% to 6.9%.

Result: New water treatment technologies are recommended for implementation in wastewater treatment plants in settlements (predicted decrease of substandard potable water samples from water supply systems by microbiological parameters from 1.44% in 2020 to 1.1% in 2030 and the share of substandard samples by sanitary and chemical parameters from 6.06% in 2020 to 1.5% in 2030).

The effect on the region: assistance in increasing the proportion of the population supplied with good quality drinking water to 87.9% in 2024, improving the epidemiological situation, and decreasing the number of acute intestinal infectious diseases.

Problem 3. Reduction of taxonomic diversity. In 2020, as compared to 2019, there was a 1.9-fold decrease in taxonomic diversity, a 2.4-fold decrease in abundance, and a 1.8-fold decrease in biomass in the Volga River delta and Volga-Akhtubinsk floodplain waterways, which lead to reduction of ichthyofauna in the Volga-Caspian basin. The reduction of species diversity and replacement of more valuable species of hydrobionts by less valuable ones, disruption of hydrological regime and pollution of water bodies lead to the impoverishment of the food ration for fish, which is the reason for the lack of global leadership in commercial fisheries in the Caspian Sea. Conservation and restoration of fish species diversity are possible by improving the quality of their habitat as well as by developing and improving biotechnologies for the creation and operation of reserve brood stocks for permanent replenishment of natural populations by young fish.

The conservation of rare and endangered plants from the Red List of Threatened Species. More than 20 endangered plant species are listed in the Red List of Threatened Species (Red List of Threatened Species of Astrakhan Region, Russian Red List of Threatened Species, endemic and relict plant species, etc.). The conservation of flora diversity will be realized through the creation of reserve populations (translocation, reintroduction) of rare and endangered species that are

at risk of destruction - this is a global trend of environmental organizations, which has not been followed in Russia yet. The application of a new generation algicide to prevent “blooming” of water bodies, created on the basis of metabolites-allelochemicals of aquatic plants, imitating the allelopathic effect of aquatic macrophytes.

Result: the implementation of new technological approaches to maintain taxonomic diversity at a level of 2020 and projected increase until 2030. Implementation of nature-like biotechnology for environmental rehabilitation and bioresources recovery of the Caspian region. The digital twin of the Caspian Ecological System.

The effect on the Caspian Sea region: conservation of species diversity of flora and ichthyofauna; sustainability of ecosystems.

Result: the prediction of natural and anthropogenic transformations of ecosystems under a variable combination of different factors. Obtaining quantitative parameters of the ecological framework stability of the Caspian region.

The effect on the Caspian Sea region: environmental sustainability based on prompt management decision-making, including in the event of extraordinary natural or human-made events.

Problem 4. Soil degradation and desertification. The vast majority of natural complexes in unique landscape areas experience significant anthropogenic pressure and, generally, are transformed, increasingly deviating from their original natural state.

Result: prevention of degradation and return to management use of land that is exposed to the negative impact of accumulated environmental damage through reclamation and ecological remediation technologies. The creation of symbiotic associations of phototrophic and heterotrophic microorganisms isolated from the studied degraded soils with drought and salt-tolerant plants will provide a scientific and practical platform for increasing biodiversity and stability of soil ecosystems, increasing fertility in extreme arid environmental conditions.

The effect on the Caspian Sea region: the share of reclaimed and environmentally rehabilitated lands involved in economic turnover will increase up to 30% in the total area of land vulnerable to the negative impact of accumulated environmental damage.