Caspian Water Quality Monitoring and Action Plan for Areas of Pollution Concern

Regional Pollution Action Plan

August 2009

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Regional Pollution Action Plan

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Table of CONTENTS PAGE

List of Tables;

List of Figures;

List of Appendixes

1. PTS Action Programme
2. Baseline Inventory Report
3. Pre-Feasibility studies
    - Thermal Soil Treatment Process.doc
    - PFS STP Atyrau and Tukhlaya Balka.doc
    - PFS Municipal Stormwater Drainage Astrakhan.doc
    - PFS WWTP sludge disposal site Astrakhan.doc
    - PFS oily waste processing site Dagestan.doc
    - PFS Mazut Lake Khazar/Chelekan.doc
4. Water box model.xls
5. Received documents for RPAP

6. Review of and additional data to the Caspian map modeling exercise as delivered by the Institute of water problems (Moscow, Russian Federation)

ABREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
ARP	Absheron Rehabilitation Programme
AS	Astrakhan Oblast
ASTP	At sea Training Programme Contamination Screening
AZ	Azerbaijan
BAT	Best Available Techniques
BIR	Baseline Inventory Report
BOD	Biological Oxygen Demand
BSC	Black Sea Commission
CASPECO	The Caspian Sea: restoring Depleted Fisheries and Consolidation of a Permanent Regional Environmental Governance Framework (third phase of CEP)
CCEMA	Caspian Complex for Environmental Monitoring Administration
CCPC	Caspian Centre for Pollution Control
CEO	Caucasus Environmental Outlook
CEP	Caspian Environment Program
CEP PCU	CEP Programme Coordination Unit
DAG	Republic of Dagestan
DDT	Kind of synthetic pesticide (i.e. Dichloro-Diphenyl-Trichloroethane)
DO	Dissolved Oxygen
DOE	Department of Environment
EC	European Commission
EECCA	Eastern Europe, Caucasus, Central Asia
EIA	Environmental Impact Assessment
ERACL	Effective Regional Assessment of Contaminants Level
ERL	Effects Range Low
ESP	Environmental State Program
EU	European Union
EUWI	European Union Water Initiative
FSU	Former Soviet union
FTP	Federal Target Program
GEF	Global Environment Facility
GIWA	Global International Waters Assessment
GOST	State Standards (*государственный стандарт)*
HCH	Hexachlorocyclohexanes
IAEA MEL	International Atomic Energy Agency Marine Environment laboratories (Monaco)
IFRTO	Iranian Fisheries Research and Training Organisation
IPPC	Integrated Pollution Prevention and Control
IR	Iran
IWRM	International Water Resource Management
KZ	Kazakhstan
LBS	Land based sources
LSE	Local Sectoral experts
MAD	Min. Allowable Discharges
MENR	Ministry of Ecology and Natural Resources
MNR	Ministry of Nature Resources
MPC	Max Permissible Concentration
MPHI	Maximum Permissible hazardous Impact
MPPI	Major Perceived Problems and Issues
N-CAP	National Caspian Action Plan
N-PAP	National Pollution Action Plan
NATO	North-Atlantic Treaty Organization
NEAP	National Environmental Action Plan
NGO	Non-Governmental Organization

NOAA	National Oceanic and Atmospheric Administration
OGPA	Oil and Gas Production Activity
OGPP	Oil and Gas Production Plant
OSCE	Organization for Security and Co-operation in Europe
PAH	Poly-Aromatic Hydrocarbons
PCB	polychlorinated biphenyl
PFS	Pre-Feasibility Studies
PH	Petroleum Hydrocarbons
PM	Project manager
Pm	Pro memory
POPs	Persistent Organic Pollutants[i]
PTS	Persistent Toxic Substances
P-RAG	Pollution Regional Advisory Group
QA/QC	Quality Assurance and Quality Control
RAGs	Regional Advisory Groups
RAPS	Rapid Assessment Pollution Sources
RC	Regional Coordinator
RPAP	Regional Pollution Action Plan
RF	Russian Federation
SAP	Strategic Action Program for the Caspian Sea[ii]
SCAP	Strategic Caspian Action Program
SCER	Sumgayit Centre for Environmental Rehabilitation
SIO RAS`	P.P.Shirshov Institute of Oceanology, Russian Academy of Sciences
SOCAR	State Oil Company of Azerbaijan Republic
SOI	State Oceanographic Institute
SPPRED	State Program on Poverty Reduction and Environment Development
STP	Sewage Treatment Plant
T	Temperature
TA	Technical Assistance
TACIS	Technical Assistance Commonwealth of Independent States
TCD	Thermal Conductivity Detector
TC	Technical Coordinator
TDA	Trans-boundary Diagnostic Analysis
TDS	Total Dissolved Solids
TM	Turkmenistan
ToR	Terms of Reference
TPH	Total Petroleum Hydrocarbons
TPS	Turkmenbashi Power Station
TRC	Turkmenbashi Refinery Complex
TSS	Total Suspended Solids
TL	Team Leader
UNDP	United Nations Development Program
UNIDO	United Nations Industrial Development Organization
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Program
WFD	Water Framework directive
WMO	World Meteorological Organization
WWTP	Waste Water Treatment Plant

[i] Stockholm Convention on persistent organic pollutants

[ii] (5 November 2003, updated Oct 2006)

1 INTRODUCTION

1.1 CaspianMAP

The Regional Pollution Action Plan for the Caspian Sea (RPAP), has been prepared as part of the project "*Caspian Water Quality Monitoring and Action Plan for Areas of Pollution Concern's (hereafter: CaspianMAP)".* The project is financed by the Tacis Programme of the European Union (EU), which has as one of its objectives the promotion of regional co-operation on environmental protection.

The overall objective of the CaspianMAP is to achieve improved quality of the marine and coastal environment of the Caspian Sea. In particular, the RPAP (current Report) provides recommendations to regional strategies for pollution reduction, with a focus on the identified *Areas of Pollution Concern.* The CaspianMAP also developed a proposal for a Regional Water Quality Monitoring Program.

1.2 CEP and the Tehran Convention

The *CaspianMAP* project supports the Caspian Environment Programme (CEP), which is a partnership between the five littoral states namely Azerbaijan, Islamic Republic of Iran, Kazakhstan, Russian Federation and Turkmenistan, as well as International Partners like EU, UNDP, UNEP, and the World Bank. The CEP aims at sustainable development of the Caspian environment, including living resources and water quality, protecting human health and ecological integrity for the sake of future generations. The CEP's mission is to assist the Caspian littoral states to achieve the goal of environmentally sustainable development and management of the Caspian environment for the sake of long-term benefit for the Caspian inhabitants.

One of the achievements of the CEP is the development of the Strategic Action Plan (SAP), which sets the agenda for enhanced regional environmental cooperation among the littoral states in two distinct five-year periods. The first five-year period started in 2003. In October 2006, an update of the SAP took place. This updated regional policy framework document lays down the principles of environmental management and cooperation for a new period of 10 years.

In November 2003, the littoral countries adopted the Framework Convention for the Protection of the Marine Environment of the Caspian Sea (Tehran Convention), which entered into force in August 2006. The Tehran Convention lays down the general requirements and the institutional mechanism for environmental protection in the Caspian. Four ancillary Protocols to the Convention are currently under negotiation. The Protocols cover the four priority areas of concern namely:

- Protocol on Conservation of Biodiversity,
- Protocol for the Protection of the Caspian Sea against Pollution from Land Based Sources and Activities,
- Protocol concerning Regional Preparedness, Response and Cooperation in Combating Oil Pollution Incidents,
- Protocol on Environment Impact Assessment in a Transboundary Context.

The purpose of the Land Based Sources Protocol is to prevent, to control, to reduce and to the maximum possible extent to eliminate the pollution of the marine environment from land-based sources in order to achieve and maintain a sound environmental status of the Caspian Sea.

The Strategic Caspian Action Programme (SCAP), which sets the long-term agenda and framework for the implementation of the Tehran Convention and its Protocols over a period of 10 years, was adopted by the littoral countries in November 2008. Littoral countries have expressed their intention to implement the SCAP through the Convention Programme of Work and National Convention Action Programmes.

Many of the SCAP targets come from the CEP SAP:

CEP SAP Target 3. Regional Monitoring Programme can be found back in the SCAP under paragraph 2.6.3.: Regional Water Quality Monitoring Programme,

- *Develop and implement a regional water quality monitoring programme focused on critical contaminants and hot-spots.*

The objectives set under CEP SAP Target 1, are only partly taken over in the SCAP in paragraph 2.2.1.:Regional strategies for pollution reduction,

- *Undertake a comprehensive regional inventory of pollution emissions from land-based sources.*

These works have been covered by the Baseline Inventory, while the current report Regional Pollution Action Plan (RPAP) fits within the following activity:

- *Develop harmonized action programmes for the reduction of pollution loads from municipal and industrial point and diffuse sources, including agriculture, urban and other runoff.*

The EU has expressed its support to the development of the SCAP and the implementation of the Tehran Convention. The project started in support of the implementation of the SAP, but consequently it is also in support of the SCAP.

1.3 Organisation of the project

The CaspianMAP project was implemented by a consortium led by DHV BV from the Netherlands, together with COWi A/S (Denmark), Ecorys (The Netherlands) and Deltares (The Netherlands).

The overall partners in the beneficiary countries included:

- The Ministry of Ecology and Natural Resources in Azerbaijan
- The Ministry of Environmental Protection in Kazakhstan
- The Ministry of Ecology and Natural Resources in Russian Federation
- The Ministry of Nature Protection of Turkmenistan

The TACIS instrument covers the countries of the Commonwealth of Independent States (CIS), therefore the Islamic Republic of Iran had a guest status only in the project.

To ensure that CaspianMAP made good use of products developed under CEP, and to bring in adequate knowledge and expertise, guidance was sought from key experts in the region to select national consultants to directly contribute to the project, including this RPAP. The following National Experts contributed to the CaspianMAP project:

Azerbaijan (AZ):	M. Ganbarov, M.Jabbarov, S. Ragimov, F. Imanov
Kazakhstan (KZ);	S. Akhmetov, G.Umbetalieva, O.Melnik
Russian Federation (RF):	A.Korshenko, I. Zemlyanov, V. Markov, M.Bolgov
Turkmenistan (TM):	G. Orazdurdyeva, T. Berkeliev, L. Berkelieva, Y. Aronsky

Staff of International Experts included:

Caspian Water Quality Monitoring and Action Plan for Areas of Pollution Concern
TACIS/2005/109244

Gijs Kok (2006-April 2008) and Winfried Pietersen (April 2008– end) Team Leader
Oleg Voitsekhovitch – Water Quality Monitoring Expert
Laszlo Iritz – Environmental Management Expert
Ary de Koning – Industrial Engineer
Dirkjan Douma – Expert
Leyla Abdrashitova – Regional Coordinator.

The project started in November 2006. The project office was located in Ashgabat (Turkmenistan).

1.4 The main features of the RPAP

This report updates prior pollution assessments, with specific attention to the so-called Areas of Pollution Concern, Land Based Sources, Offshore and Persistent Toxic Substances / Airborne/radioactive. It looks at the environmental hotspots, defined in accordance with the protocol on Land Based Sources (Tehran Convention) as a limited and definable local land area, a stretch of surface water or specific aquifer that is subject to excessive pollution and necessitates priority attention in order to prevent or reduce the actual or potential adverse impacts on human health, ecosystems or natural resources and amenities of economic importance. The hotspots have been identified by earlier projects, including the Global International Water Assessment (2002) and the Trans Boundary Diagnostic Analyses (2007). With an extension to the ToR, a conceptual model has been applied to the entire Caspian Sea to demonstrate the relative weight of different pollution sources in the three main compartments of the Sea. Finally, the RPAP provides recommendations and strategies for the future regional cooperation. The information sources were national contributions, documents from web sites of www.tehranconvention.org and www.caspianenvironment.org and references (below).

References:

1. Caspian Environment Programme, 2002, Transboundary Diagnostic Analysis for the Caspian Sea, Executive summary and Environmental Quality Objectives, Volume 1 [eng/rus].
2. Caspian Environment Programme, 2002, Transboundary Diagnostic Analysis for the Caspian Sea, Executive summary and Environmental Quality Objectives, Volume 2 [eng/rus].
3. Stolberg, F., Borysova, O., Mitrofanov, I., Barannik, V., and P. Eghtesadi, 2006, Caspian Sea, GIWA Regional Assessment 23, Global International Waters Assessment, UNEP, GEF, Kalmar University [eng]

2 UPDATED ASSESSMENT OF POLLUTIONS IN CASPIAN REGION

This chapter provides a review and analysis of the outcomes of the main studies undertaken thus far, with specific attention to the identified pollution sources. These outcomes are then updated using the contributions of the project's national experts and national inventories and reports of the Caspian countries.

2.1 Caspian Environment Programme (CEP)

2.1.1 CEP Phase 1

The CEP aims at hindering the deterioration of the environmental conditions of the Caspian Sea and promoting sustainable development in the region. In recognition of growing environmental pressures, the five Caspian littoral States expressed a need for a regional programme in 1991, resulting in the establishment of the Caspian Environment Program by the international community and the littoral states in 1998.

During the first phase, 1998-2003, the CEP became a regional coordination mechanism, which developed the Trans boundary Diagnostic Analysis (TDA), National Caspian Action Plans (NCAPs) and the Strategic Action Program (SAP). The findings of those reports are assessed in the next section.

TACIS played an important role in the first phase of the CEP, supporting the establishment of 4 out of 11 regional thematic centres amongst which the Caspian Centre for Pollution Control (CCPC) in Baku.

The thematic centre for pollution control (CCPC) assisted the countries in making initial steps to identify major pollution risks, and to make analyses of pollution emissions thereby providing the foundation of the current report. Furthermore, the CCPC prepared a proposal for compliance and ambient monitoring, which has also become a major input to the CaspianMAP. An important initiative was the establishment of a database linked to GIS, which should have become a first major step to the development of a shared information system. However, this work was never completed due to the closure of the CCPC.

Another task of the CCPC was to asses the capacities and capabilities of the laboratories in the region. This work was fulfilled and proposals for a set of reference laboratories were made.

2.1.2 CEP Phase 2

In the second phase (2003-2008) the CEP provided assistance to the implementation of the Strategic Action Plan by establishing five Regional Advisory Groups (RAGS). One of the groups was the Pollution Regional Advisory Group (P-RAG), which focused on pollution issues.

The Pollution Regional Advisory Group holds a Workshop on Rapid Assessments of Pollution Sources (RAPS) to revise/update the Tran boundary Diagnostic Analysis, Strategic Action Plan and National Country Action Plans. The workshop took place in Baku between 10th and 11th July 2006. Participants from the littoral countries agreed to implement the GIWA methodology to conduct Rapid Assessments of Pollution Resources in each country. The workshop provided the participants with examples from the Mediterranean Sea and trained them in the online application of GIWA.

Following the RAPS-process, the National Caspian Action Plans of 2002 and the Strategic Action Plan (SAP) of 2002 were updated in October 2006 and 2007. The RAPS formed an important input to the GIWA report. This Global International Water Assessment of the Caspian Sea drainage basin was completed in 2007. These assessments are the building blocks in the CaspianMAP's Baseline Inventory Report and they will be shortly summarized in the next sections.

CASPECO is the name of the third GEF sponsored phase of support, building upon the achievements of the CEP. The CASPECO's project objective is to strengthen regional environmental governance and to apply new thinking to the sustainable management and conservation of the Caspian's bioresources.

2.2 Sampling programmes

Under the CEP umbrella several pollution measurements have been carried out. The first was **the *At Sea Training Programme* (ASTP)**: *Contaminant Screening Programme*. This ASTP has lasted from October 2000 until September 2001 while 105 sediment samples were taken under the auspices of CEP with financial support of UNDP-GEF.

The main findings included:

- Petroleum hydrocarbon (PH) concentrations were quite high by global standards at some locations, notably to the south of Baku Bay.. Total PAH concentrations never exceeded the NOAA Sediment Quality Guideline value for Effects Range Low (ERL) of 4000 ng g^{-1} dry weight. PAHs tend to be derived predominantly from oil or combustion products, with the later notable in the Russian sector. [De Mora and Sheikholeslami, 2002]

- Several organochlorinated pollutants were investigated. Concentrations were invariably very low in Kazakhstan. DDT-related compounds exhibited concentrations higher than NOAA ERL values at numerous locations in the coastal zone of Azerbaijan and Iran, but were quite low in the Russian sector. However, lindane concentrations exceeded the Canadian sediment quality guideline value in the Russian sector. Similarly, the PCB content was higher in the Russian sector than elsewhere, but in this case did not surpass the NOAA ERL of 23 ng g-1 dry weight. As concerns other organochlorinated pesticides, sources strengths (i.e. local usage) in the different regions varied considerably. The Goldberg Index reflects the relative importance of industrial and agricultural sources of organochlorinated compounds. In this study, the Goldberg Index reinforced the observation of the relative importance of agricultural sources in both Azerbaijan and Iran, in contrast to industrial sources in Russia. [De Mora and Sheikholeslami, 2002]

- As indicated above, the metal concentrations are strongly correlated to the aluminium concentration, a good proxy for terrigenous material and the amount of fine-grained material present. The exception to this is barium, for which some anomalous high concentrations are probably from drilling muds. Several metals (As Cr, Ni) exhibit concentrations sufficiently high to exceed sediment quality guidelines. Such metals undoubtedly have a high natural background in this mineral-rich region. However, anthropogenic activities, notably mining, may have further enhanced the metal burdens in the sediments of the Caspian Sea. This might explain apparent hot spots for copper and zinc in Azerbaijan and Iran. Uranium levels are generally low (< 3g g-1), except for a couple of sites in the central eastern Caspian Sea where the concentration reaches 11.1 g g-1. Several metals (Ag, Cd, Pb) have relatively low levels that pose no environmental concerns. [De Mora and Sheikholeslami, 2002]

The **CEP contaminant surveys of 2005**, under supervision of IAEA MEL, was the second regional survey after the break up of the Soviet Union. The CEP sponsored sampling campaign of 2005 also included the Turkmen coast zone. During the campaign 84 surface sediment samples were taken at the Volga delta, the mouth of the Kura River, and in the Kazakhstan, Iranian and Turkmenistan sectors. No samples were taken in Baku Bay.

The main findings of the overall assessment of the environment quality of this cruise were summarized in 2006:

- Little evidence of metal contamination was observed in these surveys, apart from a number of sites in Azerbaijan with elevated mercury levels. Although some elements (arsenic, chromium, copper, and nickel) exhibited concentrations sufficiently high to exceed sediment quality guidelines, such metals undoubtedly have a high natural background in this mineral-rich region. Nevertheless, anthropogenic activities, notably mining, may have further enhanced the metal content in some sediments of the Caspian Sea. This might explain apparent hot spots for copper in Azerbaijan. Several metals (cadmium, lead, silver, uranium, and zinc) had relatively low levels posing no environmental concerns. [De Mora,2006]

- Petroleum hydrocarbon (Σ-PHs) concentrations were relatively low by global standards, with the caveat that some known pollution hot spots were not sampled in these surveys. The distribution of n-alkanes and the carbon preference index suggested a petrogenic origin for petroleum hydrocarbons at some sites in Azerbaijan, Kazakhstan and Russia. PHs in Iran and Turkmenistan, as well as some locations in Russia, derived predominantly from marine and terrestrial biogenic sources. Based on the weathering index, several sites in Azerbaijan and Turkmenistan exhibited a high degree of biodegradation and chronic contamination of degraded petrol. In contrast, relatively fresh inputs of hydrocarbons were apparent in Iran and southern Turkmenistan. The concentrations of Σ-PAH never exceeded the sediment quality guideline value of 4022 ng g-1. Based on various diagnostic ratios, the PAHs tended to be derived primarily from oil with some combustion products, especially in Azerbaijan. Minor contributions from diagenetic sources were detected, principally near the Volga Delta. [De Mora, 2006]

The CaspianMAP project has conducted four marine expeditions during 2008-2009, covering all national sectors of the participating countries (except Iran) of the Caspian Sea. The Cruises have been carried out with participation of national experts. These pollution surveys had two goals, firstly to assist the countries in the development of a regional water quality monitoring plan and secondly to assess the pollution of the Caspian Sea, focusing upon Areas of Pollution Concern.

Below follows a summary and main findings regarding the water quality assessment made. Detailed information is available in the cruise reports, and in the RWQMP report.

Azerbaijan

Widespread pollution by metals and organics were not revealed, however in the areas of pollution concern; Baku bay and in the coastal area of Sumgait, were found high concentrations of oil products and phenols. Especially, high amounts of arsenic were found, likely of natural origin.
In the area of the Shrivand sewage canal, Kura river and Baku bay, high rates of chromium, copper and other metals concentration were observed in the bottom sediments The toxic element cadmium was not found in high concentrations. This indicates that there is no considerable impact of industrial wastewater in Azerbaijan sector.
Beside the oil products in Baku bay, the contamination of the sediments with benzo(a)pyrene exceeded the international renown sediment standards of the Netherlands. In general the Persistent organic pollutants were below such standards.

Relatively fresh and high concentrations of chlorinated organic pesticides and DDT were observed in bottom sediments of Kura-Araks alluvium, despite the global ban.

Kazakhstan

Unexpectedly Metals, such as chromium, copper and nickel are close to or higher than the Admissible Concentration Limits in the water column. Mercury and phenols are even exceeding. A possible explanation would be some imperfections in the sampling methods. Only for one sample location, the oil product concentration in the water exceeded the ACL limits.

In the bottom sediments relatively high concentrations for copper, cadmium, and mercury have been found, however they are on or below the standards (Netherlands). High concentrations of Oil hydrocarbons were found at Satpaev deposits (oil-field) and the Bautino seaport. More investigation is required here.

Russian Federation

High concentrations of oil hydrocarbons were observed on all stations, particularly at the mouth of the Volga the concentration of hydrocarbons in the water is 5 times the ALC.
Phenols and superficially active substances, were relatively low, as well as the metal concentration in the water column.

At the mouths of the rivers at the Dagestan coast pollution caused by pesticides of DDT and HCCH were observed. Particularly the concentration in the mouth of the Terek river is very high.
Concentrations of PAH in the bottom sediments are high near Dagestan coast, Samur River, Derbent, and Mahachkala. Metals were within the limits and it is dominated by the geological background of the Area.

Turkmenistan
At the stage of report preparing the analysis of the bottom sediments were not done yet on organics.
Preliminary results show a relative not high concentration of metals, compared to natural back ground levels in the water column as well as in the bottom sediments.
At some locations high amounts of phenols were observed. The bottom sediments of Turkmenbashi bay were found to be heavily polluted by oil products.

General
The following problems of the Caspian Sea were identified based on these cruises:

- Euthrophication (the coastal, especially shallow water areas adjacent to settlements and encompassing almost all coastal areas of Iran, Azerbaijan, Dagestan, northern part of the Caspian Sea and the Turkmenbashi Gulf).
- High level of oil exploration and pollution from their by-products (open seas, coastal waters and rivers that flow into the Caspian). Special importance may be attached to Baku Bay, Turkmenbashi city, and the Dagestan coastline where there are many obsolete and abandoned oil extraction sites.
- Considerable amounts of anthropogenic organic and inorganic pollutants in bottom sedimentation (however in less degree in water and biota) as a result of industrial and agricultural activities and atmospheric deposits from burnt waste gas from refineries and oil extraction installations.

It is commonly accepted that the main part of the total pollution load comes from the Volga, Ural and Kura rivers. The contribution of the Terek, Samur and other rivers in Iran is relatively low. At the same time their regional impact is considerable, due to the specific water circulation mode. It is a peculiarity that the larger part of toxic substances that comes through the Volga river is deposited in its delta and in the adjacent sea area, and that the Ural river deposits in the eutrophic environment system of the shallow northern part of the Caspian Sea.

Furthermore **NATO-OSCE**, in the frame of the Science for Peace program Kura-Araks watershed project, conducted surveys in the Kura River Delta. (http://www.kura-araks-natosfp.org). At 35 locations in the Kura-Araks rivers and its main tributaries, beginning from January 2004- June 2005, downstream of the Mingechaur reservoir, were taken water samples on a monthly basis to monitor the following parameters, heavy metals (Ag, As, Cd, Cr, Co, Cu, Hg, Mn, Mo, Ni, Pb, Zn) and common characteristics (T, Ec, pH, DO, TDS, TSS, Na, K, Mg, Ca, Cl, SO4, HCO3, TN, TP). During an extension of the project also radionuclides and POPs were monitored.

Also **the IAEA** conducted a radiological survey of the Kura and Araks rivers in 2005 in Azerbaijan. Measured were ^{137}Cs, ^{238}U, ^{234}U, $^{239+240}$Pu, ^{238}Pu, ^{90}Sr and ^{241}Am activity in sediment samples as and some aquatic plants. [Sansone et al.,2005]

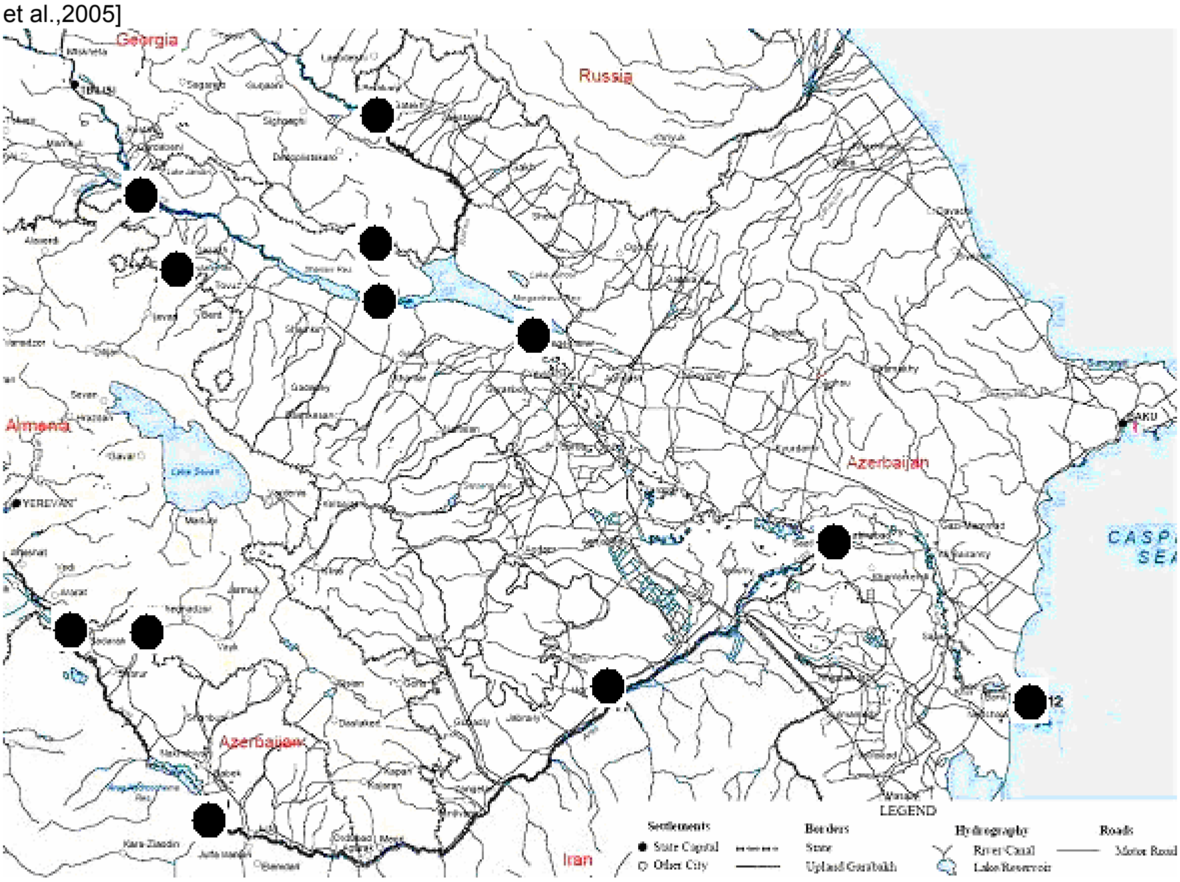

Figure 1 Radionuclides and POPs monitoring points in *NATO-OSCE project.*

The values obtained for the radionuclide levels in the freshwater sediments collected in the Kura-Araks basin (Azerbaijan) were relatively low, and in most cases below detection limit, as compared with those from other areas of the world which have been directly affected by effluents from nuclear installations or influenced by the Chernobyl accident.

The 137Cs activity concentrations measured in the sediment are mainly attributable to the atmospheric fallout from nuclear weapons tests and in part also the Chernobyl-derived caesium. The 137Cs activity concentrations on aquatic plants collected on two locations of the Kura-Araks basin are low and range from detection limits to 3.5±0.6 Bq kg-1 dry weight. The vertical distribution of 238U and 234U activity concentration values in the core sediment and in the grab sediment sample showed a constant value. The 234U/238U activity ratios vary from 0.97 to 1.00 with a mean value of 0.99±0.01 and confirm that 238U and 234U activity concentrations measured in these samples are of natural origin. The plutonium levels in sediments are similar to and in some cases lesser than in those areas which have not been directly affected by the radioactive contamination due to the effluents from nuclear facilities, deposition of radioactive waste or the Chernobyl accident. These results indicate that the main source of radioactive contamination in the study area was the nuclear explosions which occurred in the past. The 90Sr values in all the sediment samples were below detection limit.

Oil companies and Russia have surveyed the Volga Delta. However, these data are in general not public or shared between the littoral countries.

A number of scientific publications were published in recent years, including “The Caspian Sea Environment”. The Handbook of Environmental Chemistry, Volume 5 Water Pollution Part P, Springer, A.Kosarev, A.G. Kostianoy editors, 2005, and the proceedings of an International Scientific Conference “Extreme Hydrological Events in Aral and Caspian Sea Region (2006)”.

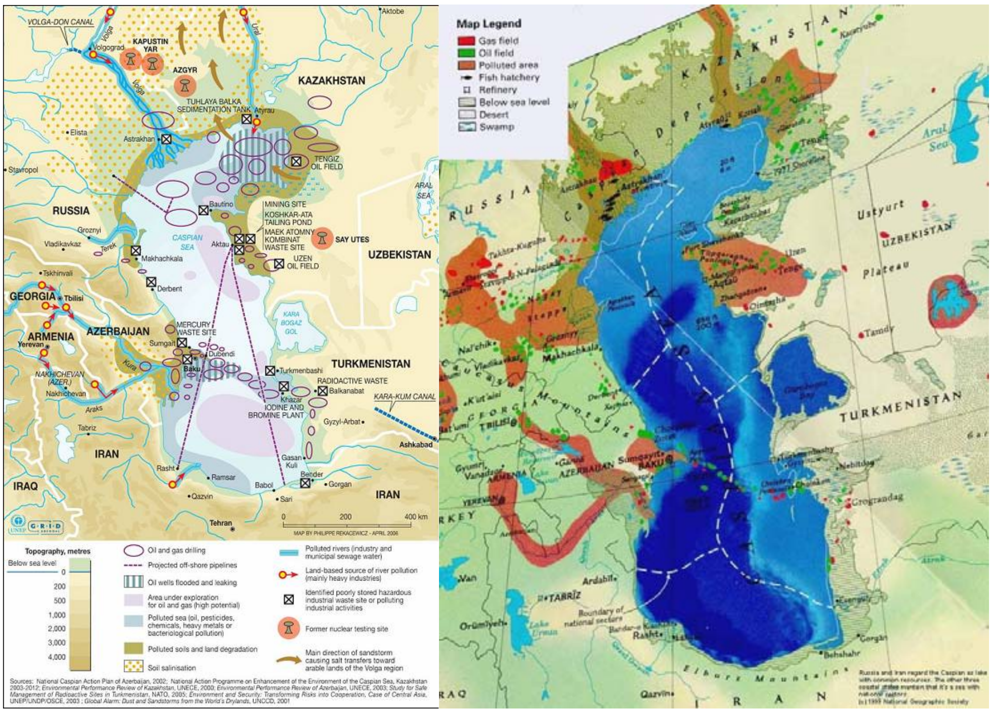

Figure 1, Mapping of pollution sources

2.3 Areas of Pollution Concern based on Rapid Assessment of Pollution Sources (RAPS) and Transboundary Diagnostic Analysis (TDA)

The Rapid Assessment of Pollution Sources (RAPS) is a method for estimating the quantity and type of contaminants arising from various sources, both point and diffuse ones found within a particular area. The load from non-point sources is estimated on land use and activity within that area, while the quantity of contamination discharged from point sources is based on knowledge of the type of industry operating in the project area.

The aim of the RAPS works was to provide an accessible, comprehensive and readily available means of assessing the causes and sources of pollution. The methodology asked questions about the type of contaminant sources within the Caspian drainage basin and, based on the received information, expected contaminant loads were assessed. Potential mitigation options, to reduce contaminant loads, such as avoidance, source control and waste water treatment options, were also recommended.

The Caspian Environment Programme's Transboundary Diagnostic Analysis Revisit (CEP TDA) was first prepared in 2002, and a revision was made in 2007. The revising team performed an intensive desk study of all reports produced for the CEP PCU between 2003 and 2007. Regional and international specialists reviewed the materials and assessed the status of the major transboundary issues. The revisit brought additional information to the forefront, and expanded the understanding of the transboundary issues. In addition, new parallel studies were commissioned on climate change impacts and land-based sources.

2.3.1 Rapid Assessment of Pollution Sources (RAPS)

The RAPS report is the result of the Global International Waters Assessment (GIWA) in particular Assessment of the Caspian Sea Drainage Basin (GIWA region 23). The project in close cooperation with the national experts assessed the RAPS; the results are summarized in the Baseline Inventory Report (Annexes 1-4). Below one can read general findings of the RAPS.

Pollution is one of the primary immediate causes of *habitat and community modification* in the Caspian Sea. Pesticides are considered the most serious pollutants and "**hot spots**" can be found in the dense agricultural areas of river deltas and along the coast of Iran. Oil pollution is currently a localized problem but could become a significant threat in the future due to the expanding oil exploration activities in the Caspian. The following paragraphs explore the main sector activities and root causes responsible for pollution in the coastal waters of the Caspian Sea and its freshwater deltas.

Agriculture

The chemicals used in the small-scale farming along the coastline of the Caspian Sea and in its freshwater deltas Azerbaijan, Iran and Turkmenistan, have resulted in an increase in run-of of these pollutants into the Caspian Sea. New farms are also dependent upon irrigation and pesticides to ensure adequate production. Today, environmentally harmful pesticides are both cheap and readily available on local markets throughout the Caspian Economic Hinterland (CEH), whereas modern and less damaging alternatives are relatively expensive and therefore seldom used by poor farmers. Public knowledge about the ecological consequences of pesticides is also generally low in the region.

Industry

Industrial discharges contribute substantially to the pollution in the Caspian Sea. This problem is directly linked to the economic difficulties in the region as well as to the limited resources given to local authorities for monitoring activities. The waste water treatment plants have been outdated and work with low efficiency if they function at all.

However, industrial pollution is not currently the main cause of habitat modification in the Caspian Sea, except in some areas with high industrial activity and poor wastewater treatment systems such as for example in the Terek Delta.

Urbanization

Most of the urban areas around the Caspian Sea rely on old Soviet wastewater treatment plants while those have became outdated because of the poor maintenance (if any) and they were not adjusted to the modern levels of water consumption. The reconstruction needs are very urgent.

Oil industry

Large parts of the Caspian Sea have not been affected by oil pollution. This is true for the northern mid- and south-eastern parts of the Caspian Sea as well as for the Iranian coastline. However, around the Apsheron Peninsula in Azerbaijan, oil pollution is an acute problem and the primary immediate cause of habitat and community modification.

The waters outside Turkmenbashi and Hazar in Turkmenistan and Atyrau in Kazakhstan are also severely affected by oil pollution (CEP 2002c).

While it is difficult to control accidental spills, improved technologies and trained staff could reduce the risks of future large-scale disasters and the sporadic smaller spills. Currently, there is a great need to modernize the technology and infrastructure used for the older and abandoned oil wells, which are often leaking in the region. Even though these spills bear local character may also have transboundary impacts by affecting critical habitats (spawning, nursing and feeding grounds) of transboundary bio-resources (sturgeon, shad, sprat and seals).

2.3.2 Transboundary Diagnostic Analysis (TDA)

The *Transboundary Diagnostic Analysis* (TDA) is a scientific and technical assessment, through which the water-related environmental issues and problems of the Caspian Sea region have been identified and quantified, their causes analyzed and their impacts, both environmental and economic, assessed. The analysis involves an identification of causes and impacts at national, regional, and global levels and the socio-economic, legal, political and institutional context within which they occur.

The TDA provided the technical basis for the development of the National Caspian Action Plans (NCAPs) and the Strategic Action Programme (SAP). There were two TDA studies made (2002 and 2007). The sections below briefly present the main findings of these works.

The TDA (2002)

Geographic Scope

The geographic scope of the Caspian Sea TDA cannot be simply described. Within the Framework TDA approved at Ramsar in May 1998, it was agreed to take the boundaries as far out to sea as can be actively managed, and as far inland as the administrative boundaries of coastal provinces. Where these boundaries impinge too far inland, the TDA should concentrate on a corridor width of between 100 and 200 km. Major rivers were addressed with their lower reaches as a priority and the remainder only as much as possible.

Pollution has a much broader scale than, since, rivers may bring pollution from all portions of the drainage basin. For instance, the Volga River services much of interior Russia, and the drainage basin extends beyond Moscow. For the Kura River, which has a strong transboundary nature, pollution may emanate from any of the countries through which it passes, including Turkey, Georgia, Armenia, Iran, and Azerbaijan. It simply is not practicable (schedule-wise and budget-wise), however, to include the entire drainage basin in all aspects of the TDA. The TDA has attempted to make up for these shortfalls by cooperating with ongoing programmes focusing on the rivers.

The major challenges of the regional process were

- The absence of open data sharing while the international assistance anticipated open sharing of available data. The reasons for limited excess were inter alia raw data may be sensitive for a variety of reasons, including its value as a real currency.
- Lack of clarity about ownership of the data, and political or cultural perspectives.
- Lack of effective intersectoral coordination on a national level also reduced the availability of data in some instances. Therefore as a major priority, data-sharing agreement was proposed that clearly laid out the regional availability of scientific data (both new and historical).
- Another major challenge was the availability and quality of data available to formulate this TDA.
- Gap in monitoring of many parameters of concern after the Soviet Union broke-up.

The TDA defined the major environmental issues and their transboundary significance:

Major environmental issue	Transboundary significance
Decline in certain commercial fish stocks, including sturgeon	strongly transboundary
Degradation of coastal landscapes and damage to coastal habitats	strongly transboundary
Threats to biodiversity	strongly transboundary
Overall decline in environmental quality	strongly transboundary
Decline in human health	weakly transboundary
Damage to coastal infrastructure and amenities	weakly transboundary
Invasive and introduced species	strongly transboundary

Major environmental issue	Transboundary significance
Contamination from offshore oil and gas activities	strongly transboundary

The decline of the three major commercial fisheries groups: sturgeons, kilka and other bony fishes was linked to the following causes:

- habitat degradation because of dam constructions, gravel and sand minings, water uses for agriculture and water pollution);
- lack and / or miss-management of fisheries leading towards overexploitation because there is no interstate agreement on fisheries management, national fishery regulation is inadequate;
- worsening geopolitical and economic climate causing negative impacts such as poor enforcement of and compliance with fishing regulations, increased poaching by jobless coastal populations);
- insufficient scientific knowledge of how fish species may adapt to a changing Caspian environment (e.g. new spawning grounds adopted by sturgeon species, since, old ones are no longer accessible); and
- possible eutrophication effects on plankton, in some river deltas and near the Absheron peninsula, due to higher nutrient levels.

The TDA (2007)

A revision of the TDA took place at the end of 2007. The revision concluded that the decline in biodiversity was continuing. It also concluded that little information was available, despite the existence of this information within some government sectors and the regional scientific community.

The TDA 2007 calls upon the activation of a full monitoring programme for fisheries, pollution and oceanography, to better conclude the status of marine biodiversity in the Caspian. No regular monitoring is undertaken, and techniques used provide only qualitative data. The need to use remote sensing to identify threats and trends is emphasized.

The transboundary issue of decline in environmental quality remains a priority concern. The efforts of CEP II focused upon a validatory assessment of the pollution status of the coastal zone, and a determination of pollution fluxes from the main Caspian basin rivers (Volga, Kura and Terek), including a second assessment of land-based sources. [TDA, 2007]

Regarding the state of the environment of the Caspian Sea, the TDA, 2007 states that concentrations of some metals in the region are often elevated relative to other locations globally. Although the origin is mostly likely natural due to the metaliferrous nature of the drainage basin, some contributions can be expected from the extensive mining operations in the region. Mercury contamination is evident in the coastal zone of Azerbaijan.

The TDA 2007, recalls the findings of the sampling exercise conducted in 2005; Little evidence exists of widespread contamination due to petroleum hydrocarbons. However, the Terek River certainly acts as a source of such pollution. Widespread contamination of chlorinated pesticides, notably DDT and HCHs (*e.g.*, lindane), continues to be seen in the Caspian Sea. Data for DDT and its breakdown products demonstrate that the pollution results from contemporary, rather than historical, sources. Because such ongoing inputs apparently result from illegal usage, a future priority in the region should be to reinvigorate or initiate enforcement of environmental legislation, such as the widespread ban of DDT.

There are many reasons to suppose that the flux of several pollutants entering the Caspian Sea has diminished since the early 1990s. Some possibilities include a decline in agricultural and/or industrial activities, improved environmental standards and legislation, possibly better enforcement of some regulations and the trapping of contaminants in the reservoirs, especially in the Volga and Kura River basins. Unfortunately, insufficient reliable data exist to validate possible claims as to improved water quality in the riverine systems discharging into the Caspian Sea. The sources of pollutants to the Caspian Sea remain poorly characterised. A robust estimate of current pollutant fluxes into the Caspian Sea remains an elusive goal for most rivers. Reliable historical data, for the most part, originate form the Soviet era. For instance, fluxes of organochlorinated pesticides have been reported for rivers in the Soviet Union. Some efforts have been made to estimate riverine fluxes from the Volga and Terek. Insufficient information is available for the Kura and Ural Rivers, as well as the Iranian rivers, to estimate their contributions. Inputs from diffuse sources, including the atmosphere, are even less understood. In this vein, the application of RAPS methodology seems to have failed, most notably because countries did not follow the same procedures. As a result, estimates of pollutant loads and fluxes cannot be readily compared throughout the region.

The Caspian Sea level rose significantly in the 1980s reaching a high point in 1995 of - 26.7m (Baltic level) causing significant flooding and economic losses. The water levels have subsequently fallen but remains relatively high and there are concerns that with climate changes levels could rise again, perhaps to as high – 25.0m in the medium term. The impacts of climate change on the Caspian environment and its water levels have been predicted by a number of teams working in the Caspian but knowledge of the system is not yet sufficient to give any assurance to these predictions. Each country has taken steps ranging from initial assessment of possibilities to actual construction of barriers against sea level rise based on an array of possible scenarios. Azerbaijan anticipates significant flooding of up to 136,190 hectares of coastal lands in the next 35 years with a 1.5m rise in sea level, including residential areas, agricultural land, industrial enterprises, oil facilities and ports. Iran is already experiencing significant flooding of its coasts, with combined problems of storm surges and erosion of coastal areas and planning difficulties are envisaged. Kazakhstan has already lost one million hectares to coastal flooding and is constructing dikes to protect settlements and vulnerable oil installations, as well as planning for new fresh water and power supplies. The coasts of Russia have experienced less notable recent changes due the influence of Volga delta, but an additional water level rise will have impacts. On the Turkmenistan coast there are significant social and economic costs predicted due to flooding, impacting oil storage depots and loss of communication lines and pipelines and there is recognition of the need for good land use planning.

The marine litter project was developed with UNEP assistance towards the creation of a regional marine litter strategy. During CEP II implementation an assessment of regional marine litter in all 5 Caspian countries was conducted. This was to lead the preparation of a draft regional strategy and its integration of the strategy into the CEP SAP. However the lack of data prevented progression. It was recognized that marine litter is an emerging issue and that it is not yet addressed in a transboundary context. It is anticipated that this will impact coastal habitats, tourism and the fishing industries especially. It is recommended that a full assessment of the scale and scope of marine litter is conducted for the Caspian.

Decline in coastal infrastructure and habitats is closely linked with other transboundary issues such as decline in biodiversity and pollution through damage to coastal habitats secondary pollution caused by flooding of contaminated lands. Rising sea waters will have significant ramifications for the planning authorities and the oil industry, ports and transportation which may not have yet been fully considered by the countries. It is recommended that regional scenarios for water level fluctuation are agreed and economic evaluations of losses, including the environmental and social losses are undertaken at sensitive sites around the Caspian.

The TDA revisit has identified a number of new directions and knowledge gaps which need to be followed and filled. The pollution picture for the Caspian has not changed perceptibly since the last TDA, although our knowledge of the pollution loading is still vague and implications of climate change causing perhaps higher run-off and flooding of contaminated lands needs to be better defined. Adaptation to climate change and specifically potential sea level rises should receive more attention particularly where sensitive conservation sites are under threat. The countries have made significant environment investments in the past five as reported in the national SAP/NCAP implementation reviews, and, with increased oil and gas revenue and public awareness as reported in the stakeholder analysis revisit, it is hoped that this trend will continue. Finally, it is with great satisfaction that the TDA revisit recognizes the strides the countries have made towards regional cooperation and management with the signing and ratification of the Tehran Convention and development of its attendant protocols; however, this success is tempered by weak national institutions which remain barriers to good governance.

2.4 Other studies

In 2005, Reza Sheikholeslami prepared a Review Study, on the “Status of Pollution Information / Institutions in the Caspian Region”. By means of Questionnaires provided by each country, the following conclusions were made:

- More information is needed for a better assessment of Status of Pollution Information and Institutions in each Caspian littoral states;
- There is no well-defined ambient contaminant monitoring for POPS / PTS particularly in marine environment in each country. In this connection a rational and regionally agreed ambient monitoring programme must be developed and implemented by the countries;
- Laboratory facilities (equipment/instrument) in some countries are well and in good condition such as I.R. Iran and Azerbaijan, but their QA/QC practice must be considerably improved for POPS and PTS measurements. In Turkmenistan, analytical facilities, skills and routine QA/QC must be improved together. For the Russian Federation and Kazakhstan it seems that there is no sufficient capacity in coastal area for analytical laboratory in term of equipment, manpower and routine QA/QC, although they might have qualified laboratory/laboratories in out region of the Caspian Sea;
- Compliance monitoring and pollution control for oil and gas activities of the Caspian countries seems to be very poor. More information is needed in this respect;
- Application of biomarker technique in marine environment for oil and gas activities is poor in the region. Limited experience existing in some countries has not been incorporated in monitoring programme, which needs to be established in some countries and improved in the region in terms of methodology, skills, and equipment;
- While the Caspian environment suffers from POPS / PTS contaminants, monitoring, prevention and control activities including clean up of the hot spots are in its early stage or totally absent in some cases. The same status applies to GEF supported POPS enabling programme at national level, particularly in the Caspian region. No information is available on POPS inventory, but the ambient screening project has shown that this issue is one of the priority areas for pollution prevention and control in the Caspian region;
- Collected information can not clearly define the organizational structure in some countries in terms of ambient and compliance monitoring, point and diffuse source pollution control in Caspian watershed or sea. More information is necessary for clarification.

2.5 River studies

As stated in the TDA from 2002, there was a gap in the knowledge on the river fluxes. When TDA was revisited in 2006-2007, some progress has been made in this respect by preparing some desk studies for the Kura-Araks, Volga and Terek River. These studies cover neither the Ural nor Iranian rivers and these gaps in TDA exist even today.

While considering the rivers as point sources of pollution in the assessment it could be concluded that pollution load from rivers is a mayor factor, see table (CEP). Data given in yellow are of interest of the project, however lacked the quality to be used.

Countries	Sources	BOD t/y	%	Nitrogen t/y	%	Phos-phorus t/y	%	Oil t/y	%
Russian Federation	Rivers	807,900	75%	805,000	91%	87,500	84%	73,100	53%
Iran	Municipalities	68,000	6%	16,000	2%	4,400	4%	7,800	6%
Iran	Rivers	49,500	5%	12,000	1%	1,200	1%	400	0%
Azerbaijan	Municipalities	38,000	4%	13,000	1%	3,300	3%	9,400	7%
Azerbaijan	Rivers	36,000	3%	19,000	2%	1,000	1%	600	0%
Iran	Industry	28,200	3%	600	0%	210	0%	12,500	9%
Russian Federation	Municipalities	16,000	1%	5,000	1%	1,400	1%	3,800	3%
Kazakhstan	Rivers	13,200	1%	6,000	1%	600	1%	400	0%
Azerbaijan	Industry	7,100	1%	1,100	0%	300	0%	14,000	10%
Russian Federation	Industry	4,900	0%	300	0%	100	0%	8,900	6%
Kazakhstan	Industry	2,900	0%	7,100	1%	100	0%	1,800	1%
Turkmenistan	Municipalities	1,600	0%	400	0%	100	0%	100	0%
Turkmenistan	Industry	1,500	0%	100	0%	3,970	4%	5,400	4%
Kazakhstan	Municipalities	800	0%	500	0%	100	0%	200	0%
Turkmenistan	Rivers	0	0%	0	0%	0	0%	0	0%
TOTAL		**1,075,600**		**886,100**		**104,280**		**138,400**	

Table 2.1 Pollution load from rivers, municipalities and industry in the Caspian Sea (TDA VolII, Table 2.6-3).

The TDA 2002 concluded the largest pollution source by far is the rivers from the Russian Federation, primarily the Volga River. Between 50%-90% of the pollution to the Caspian Sea enters from the rivers. The second largest source of pollution (though less than 10% of the river inflow) comes from municipalities on the Iranian coast. 70% of the oil pollution originates in Russia (via rivers) and coastal industrial activities in Iran and Azerbaijan.

We have to note that these data have not been confirmed by actual measurements in the sediments in the Volga delta (Volga Cascade study), as discussed in paragraph 2.5.2.

Major Indicative Symptoms		Major Sources	Data Availability	Data Reliability
Pollution Load		Urban Runoff Agrochemical Radioactive discharges	Insufficient Insufficient Not available	no no Poor

		Industrial Discharges to Waters	Insufficient	Estimates only
		Hot Spots (Offshore dumping sites)	Insufficient	Poor
		Oil Spills	Partly Available	Poor coverage
		Sewage	Insufficient	Estimates
		Air Emission	Insufficient	Estimates
		Hot Spots (Rivers/estuaries)	Available	Estimates
		Flooded Area	Available	Reliable?
		Hot Spots (Industries)	Available	Reliable
Ambient Contaminant Level	Biota	Radionuclides	None	None
	Water	Water properties	Insufficient	Mixed reliability
	Water	Organic Contaminant	Insufficient	Questionable
	Water	Inorganic	Insufficient	Reliable
	Water	Radionuclides	Insufficient	Reliable
	Water	Microbial	Insufficient	Reliable
	Sediment	Radionuclides	Insufficient	Reliable
	Sediment	Organic Contaminant	Available	Reliable
	Sediment	Inorganic	Available	Reliable
	Biota	Organic Contaminant	Available	Reliable
	Biota	Inorganic	Available	Reliable
	Biota	Microbial	Available	Reliable

Table 2.2 Overview of data related to those areas of interest for the current project (Pollution Load and Ambient Contaminant Level, TDA 2002 Vol. II, Table 2.6-19).

As stated in the above given table data is or insufficient or not reliable. Recommendations to improve the data will be given in Chapter 6.

Following on the TDA 2002 it was recommended to fill-in the knowledge gaps. On request of CEP therefore several desk studies on the pollution load from rivers have been conducted, shortly summarized below:

2.5.1 TEREK

"A Desk Study Project to determine the fluxes of major contaminants from the Terek River into Caspian Sea" has been conducted by State Oceanographic Institute (SOI) of Federal Service on Hydrometeorology and Monitoring of Environment (Roshydromet) in 2007. The report aimed at the estimation on contents of nutrients, petroleum hydrocarbons, phenols and heavy metals in water and bottom sediments in the basins of rivers Terek, Sulak and Samur over the last years.

It was concluded that the level of Petroleum Hydrocarbons (aliphatic part) in the water of the Terek River was high. The upper part of the Terek river was concluded to be more polluted than the lower part. From the Heavy metals only the copper exceeded the Maximum Allowed Concentration exceptionally. Lead and nickel had levels little more or less the MAC.

2.5.2 VOLGA

"STUDY AND REVIEW FOR DETERMINATION OF MAJOR POLLUTANTS FLOW FROM THE VOLGA CASCADE" conducted by the State Oceanographic Institute of Federal Service on Hydrometeorology and Monitoring of Environment (SOI), Caspian Marine Research Centre of Federal Service on Hydrometeorology and Monitoring of Environment (CaspMNIC), Institute of Water Problems at Russian Academy of Sciences (IWP) and Centre for International Projects (CIP) in 2006.

The report aimed to conduct a Comparison of published, archive and expeditionary data by the level of pollution of bottom sediments in the Volga delta, to reveal gaps in knowledge concerning water dynamics and process of pollutants evolution in the Volga delta and to propose major tasks for future scientific research in the area.

The table below shows the annual average flow of pollutants in the apex and in the Volga delta seashore line (DSL):

Pollutants	Unit	Delta apex		DSL, 1995-2004		
					including:	
		1977-1993	1995-2004	Total	Western part	Eastern part
Petroleum hydrocarbons	thousand tones	71.65	54.80	57.10	37.2	19.9
Detergents	thousand tones	5.29	6.96	7.95	4.35	3.60
Phenols	thousand tones	0.70	0.98	1.07	0.68	0.39
Iron	thousand tones			51.05	31.55	19.50
Zinc	thousand tones	4.97	9.42	9.45	6.01	3.44
Copper	thousand tones	2.19	1.89	1.66	1.13	0.53
Nickel	thousand tones			1.49	0.94	0.55
Lead	tone			439	276	163
Cobalt	tone			311	195	115
Manganese	tone			273	172	101
Chrome	tone			186	117	69
Cadmium	tone			122	77	45
Mercury	tone			15.4	9.7	5.7
DDT	kg	3710	186	94	56	38
DDE	kg	1320	27	29.5	23.6	5.9
Alfa-HCH	kg	-	nd	5	nd	5
Gamma-HCH 1983-1986	kg	1026	115	87	27	60

Note: For calculation of pollutant flows for DSL, their concentrations in the central part of delta were used.

Heavy metals: Chrome levels exceed the PC (permissible concentration based on the sediment quality guidelines of The Netherlands[iii]). For nickel was found an average value below the PC, however maximums exceeded the PC.

[iii] as stipulated in the 4th Water Management Policy Document for the Netherlands (1998 - 2006)

Besides 2002, the levels of Copper found were below the PC. For Zinc, cadmium and lead the levels were below the PC. Regarding other elements (mercury, tin, arsenic, vanadium, lithium, cobalt, silver, aluminum, barium, calcium) due to the absence of data, no comparison could be made.

The levels of Petroleum hydrocarbons in the sediment in the Volga delta did not exceed PC, relative low levels were found in the 5 bottom samples taken in 2005. Also for chlorinated pesticides and Polychlorbiphenyls low levels were found.

The report states that it is likely that max 10% of the pollutants originated in the Volga Delta itself. More study has to be conducted on this as well as on the absorption capacity as stated in the recommendations:

Recommendations:

1. Investigation of the role of the reservoir system on the Volga with respect to accumulation and transformation of pollutants entering with Volga River
2. Research into mechanism of organic pollutants transportation in the Lower Volga in dissolved and suspended forms
3. Assessment of impact degree of pollutants entering from local sources in the Volga delta based on annual data of the authorized state bodies with respect to intensity and amounts of pollutants discharged with industrial and communal waste water
4. Determination of background concentrations of heavy metals in delta and in shallow zones of estuarial seashore of Volga River
5. Implementation of special investigation of aquatic environment pollution with inorganic and organic forms of mercury
6. Investigation of composition variability of suspended solids, bottom sediments and their pollution in different phases of water regime in the Lower Volga (raise, peak and fall of flood, discharges, summer-autumn and winter low water)
7. Investigation of composition, condition and features of bottom sediments in estuarial seashore shallow zone and interfluvial areas flooded in spring in the Volga delta as accumulator of pollutants running with Volga flow and potential source of secondary pollution of the Caspian Sea
8. Investigation of a role of higher aquatic vegetation in retention of pollutants in delta and estuarial seashore shallow zone of Volga as a result of direct absorption of pollutants or deceleration of current velocity and settling down suspended substances
9. Investigation of a role of geochemical barrier in a mixture zone of fluvial and marine waters with respect to accumulation, transformation and depositing of pollutants arriving with Volga River.

The entire Volga River Basin is not within the scope of the current project. However, if one compares the loads form industrial sources within the zone of the current projects with pollution quantities from upstream part of Volga River then it can be concluded that transported pollution loads exceed those produced in the coastal zone. It is natural that the amount of pollutants coming with a large river, which has an extended watershed accommodating big cities such as for example Moscow, is significant.

2.5.3 URAL River

The GIWA report has given loads from Ural River. However, this information is based on data observed before 1998. Recent studies are not known by the project team.

2.5.4 Kura-Araks River

Azerbaijan Ecological Society “Ruzgar” conducted a survey in 2005 to determine the fluxes of major contaminants from the Kura to Caspian Sea. The survey covered the river reach between Mingechaur reservoir and Kura River Delta). The study found contains of As, Cd, Cr, Cu, hg, Ni, Pb, Zn were lowin sediments as well as in the water column. PAH, pesticides and PCB contamination levels were higher.

Calculation of the load coming from the Kura-Araks River System would request long term monitoring.

2.6 Contamination from offshore oil and gas activities and installations

Commercial oil and gas exploration and production has a long history in the Caspian Sea. The current international focus on oil and gas extraction and processing in the region indicates that the energy branch will be the primary economic driver for the Caspian countries. These activities lead to concerns over the environmental impacts. The Caspian Sea is a closed water body and therefore spills are not going to flow away but will disappear via natural degradation or response clean-up. Secondly, downstream activities such as oil refining, transport, and related industries may also increase the environmental pressures on the sea, sediments, and air. The environmental impacts of oil and gas activities were negative in the past with pollution and risks human health and for biota.

The historical observations commonly showed high levels of hydrocarbons, particularly phenols, in the water column but recent analysis cannot verify the earlier values. In general the water quality has reached an internationally acceptable level in most parts of the Caspian Sea.

However, hot spots can occur at locations such as in

- vicinity of leaking capped oil wells;
- areas where water level rise has encroached on well oiled soils;
- Baku Bay, where major spills have occurred over a century;
- Hazar, in Turkmenistan where near-shore activities date back to more than 100 years;
- Makhachkala, where oil transport and storage takes place; and some other locations.

Beyond the abovementioned problems, periodic oil slicks occur on the sea surface. Sources of these slicks may be oil extraction, flooding of oiled soils, release from capped wells, or natural seepage. Inundation of former oil wells by rising sea water is another documented pollution source. In particular, flooded wells in Azerbaijan, Kazakhstan, and Turkmenistan became known as sources for hydrocarbon pollution of the environment.

The Pollution Control Estimated Total Annual Oil Input to the Caspian Sea (CCPC, 2000) concluded “there is no indication that the petroleum hydrocarbon pollution is the major contributing factor to the general impairment of the Caspian ecosystems”. While there are oil pollutions in the Caspian, coming from inundated wells, offshore production, accidental releases and discharges of oil, natural seeps but measurements proved that oil and gas activities were not the major cause of ecosystem imbalance in the Caspian. Oil industry activities were estimated to input less than half of natural seeps, and only 5% of annual oil inputs.

2.7 Persistent toxic substances / radioactive/ airborne pollutions

2.7.1 Persistent Toxic Substances (PTS)

There are several information sources concerning the level of Persistent Toxic Substances in the Caspian Sea, such as the ASTP cruise in 2002 and the contaminant survey in 2005.

The overall assessment of contaminant survey in 2005 conducted by De Mora, states the following: Several organochlorinated pollutants were investigated. Concentrations were invariably low in Kazakhstan and Turkmenistan.

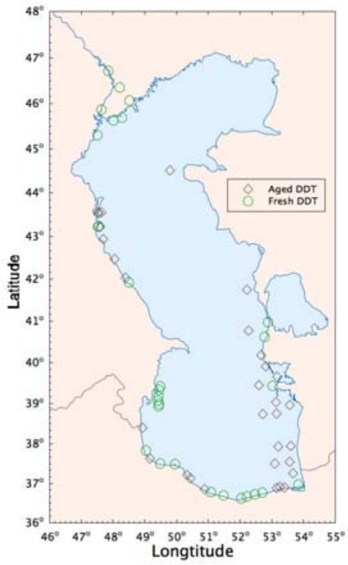

Figure 2, Sites in the Caspian Sea with fresh or aged DDT [De Mora, 2006]

Contamination with respect to DDT-related compounds was observed near the estuaries of the Volga and Kura Rivers, as well as at numerous places in the coastal zone of Iran. Hexachlorocyclohexanes (HCHs), notably lindane, was also of concern in some parts of the marine environment of Azerbaijan. Sources strengths (i.e. local usage) of other organochlorinated pesticides in the different regions varied considerably, but concentrations were generally not of environmental concern. The Σ-PCBs content was much higher in Azerbaijan than elsewhere, surpassing the sediment quality guideline value of 23 ng g-1 dry weight at two locations. PCB-chlorination distributions indicated that most sites had experienced multiple inputs of different commercial mixtures of PCBs, including Sovol and TCD of Soviet origin. The Goldberg Index reflected the relative magnitude of the principal sources of organochlorinated compounds, thereby highlighting the importance of agricultural DDT inputs in Iran and Russia compared to industrial PCB discharges in Azerbaijan. [De Mora, 2006].

PTS represents a potential threat to the environment. According to the Environmental Performance Review of Azerbaijan published by the United Nations Economic Commission for Europe (UNECE), in 2004 some 8,000 tons of obsolete pesticides, including DDT, are also stored in unsatisfactory conditions near Baku.

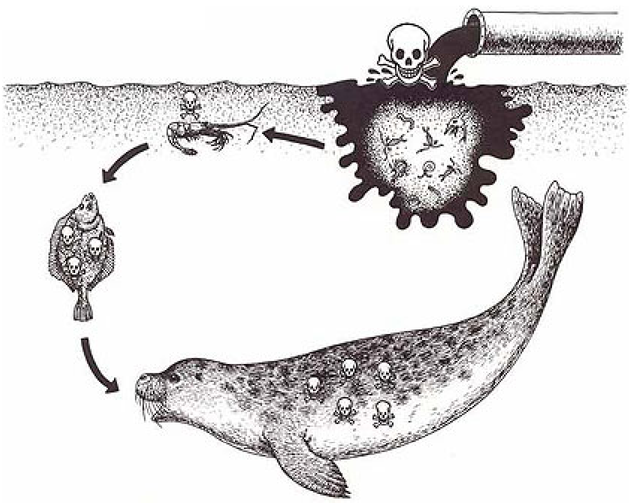

Figure 3, PTS and seals (Source: website Seal rehabilitation and research centre, Lenie 't Hart]

Under the auspices of the CEP a Regional PTS Action Plan was prepared in October 2006, as it was one of the four major transboundary areas of environmental concerns identified in the first phase of CEP with regards to the anthropogenic impacts on the Caspian waters.

The Regional PTS Action Programme followed certain criteria, to prioritize the PTS problems (full text in Annex 3.1):

No	**Regional priority problem**	**Weight**
1	Lack of regional legal instrument on PTS.	39
2	Large industrial pollution sources of PTS having major potential to pollute the Caspian Sea	38
3	PCBs containing equipment located in the near Caspian region	35
4	Occurrence of shipborne pollution and accidents at sea	34
5	Insufficient/unequal capacity in the region related to PTS issues (monitoring, QA/QC, inspection, environment quality standards, risk assessment, management/phase out of PCBs etc.)	33
6	Absence of a regionally agreed PTS monitoring program	32
7	Illegal use and trade with POPs pesticides	32
8	Stores of obsolete POPs agrochemicals located in the near Caspian region	30
9	Sites contaminated with PTS having major potential to pollute the Caspian Sea	29
10	Low awareness about potential hazards due to PTS in the general public (use of agrochemicals, entering POPs stores/contaminated sites uncontrolled burning of waste, etc.)	26
11	Lack of infrastructure for environmentally sound storage and destruction/disposal of POPs	22
12	Occurrence of large oil spills from exploitation, transport, processing and accidents	19

To address the above priority problems the following priority objectives were identified:

1. Create and implement a regional legal instrument on PTS;
2. Prevent / mitigate PTS releases from large industrial pollution sources with major potential to pollute the Caspian Sea;
3. Prevent/mitigate releases from PCBs containing equipment located in the near Caspian region;

4. Prevent/mitigate impact of shipborne pollution and accidents at sea;
5. Strengthen/equalise capacity in the region related to PTS issues (monitoring, QA/QC, inspection, environment quality standards, risk assessment, and particularly management of PCBs etc.);
6. Create and implement a regionally agreed PTS monitoring program;
7. Prevent illegal use and trade with POPs pesticides;
8. Clean up of stores of obsolete POPs agrochemicals located in the near Caspian region and ESD[iv] of the obsolete stocks;
9. Clean up of sites contaminated with PTS having major potential to pollute the Caspian Sea;
10. Raise awareness about potential hazards due to PTS in the general public (use of agrochemicals, entering POPs stores/contaminated sites uncontrolled burning of waste, etc.);
11. Establish infrastructure for environmentally sound storage and destruction/disposal of POPs;
12. Prevent/mitigate impact of large oil spills from exploitation, transport, processing and accidents.

Together with local experts the most effective implementations areas were selected:

- Regional legal instruments;
- Awareness raising, training and capacity building;
- Monitoring;
- Pilot projects to be replicated in the region;
- On-ground investments to be utilized by all countries of the region;
- The overall cost necessary for Regional PTS Action Plan implementation (the period 2007/2010 is considered) is assessed to be 4, 016, 000 US$.

The cost assessment considers only the regional costs, national costs are excluded. Annex 3.1. contains an overview of all action programmes, their timeframes and assessment of costs necessary for their implementation.

There was no information available on the implementation of this PTS action plan to update the pollution assessment in a regional context.

2.7.2 Radioactive / Airborne

The CaspianMAP team initiated an inventory of radioactive substances and airborne pollutants. This initiative has limited success due to lack of up-to-date information. Beside the RAPS of 2005 no inventory in a regional context on airborne pollution has been carried out.

There is a need for a regional inventory of radioactive substances. Not all countries are able to provided information on this subject, therefore project has limited possibilities for inventory of the known hotspots, such as Cheleken Bromide plant, and Aktau Uranium Tailing Site. The Russian Federation proposed during the Final Workshop held in July 28-29th in Ashgabat, not to present the basic inventory on airborne sources due to the outdated data.

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[iv] Environmentally sound disposal

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3 CASPIANMAP REVIEW OF LAND BASED SOURCES

3.1 Introduction

The CaspianMAP project has made a review of Land Based Sources of pollution, building upon the results of activities already carried out in the CEP and other initiatives, and making use of the PRAG network that was initially established under the CEP. The output of this exercise is to become a contribution to the further development of the protocol on Land Based Sources of the Tehran Convention.

3.2 Land Based Pollution Sources

Oil and gas activities bring contaminants into the environment. These generally occur due to drilling practices, maintenance on rigs, oil transport, and release of oil and gas from drilling operations. Oil and gas issues are of particular concern, partly due to extensive oil slicks observed in some portions of the Caspian Sea. These slicks have sometimes been traced to industrial activities; many times they simply exist in the region with no obvious source.

Mining industry is another non-quantified pollution source. Chromium mines, for instance, discharge tailings into the Caspian along the upper Ural River, which may reach the Caspian in a relatively short period as there are no impediments on the river. Uranium mining in near Aktau, is another potential source of contaminants to the Caspian, particularly given historical discharge practices. Mines along Iranian rivers discharge tailings to the rivers, some of which can be seen in sediment data. Finally, mining in the Caucasus region may create discharges into the main rivers such as the Kura. Thus far, discharges have not been quantified.

Agriculture also releases chemicals, including fertilizers, pesticides, and insecticides, into the environment. Many agrochemicals are persistent organic forms. This agricultural activity extends most intensively along the Iranian coast (where the area is small but the density is high), southern Azerbaijan, parts of the Russian coast, There is some agriculture in Turkmenistan, but little near the coast. Use of banned pesticides such as DDT is commonly reported in the region, and they appear to be widely available. Recent infestations of locusts in Russian Federation and Kazakhstan resulted in aerial spraying of DDT-based pesticides in these countries.

3.2.1 Baseline inventory

An assessment of Land Based sources was conducted as part of the CaspianMap project. Contributions and reviews were given by designated National Experts (LSE). Below the main findings and results are given. For the full description, including remarks from national experts, see Annex 4.1.

Main Findings and Results of the baseline inventory
A desk Baseline Inventory of the land-based pollution sources in the Azerbaijan, Kazakh, Russia and Turkmen sectors has been conducted based on the recent RAPS Reports (2007). The results of the desk baseline study can be summarized as follows:

Azerbaijan Sector:
- 3 main sources of municipal wastewater discharge (>100 t/yr BOD)
    - Govsan canal (Baku- Surakhani)
    - Zykh Treatment Stations (Baku-Hatai)
    - Kishly sewerage outlet (Baku-Hatai)
- 6 main sources of industrial wastewater discharges (>10 t/yr BOD and/or 1 t/yr oil)

  - Rubber Synthesis (Sumgait)
  - Organic Synthesis Plant (Sumgait)
- 3 “hotspots” of oily waste dump.
  - OGPP Bibi-Heybatneft (Baku-Sabail/Absheron):
  - Oily Rocks at Pirallahi, Jilov and Gum Adasi islands:
  - Waste dumpsite of Sumgayit:

Kazakh Sector:
- no significant sources of municipal wastewater (discharge direct or indirect into the Caspian Sea is prohibited)
- no significant sources of industrial wastewater discharges (discharge direct or indirect into the Caspian Sea is prohibited)
- 8 “hotspots” of industrial waste dump of which 6 oily waste and 2 toxic industrial waste:
- Uzen oil fields
  - Zhetybai and Kalamkas oil fields
  - Karazhambas oil field
  - Zhetybai and Kalamkas (Masuted land)
  - Karazhanbas (Masuted land)
  - flooded oil wells
  - Koshkar-Ata tailing site (uranium tailings)
  - Tuhlaya Balka sedimentation tank and infiltration field (industrial wastewater)

Russian Sector:
- 7 main sources of municipal wastewater discharge (>100 t/yr BOD)
  - Northern facilities for waste water treatment, MUE «VODOKANAL» of Astrakhan town
  - Southern facilities for waste water treatment, MUE «VODOKANAL» of Astrakhan town
  - MUE «BUYNAKSKY VODOKANAL», Buinaks town
  - MUE «DERBENTGORVODOKANAL», Derbent town
  - MUE «CITY SEWAGE TREATMENT FACILITIES », Izerbash town
  - MUE «DRAINAGE SEWAGE TREATMENT FACILITIES», Hasavyurt town
  - MUE «Sewage treatment facilities» of Makhachkala-Caspiysk, Makhachkala town
- no significant sources of industrial wastewater discharges (>10 t/yr BOD and/or 1 t/yr oil)
- 4 significant “hotspots” of industrial waste dump (3 oily waste and 1 phosphorous sludge), 2 large municipal solid waste (MSW) landfills (Mahachkala and Derbent city) and many scattered small industrial and municipal solid waste dumpsites.
  - RPC “Astrakhanskiy” branch LTD LUKOIL ”Nizhnevolzhskoil product”
  - LTD NK Rosneft – Dagneft

Turkmen Sector:
- no significant sources of municipal wastewater (discharge into desert land)
- 3 possible significant sources of industrial wastewater discharges (no pertinent data, Need further investigation)
  - Thermal Power Station (TPS) - City of Turkmenbashi
  - “Garabogassulfate” IA (Garabogas)
  - Turkmenbashi Oil refinery
- 3 “hotspots” of industrial oily waste dump.
  - Nebitdagnebit OGPA
  - Goturdepe OGPA
  - Gumdagnebit OGPA.

ToR for pilot pre-feasibility studies for selected scenario's

The list of priority scenarios for mitigating measures is as follows:
1. Untreated municipal wastewater discharge (>100 t/yr BOD)
2. Untreated industrial wastewater discharge (>10 t/yr BOD and/or 1 t/yr oil)
3. "Hotspot" with oily waste dump and/or obsolete oil & gas production installations
4. "Hotspot" with industrial toxic waste dumpsite.

For these scenario's a generic format for a pilot ToR of (Pre-)Feasibility Study, and Outlines for such studies were prepared as guideline for further activities in this field.

3.2.2 Pollution Loads from Land Based Sources

There is little published on the pollution loads. The CCPC in Baku performed studies of the pollution loads of the major industries and activities in the region with additional input from Effective Regional Assessment of Contaminant Levels (ERACL CCPC). Industrial discharges to waters were summarized by the CCPC in Table 2.10-1 Estimated Total Annual Oil Input to the Caspian Sea (CCPC, 2001) while Table 2.6-3 summarizes BOD nitrogen, phosphorus and oil data regionally and by source (ERACL CCPC).

Sewage directly to the Caspian Sea and pollution loads transported by rivers were estimated based on questionnaires. However, the information should be taken by care because of the obvious uncertainties in the provided data and conclusions. One of the major points that is says that 80% (or 85%) of the hydrocarbons (or total pollution) entering the Caspian Sea comes from the Volga River. Most reports on Caspian pollution repeat these figures, and it is so in CCPC reports: 91% of yearly inflow comes from the Volga, 79% of the yearly BOD, 95% of the hydrocarbons, 84% of the cadmium, etc. These figures are given estimates made from discharge questionnaires. The problem is that the PC CCPC estimates don't take into account neither the effects of dams and wetlands in sequestering many of these materials from the Caspian Sea nor the decays and sinks.

There is at present inadequate mass balance data to provide a quantitative estimate of existing pollution loads from the Volga or other Caspian rivers. Indeed, pollution levels in Volga sediments and deltaic sediments do not confirm the large load purported to come from the Volga. As part of CaspianMAP effort has been made to accomplish a simple mass balance model, based on data input from know literature and additional data received from Local experts. A technical note can be found in chapter 5.

Data for biological oxygen demand load (BOD), total suspended solids (TSS), total nitrogen, and total phosphorus were available for all the five Caspian countries. Though, these data were of uncertain quality, as they cannot be verified independently from the national records. Data from an initial rapid assessment for above contaminants, plus some heavy metals, were determined using by GIWA methodology, however, these data are of uncertain reliability. For example, estimated mercury input in Azerbaijan was very low, despite the fact that large quantities of the metal were released into the environment at Sumgait, Azerbaijan.

Data on agricultural input are sparse. What we say in general is that the use agrochemical use is under state control and can followed up. The use of agrochemicals in the former CIS countries has decreased after the break-up of the Soviet Union because disaggregation of the state and collective farms.

3.3 Revision of Areas of Pollution Concern (map)

The table below list the Environmental Hotspots as identified in TDA 2002:

Country	Hot Spots
Azerbaijan	• Baku Bay/ Absheron Peninsula • Sumgait • Kura River
Iran	• Sefid-Rood River area/ Bandar Anzali • Chalus/Now Shahr ports • Gorgan Lagoon
Kazakhstan	• Ural River Delta • Bautino / Fort Shevchenko • Aktau
Russian Federation	• Astrakhan/ Volga River delta • Lopatin • Makhachkala • Derbent
Turkmenistan	• Turkmenbashi • Hazar

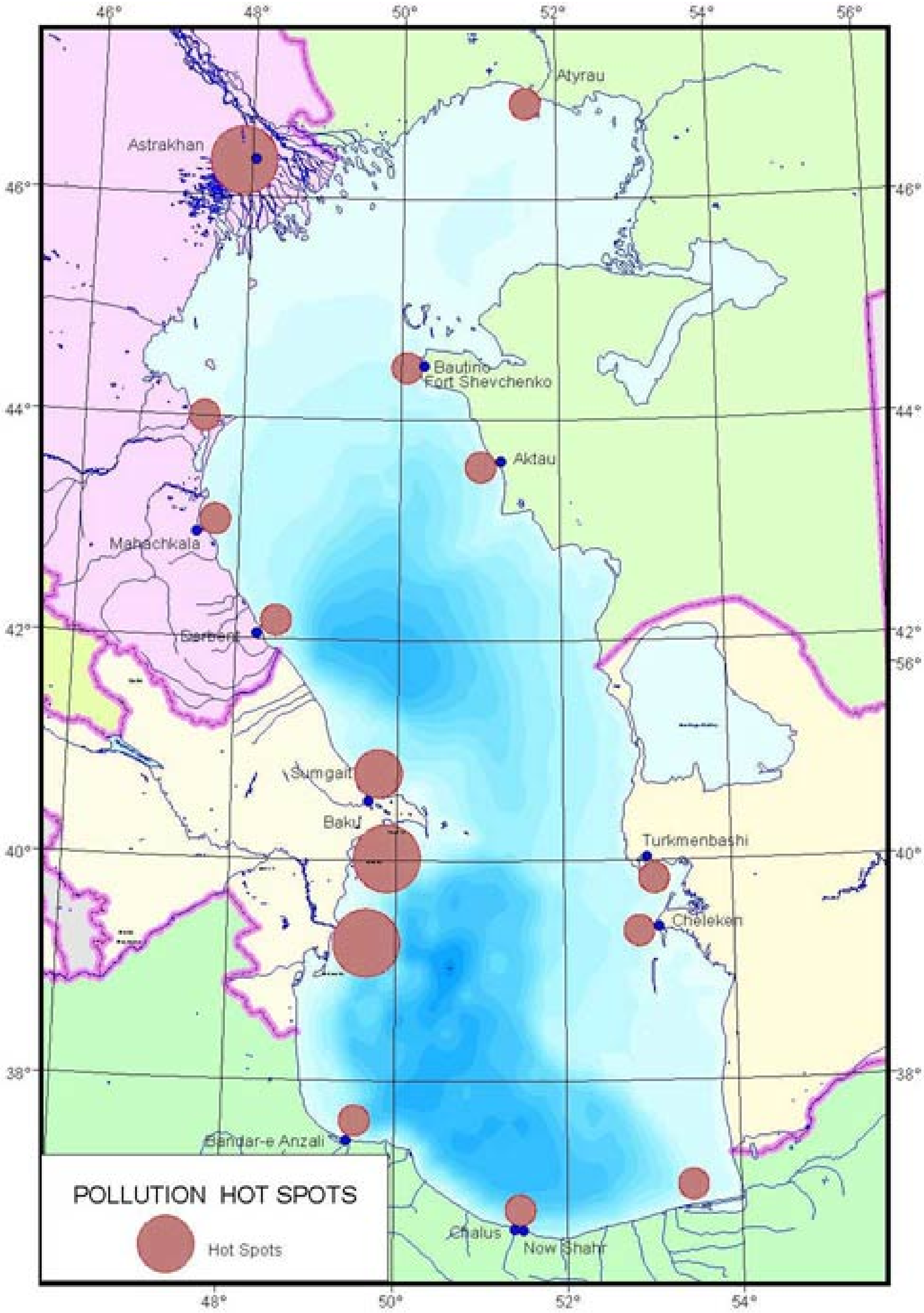


Figure 4, Hotspots [TDA, 2002]

Hot spots have been identified where improved pollution control measures would improve environmental conditions significantly. The hot spot areas generally also require some clean-up to reduce their major impact on the Caspian Sea. Areas where urgent action has been identified are:

- Apsheron Peninsular, Azerbaijan (including Sumgayit City)
- Aktau, Kazakhstan
- Cheleken, Turkmenistan
- The coastal lagoons of Anzali and Miankaleh in I.R. Iran, due to discharges of untreated wastewater and run-off from agriculture of nutrients and pesticides. In order to proceed in a sustainable and cost efficient manner, it is recommended that cost estimates and phased programmes should be prepared – suitable for implementation.

1. Apsheron Peninsular

Plans should be prepared for providing common domestic and industrial wastewater plants for Baku, Sumgayit and the on-shore oil production units located on Apsheron Peninsular. Several studies describe options for the development of a wastewater collection and treatment system. A mechanism for return of the investments will be required for both domestic and industrial dischargers. In Baku, the main issue will be the link between the water supply and wastewater services, which are currently operated separately. Some link between these services is essential to increase the revenue for the wastewater service (because payment for potable water supply is more acceptable). In Sumgayit, the issue is mainly the uncertainty about how the industrial area will recover or be redeveloped. Establishment of appropriate sewerage and treatment facilities would in the long-term support industrial development by providing industry with more cost efficient treatment options, but improved planning of the industrial zone is also needed to ensure more efficient wastewater collection and treatment.

2. Aktau and Atyrau

Several radioactive pollution problems have been identified in the Aktau region. A number of investigations have been undertaken and the problems are reasonably well described but not prioritised in relation to technically feasibility, economic and environmental criteria. However, a number of immediate mitigating measures are needed to reduce long-term impact on the population and the environment. A master plan should be prepared, covering the following areas:

- Lake Koshkarada
- Radioactive waste from Mangistau Atomic Energy Combine
- Aktal Ltd phosphate plant
- Radioactive and oily waste (both Atyrau and Aktau)
- Remediation of polluted areas (both Atyrau and Aktau)
- Assessment of environmental impact from nuclear test sites
- The drinking water of the city Aktau

3. Hazar

An environmental master plan is required for rehabilitation and reduction of environmental impact of the whole Cheleken area. The master plan should as a minimum include the following

- making safe areas with radioactive pollution
- improvement of pollution control of the iodine factory and assessment of the
- economic viability of the plant
- improvement of pollution control of the technical carbon factory, and assessment
- of the economic viability of the plant
- establishment of a more efficient municipal sewerage system and treatment plant for Cheleken area
- establishment of reception facilities for ballast water
- improvement of pollution control in the oil fields located in the city.

4. I.R. Iran

Generally wastewater treatment plants should be constructed at all the cities along the Iranian coast, which should reduce the eutrophication of the coastal lagoons of Anzali and Miankaleh in I.R, Iran. Wastewater treatment plants should be established at industries that currently discharge wastewater untreated.

[From TDA 2001]

3.3.1 Baseline Inventory Report

To update the list of hotspots, the identified pollution sources (BIR 2009) have been verified against existing state programmes, as given by National Experts.

The following table summarizes the identified pollution sources of the BIR and adds information on current programmes aiming to reduce the pollution impact or elimination as a pollution source. It also adds the CaspianMAP expert view on the need for further investigation, including recommendations:

Table 3, List of Land Based Sources

	List of Land Based Sources	State programme exist	Further need for action/inventory
AZ			
	3 main sources of municipal wastewater		
	▪ Govsan canal (Baku-Surakhani)	√, see kishly sewerage outlet	
	▪ Zykh Treatment Stations (Baku-Hatai)		Mechanical treatment installation exists, build in 1930, and outdated. There is a need for improvement
	▪ Kishly sewerage outlet (Baku-Hatai)	At present time, construction and expansion of the capacity of the Aeration Station of Govsan takes place, After that Kishly Sewarage outlet will be connected to the Govsan station. [stated LE in BIR]	
	6 main sources of industrial wastewater discharges		
	▪ Rubber Synthesis (Sumgait)	BIR: only discharges normative clean waters.	
	▪ Organic Synthesis Plant (Sumgait)	BIR: The Organic Synthesis Factory wastewater flows are discharged into the sea after biological treatment.	
	3 “hotspots” of oily waste dump		
	▪ OGPP Bibi-Heybatneft (Baku-Sabail/Absheron):	ARP	
	▪ Oily Rocks at Pirallahi, Jilov and	Treatment facilities under	

	List of Land Based Sources	State programme exist	Further need for action/inventory
	Gum Adasi islands:	construction (BIR)	
	▪ Waste dumpsite of Sumgayit:		No current information. huge inherited Contaminated land, clean up operation required at National Level
KZ			
	no significant sources of municipal wastewater (discharge direct or indirect into the Caspian Sea is prohibited)	Prohibited by the Environmental Code of the Republic of Kazakhstan	Infiltration fields and evaporation ponds sometimes near the sea. At a national level monitoring should be established.
	no significant sources of industrial wastewater discharges (discharge direct or indirect into the Caspian Sea is prohibited)	idem	
	8 "hotspots" of industrial waste dump of which 6 oily waste and 2 toxic industrial waste		
	▪ Uzen oil fields	NCAP: clearing the mazouted areas and liquidation of oil barns (tanks or pits?) with carrying out work on revegetation of the soil in oil fields, 2008-2010 (stage 1)	
	▪ Zhetybai and Kalamkas oil fields	idem	
	▪ Karazhambas oil field	idem	
	▪ Zhetybai and Kalamkas	idem	
	▪ Karazhanbas	idem	
	▪ flooded oil wells	State programme: liquidation and conservation of flooded oil wells". NCAP: implementation period 2008-2010	
	▪ Koshkar-Ata tailing site (uranium tailings)	NCAP; stabilization of the waterlevel, 2007-2009.	
	▪ Tuhlaya Balka sedimentation tank and infiltration field	Pilot study Baseline Inventory, +	Implementation of PFS is recommended

	List of Land Based Sources	State programme exist	Further need for action/inventory
		NCAP; localization (i.e. limitation) of negative impacts of sewage water evaporation fields on the environment, for example "Tukhlaya balka" in Atyrau city (2008-2009)	
RF			
	7 main sources of municipal wastewater discharge	Under Federal State programme.	
	▪ Northern facilities for waste water treatment, MUE «VODOKANAL» of Astrakhan town		
	▪ Southern facilities for waste water treatment, MUE «VODOKANAL» of Astrakhan town		
	▪ MUE «BUYNAKSKY VODOKANAL», Buinaks town		
	▪ MUE «DERBENTGORVODOKANAL », Derbent town		
	▪ MUE «CITY SEWAGE TREATMENT FACILITIES », Izerbash town		
	▪ MUE «DRAINAGE SEWAGE TREATMENT FACILITIES», Hasavyurt town		
	▪ MUE «Sewage treatment facilities» of Makhachkala-Caspiysk, Makhachkala town.		
	no significant sources of industrial wastewater discharges		
	4 significant "hotspots" of industrial waste dump (3 oily waste and 1 phosphorous sludge), 2 large municipal solid waste (MSW) landfills (Mahachkala and Derbent city) and many scattered small industrial and municipal solid waste dumpsites.		Pilot for oil waste Dagestan is proposed in the Baseline inventory
	▪ *CJSC "Nature Protection Complex "Eco+"*		
	▪ RPC "Astrakhanskiy" branch LTD LUKOIL "Nizhnevolzhskoil product"		
	▪ LTD NK Rosneft – Dagneft		

	List of Land Based Sources	State programme exist	Further need for action/inventory
	▪ *OSA "Dagfost", Plant of salt of phospohorus*		
TM	no significant sources of municipal wastewater (discharge into desert land)	Turkmenbashi sewage system will be reconstructed and treatment facilities will be constructed, as part of the Saimonov bay remediation (Emirol ltd), NE: Work on the reconstruction of the sewerage system are under way by Polimex	
	3 possible significant sources of industrial wastewater discharges		(no pertinent data, need further investigation, Baseline inventory)
	▪ Thermal Power Station (TPS) - City of Turkmenbashi	BIR: low polluted cooling water and treated wastewater + Reconstruction of discharge facilities of Turkmenbashi thermoelectric power-and-heating station as part of the Saimonov bay remediation (Emirol ltd)	
	▪ "Garabogassulfate" IA (Garabogas)	BIR: The Garabogas Sulfate Plant discharges wastewater with mainly mineral salts (chloride and sulfate),	No regional priority source of water pollution.
	▪ Turkmenbashi Oil refinery	Under reconstruction by Emirol LTD	
	- 3 "hotspots" of industrial oily waste dump.	Mazoutted lake, BIR Pilot, which is likely to be cleaned by WET international (start construction summer 2009, appr. Cleaned by 2012)	Masterplan Cheleken to be drawn up, including a mapping of all oily wastes at a national level recommended.
	▪ Nebitdagnebit OGPA		
	▪ Goturdepe OGPA		
	▪ Gumdagnebit OGPA.		

3.3.2 Outside scope of BIR

For updating the assessment, the project looked further than the scope of the BIR. The following information is gathered and structured by the Hotspots, especially looking at pollution loads.

Azerbaijan

Identified hotspots: Baku bay and Absheron peninsula, Kura River and Sumgait.

Sumgait

A description of Sumgait as a hot spot is given in

Box 1.

Box 1, Sumgait, an environmental Hot Spot

> Sumgayit was founded in the 1950s as a center for the chemical and petrochemical industries. It quickly became one of the largest industrial centers of the FSU. Industrial areas occupied more than a third of the city, and about 88 large facilities were built, of which 10 became heavy air polluters. Annual air emissions were about 100,000 tons. Annual air emissions per square kilometer amounted to 1,200 tons in 1990–1991, while the average value for Azerbaijan was about 24 tons per square kilometer. Hazardous substances, including mercury, chlorine, hydrogen fluoride, and heavy metals, were released into the ambient air, affecting the local population, especially sensitive groups. Persistent organic compounds, such as dioxins and dibenzofuranes, were released from petrochemical industries. Soils around steel manufacturing plants in Sumgayit remain contaminated with mercury, benz(a)pyrene, lead, copper, zinc, molybdenum, and other chemicals, exceeding background concentrations more than 10 times. The most severe pollution problem is linked to the production of mercury as a byproduct in chlor-alkali production, reaching 1 kilogram per ton of chlorine. At present, about 300 grams of mercury per ton of chlorine are produced, compared with 2–3 grams per ton or even less in a well-maintained and controlled factory. The mercury produced is either emitted into the atmosphere, discharged with wastewaters, or discharged with industrial wastes. About 200,000 tons of mercury sludge, with 0.1–0.3% mercury content have accumulated since the 1980s. At the present level of production, mercury-contaminated wastes are accumulating at about 7,000 tons per year. The wastes are inadequately stored, heavily contaminating groundwaters and the Caspian Sea bed sediments through seepage. As a result, the city had one of the highest morbidity rates during the FSU period. In 1992, the city of Sumgayit was declared an environmental disaster zone. The city was later designated a free economic zone, in order to foster economic growth and the introduction of new technologies. However, partly because the processing equipment is outdated and in very poor condition, the problem of uncontrolled emissions, persistent pollutants, and the liability for the past pollution remain largely unsolved.
>
> Source: Caucasus Environmental Outlook, 2002.

CaspianMAP project concludes based on the provide information that Sumgait, remains hotspot, there is no untreated-municipal waste water and industrial waste water enters Caspian, as reported by LSE in BIR. However a huge clean up challenge remains.

Absheron[v]

In Azerbaijan, lands polluted with oil and oil products, are widely spread out on the Absheron peninsula. There are 21,3 thsnd ha of lands polluted with oil, in different degrees: 10,1 thsnd ha is polluted layer or -aquifer, and 8 thsnd ha is covered with oil, the others are water pools. These lands are spread out on the west of peninsula beginning from the

[v] Input from LE AZ

eastern side of the cement mill in Garadag and a narrow strip of land till the Pyrallahi island. The usage of oil pools in this zone for a long time made serious anthropogenic changes to the environment and natural landscape.

The most toxic elements on the Absheron peninsula are B, Al, Pb, U, Se, Fe, C, Na and Mg. In Azerbaijan unused and requiring recultivation lands can be found mainly on the Absheron peninsula, partially on the Siyazansky-Sumgait massif, and in the Salyansky- and Neftechalinsky regions. On these indicated places, the soil spots polluted with oil have surface area of 0,3 – 0,5 till 50 – 100 ha. On these areas due to the absence of recultivation measures, upper fertile strata and deep rocks are polluted with the crude oil. On such areas micropits and lakes, filled up with the well's water, in many places transform into a burial ground of old manufacturing, construction and household rubbish.

On the Absheron peninsula, lands polluted with oil and those requiring recultivation, are located, basically, in the Karadakh, Sabunchinsky, Binagadinsky, Surakhaninsky, Azizbekovsky regions, and are state owned lands. In the most severe and spread form, oil pollutions occurred in Pirallahi, Gala, Mashtagi, Romanah, Sabunchi, Surakhani, Binagadi and Garadag.

Oil polluted areas on the peninsula have different depths:

- 1029,2 ha is polluted till a depth of 10 cm
- 857,3 ha till 25 cm and
- 1285,7 ha till 50 cm,
- the rest more than 50 cm.

Recently accomplished large-scale soil-geographical investigations and stationery observations studied soil properties of the most upper layer in the eastern part of Absheron Peninsula. Results revealed that the upper sol layer has considerably changed due to the sea level rise and the linked groundwater rise, as well as by waters from the oil wells and irrigation. It was revealed that that underground water levels are approaching to the soil's surface (depth is 0,5 – 1,5 m) in Pirshagi – Kurdakhani, Bina – Airport, Sarai – Khirdilan, Binagadi – Novkhani and on the other areas, and formation of man-made lakes favored the water logging and secondary salinization. It was assessed that up to 5,0 thousands ha of arable soil was damaged (noit suitable for agricultural production).

The lands polluted with oil on the area of «Siyazanneft». These land areas spread out from the borders of village Zarat to Siyazan town between the Caspian Sea and highway Baku-Siyazan in the form of narrow stripe. Part of the oil wells spread out till the resort Galaalty.

On the Siyazan massif amount of oil is percolating into the upper soil layer (0-14 cm) and forms a 21% in a column mass, in a lower layer (14-26 cm), the content sharply decreases (to 2.1%).

The land polluted with oil in Salyansky region. On the area of Salyansky region there are 4177.2 ha lands polluted with anthropogenic products.

The land polluted with oil in Neftechalinsky region. In this region more than 3425 ha have been polluted with anthropogenic activities like oil dumps and secondary salinization. Within this are 1768 ha was polluted with oil. Oil content in the soil: 100 ha are polluted in the depth interval 0-10 cm, 70 ha in depth of 0-25cm and 6,8 ha in depth of 0-50cm.

There are oil polluted lands in the vicinity of the village Gartamekle, at the flank of highway, leading to Neftechal and around the village Sovetabat and they spread to the Caspian Sea.

The reclamation of contaminated land has been started. However Absheron Peninsula is facing a huge clean-up challenge.

Figure 5, Absheron peninsula [CEP, 2002]

Baku bay

CaspianMAP project concludes based on the provide information that Baku bay is an area of environmental concern. The amount of oil in the sediments in Baku Bay, according to the Caspian Environment Outlook is 270-2100 mg/kg. The levels of mercury and phenols are high too, amounting to over 0.2-1.0 and 5.0-140 g/kg of sediment in Baku Bay respectively. Not only the sediments also the oil in the water column exceeds the standards about 30 times. The recent monitoring data of TACIS Caspian cruise, will show if there are changes.

Baku port

Ports, in general, have a potential impact on the environment. The pollution loads, whether discharged or accidentally released to the environment are not identified by the project, due to the data constrains the project faced.

Kura River

The Kura-Araks has been described earlier in the paragraph ‘river studies’. Local experts provided brief information on two international and national funded programmes, i.e. Europeaid funded project Trans-boundary River Management Phase II for the Kura River – Armenia, Georgia and Azerbaijan, which aims at

- improving water quality in the Kura River basin through transboundary cooperation and implementation of the integrated water resources management approach
- supporting the establishment of transboundary monitoring and information management systems to improve transboundary cooperation in the Kura River basin
- Enhance capacities of environmental authorities and monitoring establishments engaged in long-term integrated water resources management in the Kura River basin

Tacis funded Water Governance in the Western EECCA Countries project; which objective is to contribute to the reduction of pollution, to fair sharing and effective use of scarce water resources, to the improvement of the quality of shared water resources, such as trans-boundary rivers.

The expected outcome would be:

1. Improved inter-state collaboration on IWRM, especially acceptance of exchange and compatibility of information.
2. Beneficiary country agreements concerning the quality status of water bodies and the emission limit values to be applied to each.
3. National legislation adopted at the relevant level (parliament, government or ministry) that enable the practical implementation of the standards and norms identified and agreed.
4. Institutional and procedural changes adopted that help to ensure the application of the texts on the ground.
5. Effective operational procedures established for water quality and quantity management.

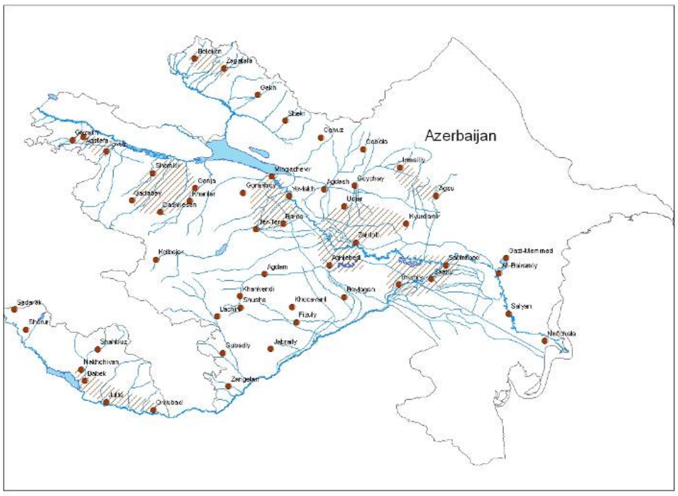


Figure 6, Pollution areas

Kazakhstan

Identified hotspots are Ural River delta, Fort Shevchenko and Aktau.

Ural River

The main inflow of pollutants into Ural River is caused by runoff of smaller rivers of Russian Federation and also from the territory of Aktyubinskaya and Zapadno-Kazahstanskaya oblast. In whole length the river is exposed to pollution by chemical fertilizers, wastes of industry and construction companies, communal and cattle-breeding complexes.

The river length at the section Uralsk-Atyrau is 840 km and inflow into the Caspian Sea. Streaming by the Caspian Plain, it is transporting a huge amounts of suspended sediments consisted of long-distance upstream alluvium and local share, caused by riverbed and stream-bank erosion.

Annual average volume of suspended sediments on the Ural River station within the precincts of Atyrau city is equal to 3,5 million tons. There are 5 million tons of sand discharged to the sea annually. For 4 months of spring-summer tide (April – July) falls 96,6 % of annual volume of sediments.

On the territory of Kazakhstan 17 legal entities, listed in the table below, discharge sewage waters to the Ural River. It is considered that the effluents are conditionally clean and mainly treated according to the standard.

Table 4, Water users discharging sewage (1000 m 3)

Water users discharging sewage	Total	Including	
		Conditionally clean	Treated according standard
Atyrauskaya oblast			
JSC «Atyraubalyk»	21,5	21,5	
JSC «Atyrau Heat power Plant»	14359,1	14359,1	
JSC «Atyrau Oil Refinery Plant»	875,5	875,5	
LLP «Panalpina Word Transport»	62,0	62,0	
LLP «Atyrau branch of KompaniyaSpetsStroy»	71,4	71,4	
PSE «Atyrau Su Artasy»	1686,1	1686,1	
RSBSE «Uralo-Atyrauskyi ORZ»	725,5	725,5	
RSBSE «Atyrauskyi ORZ»	1576,7	1576,7	
JSC «Arna»	10,2	10,2	
«Turmystyk kyzmet»	60,0	60,0	
Inc. «Adjip»	32201,9	32201,9	
JSC «Atyrauzenporty»	144,6		144,6
TOTAL	19592,6	19448,0	144,6
Aktuybinskaya oblast			
JSC «Akbulak»	10000		10000
LLP «Kentavr»	101,3	101,3	
TOTAL	10101,3	101,3	10000
Zapadno-Kazakhstanskaya oblast			
«Zhayikteploenergo»	6740,0	6740,0	
PSE «Oral Su Arnasy»	876,0		8760
Karachaganak Petroleum Operating	4,6		4,6
TOTAL	7620,6	6740,0	880,0

Table 5, Sewage discharge to the «Koshkar-Ata» Tailing Pit

2001	2002	2003	2004	2005, 1st quarter
5372731 m3	6742175 m3	6166061 m3	6686939 m3	1603767,5 m3

Table 6, Sewage composition discharged to the «Koshkar-Ata» Tailing Pit

Title	Unit	Qnt
Five-day BOD	mg/l	4,8
COB	mg/l	16,7

Dissolved oxygen	mg/l	7,1
Residual chlorine	mg/l	1,42
Ammonium	mg/l	1,6
Nitrates	mg/l	0,20
Nitrites	mg/l	73,0
Phosphates	mg/l	3,2
Phenoles	mg/l	0,006
Oil products	mg/l	18,0
Detergents	mg/l	0,35
Iron	mg/l	0,31
Chlorides	mg/l	660
Sulphates	mg/l	417
Suspended particles	mg/l	480

Some effluence waters can be considered only conditionally as sewage because they are discharges from Atyrauskiy fish-factory during release of juvenile fish or water discharges from the cooling system of Heating and Power Plant or waters from the cooling systems of sea vessel.

Sewage discharge into surface waters is prohibited, thus, the entire pollutant volume in Atyrauskaya oblast originates from drying / infiltration beds of sewage. There are 24 drying / infiltration beds of sewage in Atyrauskaya oblast, which are in the balance sheet of oil-and-gas production enterprises, processing industry and local authorities / municipalities.

The drying / infiltration beds are located as follows: 3 – in the regional centre, 8 – in Zhylyoiskiy, 3 – in Isatayskiy, 2 – in Kurmangazinskiy, 3 – in Inderskiy, 3 – in Makatskiy, 1 – in Makhambetskiy and 1 – in Kyzylkurganskiy districts. Pollutants load transported by sewage was 84.000 tons in 2008.

Table 7, Sewage emission

Sewage Emission	2008	2007
Total volume of discharged industrial sewage, thousands cubic metre.	28 756,08	29 022,67
Total volume of discharged of household sewage, thousands cubic metre.	32 644,90	33 409,6
Total volume of discharged of combined sewage, thousands cubic metre.	61 400,98	62 432,
Sewage overflow, thousands cubic metre.	0,012	0,205

Accordingly to analysis results of the samples taken at 10 points in the Ural River Delta in the first half of 2008, was revealed excess of MPC having importance of commercial fishing: petrochemicals, phenols, ammonium saline, nitrites, general iron, copper, manganese, COD, five-day BOD.

Port Shevchenko (Port Bautino)

Table 8, water disposal, thousand m3

Water consumers, discharging sewage	Total	Including	
		Conditionally clean	Treated according the standard
Mangucnfuskaya oblast, Bautino			
JSC «Bautino»	92,0		92,0
Branch of the Adjip company «Baza podderzhki Bautino»	3236,0		3236,0
LLP «Kurmangazy Petroleum»	229,0	229,0	
TOTAL	3557,0	229,0	3328,0

Aktau

Table 9, Water disposal, thousands m3

Water consumers, discharging sewage	Total	Including	
		Conditionally clean	Treated according the standard
Mangucnfuskaya oblast, Aktau			
JSC «Kazmorgeofizika»	46,0	46,0	
LLP «MAEK-Kazatomprom»	721796		721796
RSE «Morskoi Torgovyi Port»	17.9	17.9	
TOTAL	721859,9	63,9	721796

Uranium waste

On the territory of the Mangistauskaya oblast, there are 19 enterprises using radioactive substances in their production cycles. The major of them is reactor plant State Enterprise of the Republic "MAEK" with BN-350 unit, which was closed down in 1993. However, with annual retention, it was used up to December 1998.

Accumulated wastes of Ltd. "Kaskor" are also considered as wastes of uranium-mining industry. The Company excavated and processed uranium-phosphoric-and-rare-earth ore by 1991 and wastes were disposed into the "Koshkar-Ata" Tailing Pit.

In the southern part of the tailing pit, 2011 tons of solid radioactive wastes were disposed without permission. Moreover, on the site of Chemical and Ore Mining and Smelting Plant 5000 tons of radioactive scrap metal are stored.

Several deposits of the region (Kalamkas, Zhetybay) contain of uranium minerals and during mining, the equipment and pipes were contaminated with radionuclides, which is stipulated by continuously influence of waters enriched by natural radionuclides. The volume of such accumulated radioactive wastes in the region as much as 2331,2 tons.

Today, 17694 tons of radioactive wastes are accumulated in the Mangistauskaya oblast, excluding RAW of the "Koshkar-Ata" Tailing Pit. In the region were generated 1140,4 tons of radioactive wastes by 2000.

Alpha-active long-lived radionuclides mesurement were made in the ambient air of the beach zone of «Koshkar-Ata» and Aktau city. Measured maximum of active aerosoles equal to 0,041 Bq/m3 on the «Koshkar-Ata» tailing Pit and 0,034 Bq/m3 within the precincts of the Aktau city are not harmful for people.

The most serious ecological threat in the region is the problem with drying of «Koshkar-Ata» Tailing Pit, where uranium and rare-earth ore processing wastes are stored.

Aktau city, reactor plant State Company of Republic "MAEK", 2005.

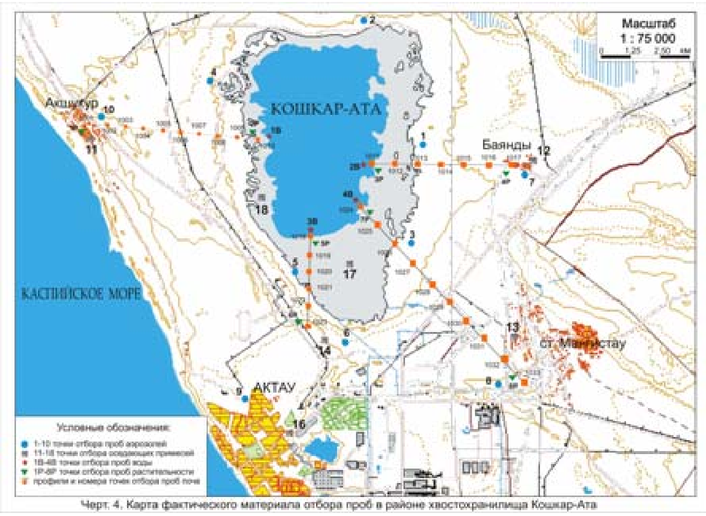
The total area of tailing pit is 77 km2 and has not the equal one in the world. The total area of disposed wastes is 66 km2, the area of bared surface is nowadays about 40 km2. The water level is still decreasing. Composition of disposed wastes includes such substances as: nitrites, nitrates, ammonium, iron, phosphates, fluorine, strontium, zinc, copper, chrome, molybdenum, manganese, lead, uranium, radium and thorium.

During whole period of operation in the Tailing Pit were disposed 51 790 000 tons of RAW with total activity of 11242,825 Curie. There are5 million tons of toxic and radioactive wastes stored in the tailing pit.

Wastes in form of pulp or sewage were placed in the tailing pit from the southern side. In the years of 1986 – 87, such one-side sewage deposition has lead to formation of so-called «beach». However, analysis of available data on hydrodynamic and hydro-chemical conditions in the area of the Tailing Pit showed that there was no real danger for contamination of Caspian Sea from it.

Since 2001, there is more than 8,4 million m3 effluents injected into the Tailing Pit annually.

Alpha-active long-lived radionuclide measurements were made in the ambient air of the beach zone of «Koshkar-Ata» and Aktau city. Measured maximum of active aerosols was equal to 0,041 Bq/m3 on the «Koshkar-Ata» tailing Pit and 0,034 Bq/m3 within the precincts of the Aktau city, which levels are not harmful for people.



Черт. 4. Карта фактического материала отбора проб в районе хвостохранилища Кошкар-Ата

Figure 7, Aktau Tailing site [presentation Oleg, Inception workshop CapsianMap. 2007]

The Atyrau region has 275 oil fields contaminated by natural radionuclides (uranium, radium, thorium). The radionuclides originate from the extracted water from oil strata and also occurs as a result of leakage of oil from abandoned oil wells at sea.

On the territory of Atyrau region 21 logging operations and for quality control of welded joints, as well as for geophysical research wells using sources of ionizing radiation (hereinafter referred to iii), which comprise 204 units. All sources iii are closed and registered with the Department of state sanitary - epidemiological surveillance area. Total storage for the storage of private iii 15, did not meet sanitary requirements there. Radioactive waste in the area and there are no grounds for the burial of radioactive waste are not registered.

Currently, radioactive waste (RAW) in the Mangistau region stored in the company MangistauMunayGaz (2,870.3 tonnes), the AO RD «KazMunaiGaz» (6371,8 tons), the LLP «MAEK-Kazatomprom» - warehouse iii, liquid and solid radioactive waste (iii 187sht., the total amount of radioactive scrap metal - 7.75 tons of solid radioactive waste - 7,204.599 tonnes, the total amount of liquid radioactive waste - 3090.8 m3). Data provided by mr.Ahmetov.

On the territory of Mangystau region works with the use of radioactive substances 19 companies. The most powerful - reactor plant RGP "MAEK, with the BN-350, the designated life of which expired in 1993. Prior to December 1998 worked with an annual extension of service.

Wastes uranium industry are also radioactive waste accumulated during the activities of AK Kaskor "until 1991, producing and processing uranofosfornoredkozemelnyh ore, waste that were dumped into the tailings" Koshkar-Ata." At the southern board without the tailing project dumped 2011 tons of solid radioactive waste. In addition, in the territory of the plant is kept Himikogornometallurgicheskogo 5000 tons of radioactive scrap metal.
A number of areas (Kalamkas, Zhetybai) contains uranium mineralization and occurs in the extraction of radionuclide equipment and pipes, which is related to prolonged exposure to the oil-water, enriched with natural radionuclides. These radioactive wastes are accumulated in the field of 2331.2 tons.
Total is currently in the field of Mangystau accumulated radioactive waste, excluding radioactive waste stored in tailings ponds "Koshkar Ata" 17,694 tons. In 2000, appeared in 1140.4 tons of radioactive waste.

Flooded Oil wells
Activities for the Elimination of flooded oil wells in the Caspian Sea is currently being implemented within the framework of the Development Program, resource base mineral complex of Kazakhstan for 2003 - 2010 years, approved by Government Decision of 29 December 2002 № 1449.

Surveys revealed the presence in the Atyrau and Aktau areas of 90 oil wells in a submerged or waterlogged conditions. Of these 48 wells refers to the government fund 42 - belong to different natural resource users.

During the period from 2004 to 2007 are 32 oil wells eliminated in the flooding zone of the Capsian Sea. It includes: 2004 - 5 (coastal), in 2005 - 7 (coastal) – 1 (Desert) - 4, Tazhigali South-West - 2) in 2006 - 12 (deposit Tazhigali - 6, Tazhigali (2) - 3, Coastal - 1, Desert - 1, East Kokarna - 1), in 2007 - 8 (deposit Teren - Uzyuk - 5, Teren - Uzyuk West - 3). The cost of this operation were about 2370 million tenge of the republican budget.

For 2009 and 2010 planned are to eliminate upto 6 oil wells/each year in flooding zone. Thus, in 2010, the Elimination of flooded oil wells in the area flooded by sea will be completed.
Despite the state efforts, it is possible that in future years there will be leakage of oil from drowned oil wells. Therefore, the Ministry of Energy, in consultation with the Ministry of Economy planned for the period up to 2011 to conduct additional surveys of oil wells in the area flooded by sea, accordingly to compile inventories of wells for insulation-liquidation activities.

Russian Federation

Identified hotspots: Derbent, Makhachkala, Volga River Delta

Derbent, Makhachkala

Based upon the BIR inventory; Derbent and Makhachkala are still hotspots. With an implementation of the proposed pilot to clean up oily landfills, and the State programme covering the treatment of Municipal waster water, this could change. Although it is unclear if the municipal waste will be safely stored as well.

Volga River

The Volga River remains a HOTSPOT for northern Caspian basin. Therefore further investigations, monitoring and appropriate River Basin Management Programme are needed. The latter one is recommended to be included into a regional frame because of its regional impact.

Turkmenistan:

Identified hotspots: Krasnavodsk, Chelekan (Currently named: Turkmenbashi and Hazar)

Turkmenbashi

Saimonov bay is the main hotspot in Turkmenistan. Saimonov bay comprises an area 8 km2. The volume of water in the bay depending on the level varies from 9 to 21 mln. cubic meters, the volume of polluted sediments is calculated as 9 mln. cubic meters. Relatively high levels of oil and BOD have been found in Saimonov Bay. Emirol LTD monitors permanently the water chemical composition. The Saymonov bay is located approximately 1.6 m above sea level, and seepage of oil to the Caspian Sea may happen. Saimonov bay was connected to the sea via submerged pipes. The run-off of ground waters polluted with oil waste is estimated as up to 6 thousand tons per year;

The Turkmenbashi oil refinery, the Turkmenbashi power plant, and the city sewage system have their effluent to Saimonov bay. The oil company Emirol LTD is contracted for the remediation of Saimonov bay.

The contract with Emirol LTD has been paused to purchase equipment for reconstruction of water and sewer systems, which has been currently put out to tender for environmental projects in TKNPZ

Currently the company Polymex is implementing a project in the city of Turkmenbashi on the reconstruction of the city sewage system and the construction of new water pipes. The Turkmenbashi refinery replaced the pumping installation and partial reconstruction and diversion of the sewage pipes. The Turkmenbashy power plant completed work on the reduction of pollutants in waste water: repaired water pipes, eliminating the leaking of acid, cleaned sites contaminated with oil products.

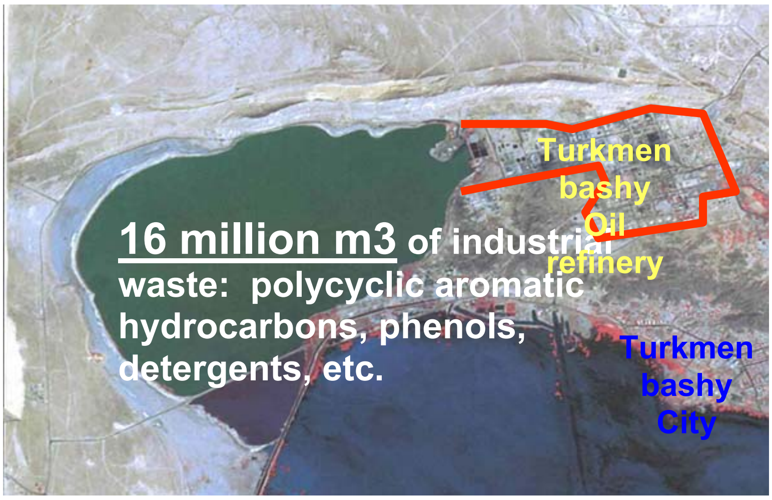


Figure 8, Saimonov Bay [Presentation Emirol LTD, Inception workshop Caspianmap, 2007]

TRC

Turkmenbashi Oil Refinery is a state owned company and employs 2832 people.. The products are refined oil products like gasoline, diesel, kerosene, asphalt, as well as coke. The Turkmenbashi Oil Refinery, discharges without treatment (up to 20 thousand tons/year) to Saimonov bay since 1966. These were technological and emergency discharges. This caused the current oil pollution of bottom sediments and coastal substratum. In 1966 and in 1995 a wastewater treatment facility became operational, reducing the discharge of oil waste with wastewaters of the plant to70 tons per year.

The amount of oil sludge generated, is disposed on special designed landfills at the territory of the TRC, (TRC reported to National experts). The air emissions reported to be 24 tons NOx/yr, 1203 tons SOx/yr and 312 CO2/yr.

Several projects have been implemented or are planned to upgrade the TRC:

1. Reconstruction of the sewerage system TKNPZ and the construction of new wastewater treatment facilities of industrial waste water were put on tender.

2. Reconstruction of a revolving water processing plants with the introduction of local cleaning and transfer vodoblokov TKNPZ with desalinated sea water to were put on tender.

3. Development of technical project of recycling oil and oily soils on the territory TKNPZ: This project will reduce emissions of hydrogen sulfide at 13 tons per year and sulfur oxide by 8 thousand tons per year. In Decree number 5548 dated 05.03.2002., President of Turkmenistan allocated 27 million dollars to environmental activities at TKNPZ.

4. New wastewater treatment systems are planned, which will submit the outdated sewage plants. At the same time, gross pollutant emissions into the atmosphere will decrease by 4.5 thousand tons per year. Besides a technical designs are developed for tanks of TKNPZ to prevent hydrocarbon vapors into the

atmosphere. As a result emissions of pollutants into the atmosphere will be reduced by 4.5 tones per year.

Turkmenbashi port

In 2008, 10 vessels have been decommissioned in order to clean the Turkmenbashi sea port. The vessels have been brought for disposal and were transferred into recycled metal: 10 units at the Turkmenbashi port and 3 units in the Kenarskoy oil terminal. In total a 390 tons of recycled metal was gained. The work is still continuing.

Negotiations are going on between the Office «Turkmdenizderyaellary» and Russian companies concerning construction of a ship dock in Turkmenbashi bay to promote the decomposition works.

The Office «Turkmdenizderyaellary» obtained equipment for localization and reclamation of emergency pollutions in 2004. The Caspian Environment Program provided the grant for purchasing the equipment, which was installed on the M/S «Arslan». Office «Turkmdenizderyaellary» is currently studying the availability equipment for reclaiming spills of petroleum products and seeking for technical assistance and financial resources.

A feasibility study revealed that the dredging of the basin of Turkmenbashi port and navigation canal requires repair of vessels and equipment. The relevant tender was announced and bids has been submitted.

The current project recommends strongly the study of the disposal requirements and to conduct the broad sediment survey in order to find solution which satisfying the environmental conservation rules.

Cheleken

Hazar Chemical Plant,

This iodine bromide plant is located right on the shoreline and has just 200 m from the shoreline a landfill of readioactive waste. The plant was established in 1932. The company explores natural ground water as raw material for the production of Iodine and bromine products. The production of FeBr2 started in 1940. This plant used to produce Iodine, ferrous bromide, potassium iodine, iodoform and iodine acid. The solid waste produced at the site is radioactive and due to that during the soviet period Cheleken City was restricted area. [UNIDO, 1998]

Open dumps and vessels of exhausted iodine installation in Cheleken Chemical Plant contain 18,420 t of radioactive activated carbon with radioactive exposition dose range from 2,500 μR/h to 4,000 μR/h. The radioactive waste was identified as a Priority action in the Neap. [UNIDO, 1998].

By Decision of the President of Turkmenistan (No. PB 1255, 19.06.96, About Utilisation of the Wastes from Cheleken Chemical Plant and Nebitdag Iodine Plant) an area for a burial deposit has been allocated in Akikul. The construction has been completed. A contractor Ekomed will transport the radioactive waste to the new build storage facility shortly. The estimated costs are about $ 400 000. According to the contract all waste will be transported by 31.12.2010.

Figure 9, Hazar Chemical Plant, [Presentation Turkmenistan, First Regional Caspianmap workshop, 2008]

Figure 10, effect of sea level rise

Due to the sea level rise, and the absence of a dock, the coastal area of Turkmenistan consist of several abandoned installations and ship wrecks. The Turkmen government started the removal of old shipwrecks and other actions are foreseen. The NEAP, item 42, Renewal of existing obsolete and oil drilling equipment, indicated implementation period 2002-2010. It is unclear if there are abandoned platforms (inherited from Soviet times), and which actions the Government has planned.

Figure 11, Oil platform [Presentation Dragon Oil, Inception workshop Caspianmap 2007]

General Conclusion

This inventory shows that less pollution is originated by industry (except oil industries) and municipalities in the Caspian zone compared the loads transported by Rivers Volga and Terek.

Reference

1. CASPIANMAP, 2009, BASELINE INVENTORY

4 PRE-FEASIBILITY STUDIES OF DEMONSTRATION PROJECTS

Priority Investment Programme

4.1 Introduction

The Priority Investment Programme to be developed under the CaspianMAP project is limited to land-based point sources of pollution concern by agreement with the client (EU TACIS) and the beneficiaries (country representatives of the riparian states) on delineation of activities (1st Regional Workshop February 4-6, 2009).

In several working sessions with national experts a list of major sources of pollution was identified per riparian country based on the previous CaspianMAP Baseline Inventory Report (presented in Appendix 4.1). Out of this list a shortlist of ranked regional priority pollution sources was distilled (presented in Appendix 4.2) on basis of which a priority investment programme was established. For the methodology and results of the project identification, prioritization and selection is referred to the separate “Final Baseline Inventory Report of Task 5”.

The investment programme includes some identified ‘Hotspots’ as well as some smaller but exemplary cases of pollution of concern which can act as examples for similar pollution sources scattered all over the coastal zone of the Caspian Sea. The selected pollution sources are worked out as pilot projects at pre-feasibility level to enable further development and possible international financing. Some of the pre-feasibility studies had to be kept limited and indicative as some vital information could not be obtained or appeared to be classified and was not revealed .

4.2 Selection of Pilot Projects

For the selection of pilot projects for pre-feasibility studies the following criteria have been applied:

- Not being included in some other national or international remediation project (to avoid double or unnecessary work).
- Suitable as ‘model function’ for one of the following pollution sectors:
  - urban wastewater discharge;
  - industrial wastewater discharge;
  - uncontrolled dumpsites of municipal or industrial waste;
  - Oil polluted land (‘masutted’ soil).
- Considerable but comprehensible in extent and character (not too big or complex to loose view and control).
- Interested and cooperative ‘problem-owners’ to get access to information and obtain constructive involvement.

The following project proposals have been selected for further study and these will be worked out on pre-feasibility level:

1. KZ: Construction of WWTP Atyrau Left Bank and Reclamation of Tukhlaya Balka Sedimentation Tank
2. RF-AS: Controlled Discharge of Municipal Stormwater Drainage in City of Astrakhan
3. RF-AS: Reclamation of Wastewater Treatment Sludge Disposal Site at City of Astrakhan
4. RF-DAG: Development of a General Processing Site of Oily Waste of Oil & Gas Drilling Activities at Dagestan
5. TM: Cleanup of masutted lake at Khazar (former name Cheleken)

For Azerbaijan no projects were identified as almost all pollution sources of concern are already subject to completed or ongoing remediation programmes. The Azerbaijan National Expert has however provided a very useful description of a central oil & gas drilling waste processing facility (in principal similar to proposed pilot project No. 4), and an interesting photo log of the remediation and recultivation of former OGPP Bibiheybatneft at the Absheron Pininsula.
The Project description of the so called ‘Thermal Soil Treatment Process’ is attached as Appendix 1.

The above listed projects have been discussed and agreed with the local counterparts of the CaspianMAP by the National Experts assigned under the project. A synopsis of these proposed projects is furnished in the next section and pre-feasibility assessments are presented in the appendices.

4.3 Short Description of the Selected Pilot Projects

1. Construction of WWTP Atyrau Left Bank and Rehabilitation of Tukhlaya Balka Sedimentation Tank

A large ecological problem for Atyrau city and for the off-shore part of the Caspian sea is the sedimentation tank «Tuhlaya Balka», which is situated on the left-bank of Atyrau, and which belongs to the evaporation and infiltration fields of LTD «Atyrau Petroleum Refinery» (APR).

The sedimentation tank is one of potential pollution sources for the Caspian Sea. By present time, the filtration fields of this tank have accumulated around 50-70 million m3 of highly contaminated liquid waste. This wastewater contains high concentrations of chlorides, ammonium salts, sulfates and heavy metals (copper, zinc, chromium, etc.). The concentration of oil products ireaches up to 200 times the MPC, phenol - from 20 to 80 times MPC. As the Caspian Sea water level rises, it closely approaches (up to 10 km) to the tank. During surges the distance between the tank and the sea reduces to 3-4 km. In case of spillage of the tank water into the Caspian Sea serious adverse environmental consequences are possible.

Wastewater drains from the left part of the town are discharged to the infiltration fields without purification. Uncleaned drainages are discharged by numerous accumulators to the storage pond of raw wastewater («Tuhlaya Balka»), which is a source of bad smells (violation of sanitary and ecostandards). Besides, these raw wastewaters pollute the soil and ground water.

In this pilot project the construction of sewage treatment facilities for the left bank of Atyrau is proposed. For complying with the norms, construction of mechanical and biological treatment facilities of waste water is necessary for the decontamination of wastewaters before their disposal at the evaporation and infiltration fields and to the pond-storage.

The realization of the project «Construction of the full complex of sewage treatment facilities for the left bank of Atyrau» will considerably improve the condition of the ecological and sanitary epidemiological situation in Atyrau, as far as the problem of sewage water treatment for the left bank of Atyrau will be solved for the rated 2015 year, and naturally formed sedimentation tank «Tuhlaya Balka» may be rehabilitated and used for other recreational purposes.

The estimated investment costs are as follows:
Construction cost of the sewage treatment facilities is around 16,400,000 USD.
Construction cost of the head sewage pump station is 4,750,000 USD.
Construction cost of the pond-evaporators is 11,450,000 USD.
Total estimated capital investment cost is 32,600,000 USD.

2. Controlled Discharge of Municipal Stormwater Drainage in City of Astrakhan

Annually 540,000 m^3 of polluted run-offs on average is passing through the stormwater-drainage collection system from the territory of Astrakhan and is discharged by pump stations to the Volga River Delta. A significant part of the above run-offs is also reaching the Volga Delta via self-flowing.

Studies show that the following contaminants can be found in the specified categories: heavy metals (iron, copper, zinc, and lead), suspended solids (SS), oil-products (TPH), chlorides, sulphates and others.

The total amount of pollutants discharged is significant. Their discharge is distributed across 14 releases, of which only 2 are connected to a biological treatment system. For the remaining 12 it is not feasible to construct individual biological treatment facilities, also because the concentration of pollutants is too low to allow efficient biological purification.

To reduce the load of pollutants to the Volga Delta, it is proposed to intercept the storm water drainage releases before the pumping stations by so called ‘equalization-sedimentation tanks’, in which storm water is buffered to prevent overloading of the pumps causing possible flooding. The suspended solids can settle and periodically be removed to be processed at the existing Sewage Treatment Plants. The underground tanks should have no bigger footprint than 10 to 20 m^2, and must be designed on basis of the drained paved surface and the statistical hourly rainfall data.

The capital investment cost of such systems are estimated at about USD 100,000 each, including connecting pipe works, sludge scraper and sludge removal pump. The total investment for 12 outfalls is than USD 1,200,000.

3. Reclamation of Wastewater Treatment Sludge Disposal Site at Astrakhan

The sludge produced at the southern wastewater treatment plants (WWTP) of Astrakhan are disposed off at a sludge disposal site. This facility embraces an area of 3.6 hectares. On four beds 49 thousand m^3 of sludge of the WWTP’s, cesspits and household drainage is accumulated.

The Committee of Housing and Communal Services of the Astrakhan City Administration has proposed to close and reclaim the WWTP sludge disposal site.

The sludge beds have leak proof concrete walls, in which deformation is reported. Therefore, the Infiltration of polluted sewage waters into the ground waters might be taking place. The project will consist of removal of part of the existing sludge disposal beds and rehabilitation of the land for urban development purposes. According to a preliminary assessment, the total costs for reclamation will amount about 230,000 USD.

4. Development of a General Processing Site of Oily Waste of Oil & Gas Drilling Activities in Dagestan

Considering the significant expansion of activities related to the oil and gas extraction in the Caspian Sea and its coast, the priority actions to reduce the adverse impact of economic activity on the marine environment should be activities for collection and integrated treatment of drilling wastes of Oil and Gas Producing Plants (OGPP’s) in an environmentally safe and economic feasible way.

There are over 4 mln. tons of wastes of different types and hazard classes generated at the territory of the Republic of Dagestan at warehouses, drilling sites, dumps, disposal sites, and other objects for wastes storage. Provision of facilities of the majority of these objects does not meet the sanitary and environmental requirements.

The Department on Technological and Ecological Supervision of Rostechnadzor of the Republic of Dagestan has proposed as a pilot project to CaspianMAP to consider and prepare a pre-feasibility study for establishment of a special general processing site for the whole Republic of Dagestan for collection, cleaning and neutralization of the above mentioned wastes for the purpose of reutilization, recovery and disposal.

The proposed project will consist of the establishment of a special collection and processing site for oil & gas drilling waste for the whole coastal zone of Dagestan to be located in area of the City of Makhachkala. Estimated cost of the establishment of the treatment site can amount US$ 4 mln.

5. TM: Masutted lake cleanup at Khazar (former name Cheleken)

On the territory of Khazar/Cheleken region there are several areas polluted with crude oil (mazut). One of the worst locations is the so called “Mazut Lake” to the south of the town of Khazar, on the Turkmen sector of the Caspian Sea, directly bordering to the sea.

In the present project it is proposed to develop a pilot for the cleaning of the mazutted lake. The pilot project can be a model and used in the other littoral countries for the cleaning of the mazutted lands. The recommended technological installation can be used for collection, soil regeneration, polluted by oil, oil sludge, collection of oil spills, processing of mazutted soils, ground store houses, waste burial places for the restoration of soil fertility till the residual oil components in the limits of 1% of weight of the cleaned soil. Besides, the recommended technological method of cleaning is based on the extraction process of oil products and allows its reuse.
The estimated investment cost for the semi-mobile installation is US$ 182,000 - 303,000. The cost of the treatment of the estimated amount of polluted soil: minimum 50,000 t: at US$ 100 = US$ 5,000,000 and maximum 150,000 t at US$ 100 = US$ 15,000,000

4.4 Summary of Projects' Costs

A summary of the capital investment cost and service cost for e.g. secure waste disposal are presented in the following table.

No.	Country	Project Name	Capital investment cost (USD)	Service cost (USD)	Remarks
1	Kazakhstan	Construction of WTWP Atyrau Left Bank and Reclamation of "Tuhlaya Balka" Sedimentation Tank	32,600,000	n.a.	Cost of sludge disposal are not anticipated
2	Russian Federation	Controlled Discharge of Municipal Stormwater Drainage in City of Astrakhan	1,200,000	n.a.	Cost of sludge disposal are not anticipated
3	Russian Federation	Reclamation of Wastewater Treatment Sludge Disposal Site at City of Astrakan	230,000	1,225,000	Service cost for the secure disposal of excavated sludge
4	Russian Federation	Development of a General Processing Site of Oily Waste of Oil & Gas Drilling Activities at Makhachkala, Republic of Dagestan	4,000,000	-	Service cost for the excavation, transport and processing of oil-polluted soil/sediment
5	Turkmenistan	Masutted lake cleanup at Khazar	1,212,500	-	Service cost for the excavation, transport and processing of oil-polluted soil/sediment
	Total		**269,512**		

Appendices:

3.1 Thermal Soil Treatment Process.doc
3.2 PFS STP Atyrau and Tukhlaya Balka.doc
3.3 PFS Municipal Stormwater Drainage Astrakhan.doc
3.4 PFS WWTP sludge disposal site Astrakhan.doc
3.5 PFS oily waste processing site Dagestan.doc
3.6 PFS Mazut Lake Khazar/Chelekan.doc

5 CASPIAN SEA WATER AND MASS BALANCE ESTIMATION

5.1 Introduction

Different projects have made a number qualitative / descriptive studies of pollution loads in the Caspian Sea produced by different sectors and activities during the last decennium. The current project considered that the next phase should already focus on qualitative assessments, which can give base for planning of monitoring, assessing the effects of potential protection measures and revealing the major points for regional co-operations.

The quantitative assessments in regional scale ceased at the time break up of the Soviet Union because of a series of reasons. As a consequence, all the others activities (monitoring, implementation of assessment methods and development competence), which could make possible fulfilling such works also were terminated. Therefore, it was decided apply a conceptual method, which can work with extremely limited database, easy to set up and simply to use.

The ultimate objective of the numerical modelling was to demonstrate applying a preliminary simple water and mass balance model for the Caspian to check the consistency of exiting data, to highlight the main points of the future regional monitoring and to draw the attention of the national experts to the usefulness of numerical assessments. The model is intended to function as an overall framework in the future for:

1. More detailed hydrodynamic and water quality modelling;
2. Planning and interpretation of future monitoring/surveys; and
3. Quantification of land based pollution sources.

The current (demo) assessment work was divided into five phases:

- preparing data input
- augmenting missing data
- setting up the model
- numerical modelling
- evaluating the results

The model was formulated in an MS-Excel workbook document so that data and links to modelling could be made explicit and open to potential users.

In the following sections the above phase will be briefly reviewed.

5.1.1 Background

Apart from the input from the Volga River, the majority of pollution sources to the Caspian Sea originate from the coastal zone, e.g. in a band of about 100 km from the coastline. Mapping of the land-based pollution sources, starting from the present situation presented in the previous section was conducted in order to identify, localize and quantify pollution sources, as presented in Chapter 4.

The other side (relative to the land-based source assessment) of the Action Plan development is to make an assessment of the pollution absorption capacity for a set of indicator contaminants (parameters) in the coastal zone – a receptor quality/capacity plan. The purpose of the receptor quality plan is to establish (distributed for a number of compartments) the maximum allowable concentration, and consequently pollution load (= flow * concentration) of the various indicator parameters.

A distributed 3D hydrodynamic and water quality model would be the ultimate tool to assess along the coastline and in the global water body of Caspian Sea maximum allowable pollution load from land-based and coastal activities to the Caspian Sea. Such a model, however, requires a vast amount of data and complex calibration and validation procedure, which all are outside the scope of the current project.

To revitalize the qualitative assessment works was proposed to set up an overall box-model, i.e. a conceptual/lumped water and pollution mass balance model for the Caspian Sea using existing and generated long-term (annual) average data. This required a division of the Caspian Sea into a sub-compartments with a spatial resolution that matches the time scale and the existing data.

Ideally these spatial boundaries should follow physical as well as national boundaries (which again later could be sub-divided into more detailed model grids). There is, however, not enough data to support a division involving national boundaries, since, this division would require knowledge of a large number of fluxes within the national as well as physical boundaries. This details are not available today.

Based on the hydrography and boundary conditions of the Sea, the main effective flow direction is from North to South. The Sea furthermore consists of four main basins (including the Kara Bogaz Gol), which are separated by more or less pronounced ridges/thresholds. Estimated typical hydrodynamic circulation patterns are shown in **Figure 12**.

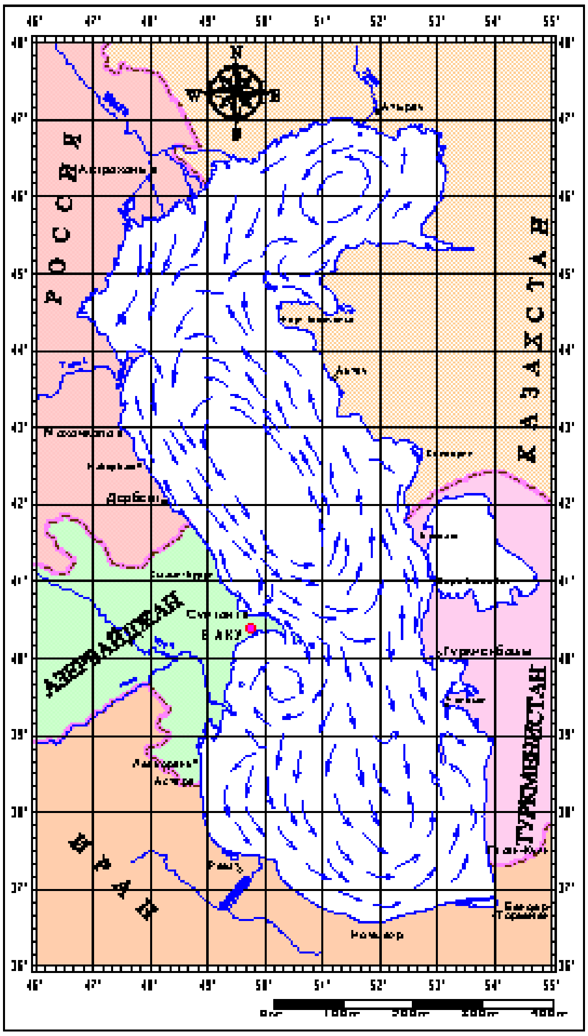


Рис.33 Схема обобщенных течений по данным инструментальных наблюдений

Figure 12: Estimated surface current patterns

The surface current pattern clearly shows the three main basins in the Sea. The current pattern also shows that pollution discharged in one point on the coast will be partly transported to other parts of the Sea. The transported pollution portions between the compartments are significant but of different magnitude therefore the planning of protection / countermeasures clearly calls for concerted action in quantitative assessment works.

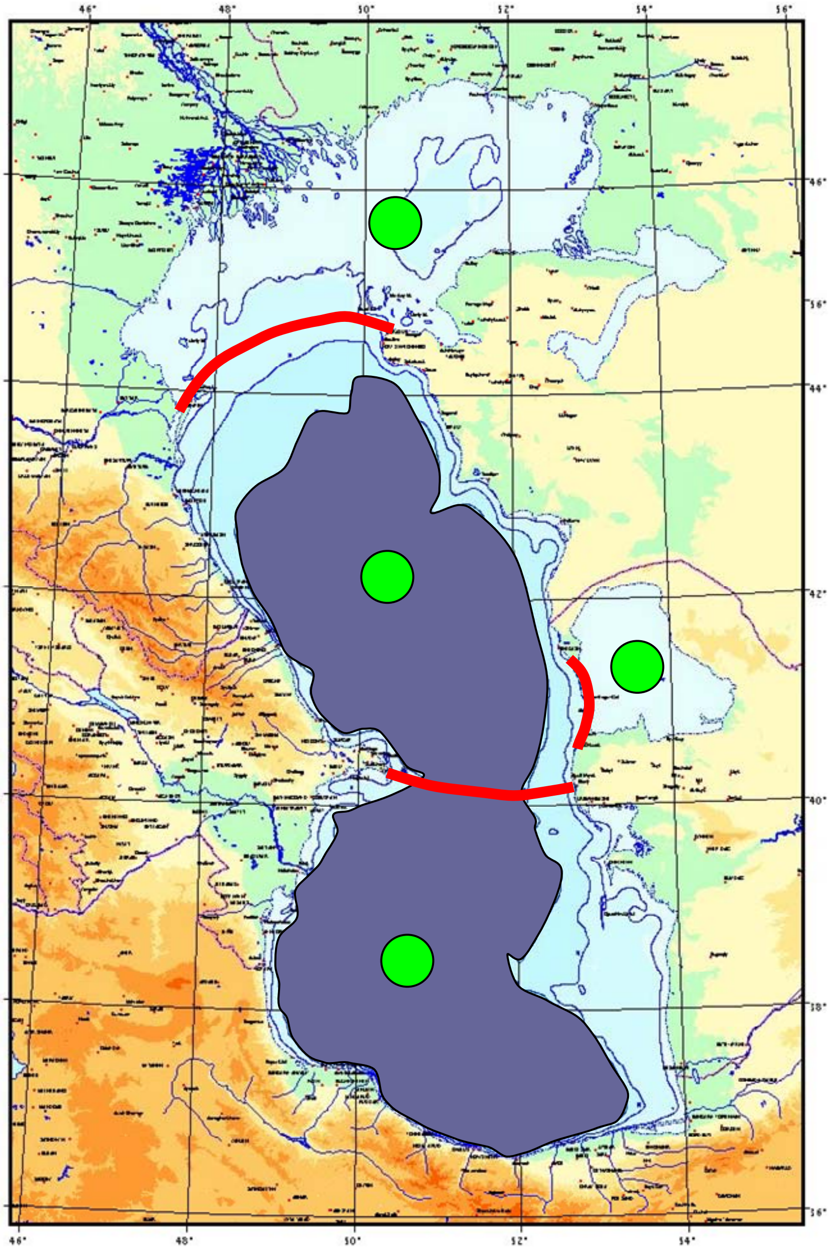


Figure 13, Division of the Sea into compartments. Red lines indicate physiographic thresholds.

Then, for each of the four compartments, the mass balance model shall seek to establish:

1. The baseline situation;
2. An estimate of the exchange of pollutants between the neighbouring compartments, incl. assessment of the origin of pollution sources to each compartment; and
3. An estimate of the sedimentation/degradation in each basin.

The main problem here is to establish the flow and the net pollution transport between compartments. Hence, for each of the four compartments, the key transport processes shall be estimated:

- Flushing time (pollutants mean residence time in the water column)
- Sedimentation rate of a conservative pollutant (TP is used as indicator of nutrients and conservative substances)
- Exchange of water and pollutants between compartments

If it would be possible, based on the existing data, to estimate the fluxes from one basin to the next, a quantitative estimate of the mass balance for each basin could be established.

5.2 Data

Data used in the box model set-up is primarily collected from the following publications and reports:

- GIWA report, p. 16, table 2
- A.V. Frolov/GEOS 2003, p.11, table 1.1
- RAS Moskva 2006, p.348, fig. 3
- TDA 2002, vol II, Figure 1.2-2
- Caspian Sea Environment 2005
- DHI/TACIS CEP 2000 (Caspian Environment Programme, Pollution Load Inventory of the Caspian Sea. A Demonstration of the Decision Support System)
- Mamedov, 2007 (Caspian Sea: Hydrometeorological variability & ecogeographical problems)

The above existing references have been supplemented with updated data and other information from the national consultants employed by the project.

Data are presented in a separate sheet the MS-Excel Model File.

Atot=	406120	km2			Total sea surface area
Vtot=	76632	km3			Total sea volume
	TDA Vol II figures		GIWA data		
Atot=	436000	km2	378000	km2	Sea surface area estimates
Vtot=	78000	km3	78100	km3	Sea volume estimates
Dm=	179	m	207	m	Average sea depth
Abasin=	3500000	km2			Total catchment area
Arivers	2150000	km2			Total river catchments

Figure 14, Overall area and volume data. Data used in the calculations is indicated with a black frame.

There are some discrepancies in the overall physiographic data (e.g. sea surface area/volume, catchment areas, etc.) reported in various reports (see *Figure 14*). An average of the most recent estimates is used in the calculations.

Similarly, a set of basin data has been extracted from the existing reports, see *Figure 15*.

Parameter	Unit	Name	1. Northern	2. Middle	3. Kara Gol	4. Southern
Basin surface area	km2	Abasin=	1,860,000	38,700	5,000	249,000
Average temperature	C	T=	11	13	15	16
Average salinity	ppt	Cs=	0.1	10	10	13
Inflow catchment area	km2	A=	102,060	143,640	13,000	147,420
Average depth	m	Dm=	5.5	190	10	330
Basin volume	km3	Vm=	561	27,292	130	48,649

Figure 15, Basin data

The annual inflow data and boundary/initial conditions are given in the MS-Excel model sheets, where yellow highlighting generally indicates input data. Red highlighting in the model sheet indicates cells/variables that are determined from the optimisation procedure (linear programming function).

Based on the existing data reported in the above mentioned reports, and with additional data collected during the project, it has been possible to establish a time series of key input data for a period of 21 years from 1980 to 2000.

5.3 Method

The box model is based on the conceptual set-up presented in *Figure 16*. Blue arrows show the inflow from the four largest rivers. Other inflow sources are related to direct inflow (catchments that discharges directly to the sea and Land Based Sources from human activities) to the individual basins.

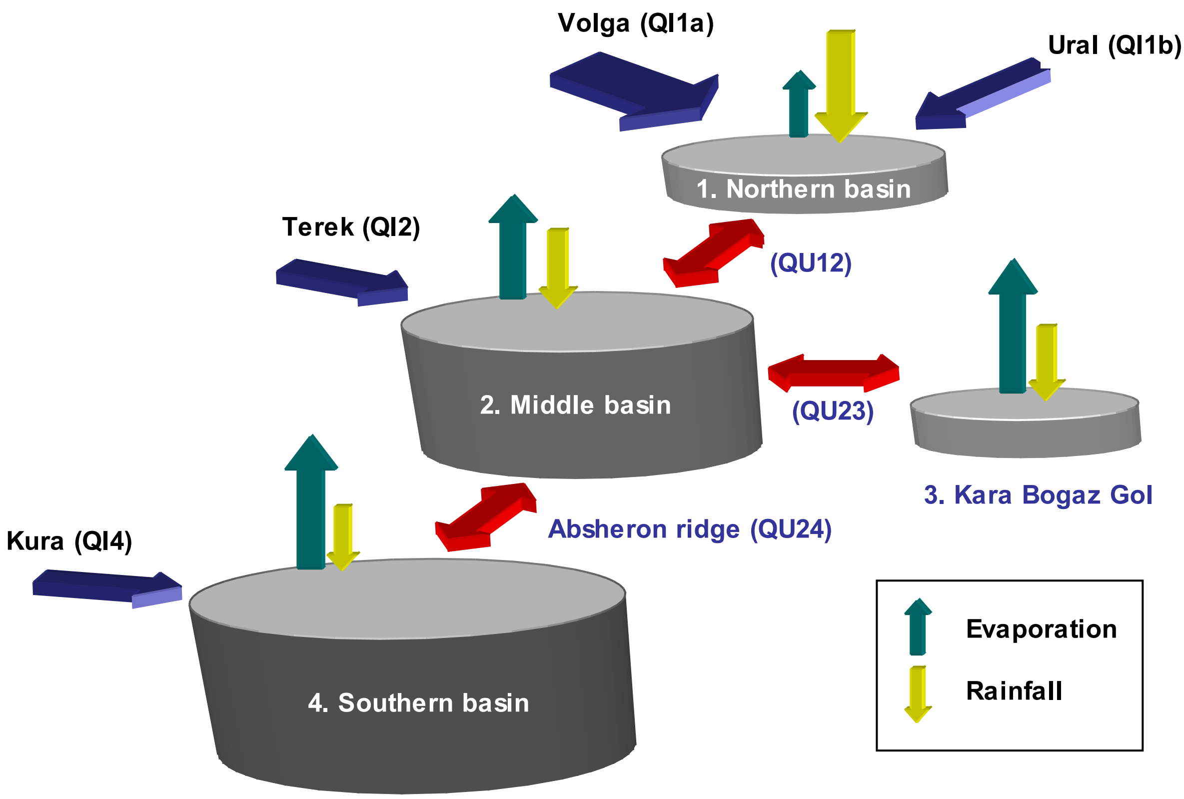


Figure 16, The four compartments and illustration of the key processes. The blue arrows indicate river inflow and the red arrows indicate the unknown net fluxes between compartments.

The four basins are, obviously, interlinked and outflow from one basin becomes the inflow to the next. In the actual model that operates on large scale both in time and space, the net flow is from north to south and the assumption is that on average over one year there is no return flow from south to north.

The Kara Bogaz Gol and the Southern basin have no river outflow and the only mechanism of removal of water is through evaporation. Likewise, the only pollution sink is sedimentation, which therefore both becomes important processes to investigate.

The general meteorological pattern is that the rainfall decreases from north to south whereas the evaporation increases from north to south.

5.3.1 Water balance model

The water balance model outlined above is formulated in four coupled box-averaged ordinary differential equations (converted to difference equations in the MS-Excel model implementation):

$$
\begin{aligned}
A_1 \frac{dh_1}{dt} &= Q_{IN1} + Q_{D1} + P_1 - Ea_1 - Q_{12} \\
A_2 \frac{dh_2}{dt} &= Q_{IN2} + Q_{D2} + Q_{12} + P_2 - Ea_2 - Q_{23} - Q_{24} \\
A_3 \frac{dh_3}{dt} &= Q_{IN3} + Q_{D3} + Q_{23} + P_3 - Ea_3 \\
A_4 \frac{dh_4}{dt} &= Q_{IN4} + Q_{D4} + Q_{24} - Ea_4
\end{aligned}
\qquad (1)
$$

where $V_i = A_i * h_i$ and Q_D is the direct inflow to the basins (direct catchments and human activities). The unknowns in this system of equations are the net fluxes between the four compartments, Q_{12}, Q_{23} and Q_{24}, which are estimated using an optimisation procedure based on the inflow and meteorological data, and the observed variations in water levels.

5.3.2 Mass balance model

The simple mass balance model (a conservative substance) is formulated in a similar way. Here total phosphorus is chosen because: (1) it is an important indicator of human activities; (2) it is a parameter where the existing data is most homogeneous; and (3) exemplifies transport of conservative substances.

The mass balance model is then formulated as follows:

$$
\begin{aligned}
V_1 \frac{dc_1}{dt} &= T_{IN1} + T_{D1} + T_{P1} - T_{12} - S_1 \\
V_2 \frac{dc_2}{dt} &= T_{IN2} + T_{D2} + T_{P2} - T_{23} - T_{24} - S_2 \\
V_3 \frac{dc_3}{dt} &= T_{IN3} + T_{D3} + T_{P3} + T_{23} - S_3 \\
V_4 \frac{dc_4}{dt} &= T_{IN4} + T_{D4} + T_{P4} + T_{24} - S_4
\end{aligned} \qquad (2)
$$

where S_i are the net sedimentation processes for each compartment. The temporal variation of the basin volumes are determined from the water balance model (A_i*$h_i(t)$).

The pollution transport processes in (2) are modelled as simple convective processes:

$$
\begin{aligned}
T_{IN} &= Q_{IN} c_{IN} \\
T_D &= Q_D c_D \\
T_P &= P c_D \\
T_{ij} &= Q_{ij} \hat{c}_i
\end{aligned} \qquad (3)
$$

where c_x denotes the concentration (Total Phosphorus) in each of the inflow/input sources (x) estimated in the water balance model. These are generally observed except $\hat{c}_i$ that are the simulated concentration values.

Some phosphorus concentration data from Caspian Sea basins can be found in the literature and those data has been used to estimate a record of TP-concentrations for each compartment for the period 1980-2000. These time series are then used to estimate the net sedimentation amounts via an optimisation procedure that finds the net sedimentation that, given the inflow data, minimises the distance between simulated ($\hat{c}_i(t)$) and observed ($c_i(t)$) concentration values in the water phase of each basin:

$$
Find\, S_i(t) \rightarrow \min\left[\left(\hat{c}_i(t) - c_i(t)\right)^2\right] \qquad t \in \{1980;2000\} \;\; and \;\; i \in \{1;4\} \qquad (4)
$$

The average of the simulated net sedimentation processes can then be evaluated against general empirical net sedimentation models in order to check the reasonability of the mass balance model results.

5.4 Calculations

This paragraph presents a part of the box model simulations for the period 1980-2000. Only results from the Northern basin are presented in order to demonstrate and explain the structure of the model. The reader is referred to the MS-Excel document provided to all participants where all results are available.

5.4.1 Water balance model

The results of the water balance calculations are shown in *Figure 17*. For the remaining three basins, the reader is referred to the MS-Excel water balance simulation sheet In Annex 6.1

Calculations - water balance

1. Northern basin

	Rivers	Direct	Precipitatio	Evaporatioı	Outflow					
	m3/s	m3/s	m3/s	m3/s	m3/s	m3	m3	m	m	m2
t	**QI**	**QD**	**P**	**Ea**	**QU12**	**dV1**	**V1**	**h1sim**	**h1obs**	**dh2**
1979		2%					5.61E+11	-28.8		
1980	6858	137	981	2223	4935	2.6E+10	5.9E+11	-28.5	-28.3	0.1
1981	8230	165	872	2033	6976	8.1E+09	6.0E+11	-28.5	-28.2	0.1
1982	9327	187	817	2329	7533	1.5E+10	6.1E+11	-28.3	-28.2	0.0
1983	8230	165	708	2270	6613	6.9E+09	6.2E+11	-28.3	-28.1	0.0
1984	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.3E+11	-28.2	-28.0	0.0
1985	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.4E+11	-28.0	-27.9	0.0
1986	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.5E+11	-27.9	-27.7	0.0
1987	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.7E+11	-27.7	-27.5	0.1
1988	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.8E+11	-27.6	-27.5	0.0
1989	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.9E+11	-27.6	-27.4	0.0
1990	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.9E+11	-27.6	-27.4	0.0
1991	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.9E+11	-27.5	-27.2	0.1
1992	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.1E+11	-27.3	-27.0	0.1
1993	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.4E+11	-27.1	-26.9	0.0
1994	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.6E+11	-26.8	-26.7	0.0
1995	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.8E+11	-26.6	-26.5	0.0
1996	9739	195	872	2631	8717	-1.7E+10	7.7E+11	-26.8	-26.8	0.0
1997	9327	187	817	2596	7481	8.0E+09	7.7E+11	-26.7	-26.9	0.0
1998	8230	165	763	2808	7039	-2.2E+10	7.5E+11	-26.9	-27.0	0.0
1999	6858	137	708	2855	5800	-3.0E+10	7.2E+11	-27.2	-27.0	0.0
2000	5624	112	708	2848	4794	-3.8E+10	6.8E+11	-27.6	-27.1	0.2
Average	**8373**	**167**	**868**	**2441**	**6781**					**0.9**
Balance		In	9409	Out	9222	Storage	186			
				Balance	**187**	**OK**				

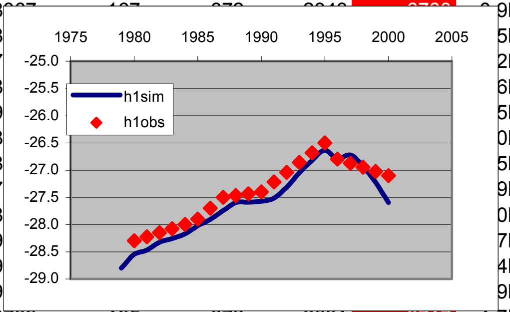


Figure 17, Water balance model for the Northern Basin

The first column holds the time in years. The total observed river inflow is given in the second column and the direct inflow (in the calculations estimated as 2% of the river inflow since no explicit data exists) is given in the third column. Precipitation in column 4 and actual evaporation in column 5 concludes the range of input processes.

The unknown flux from the Northern to the Middle Basin in column 6 (white font colour and highlighted red) is to be determined as the series of annual outflow from the Northern basin that minimises the sum of squared deviations between simulated and observed water levels (column 11). The change in basin volume in column 7 is calculated as:

$$\Delta V(t) = Q_{IN} + Q_D + P - Ea - Q_{12} \qquad (5)$$

and the new volume in year *t* = *V*(*t*) = *V*(*t*-1) + □*V*(*t*) as listed in column 8. The simulated water level in column 9 is then calculated as *V*(t)/*A*, where *A* is the basin surface area. The observed water level is given in column 10. The results of the calculations are shown in *Figure 18*.

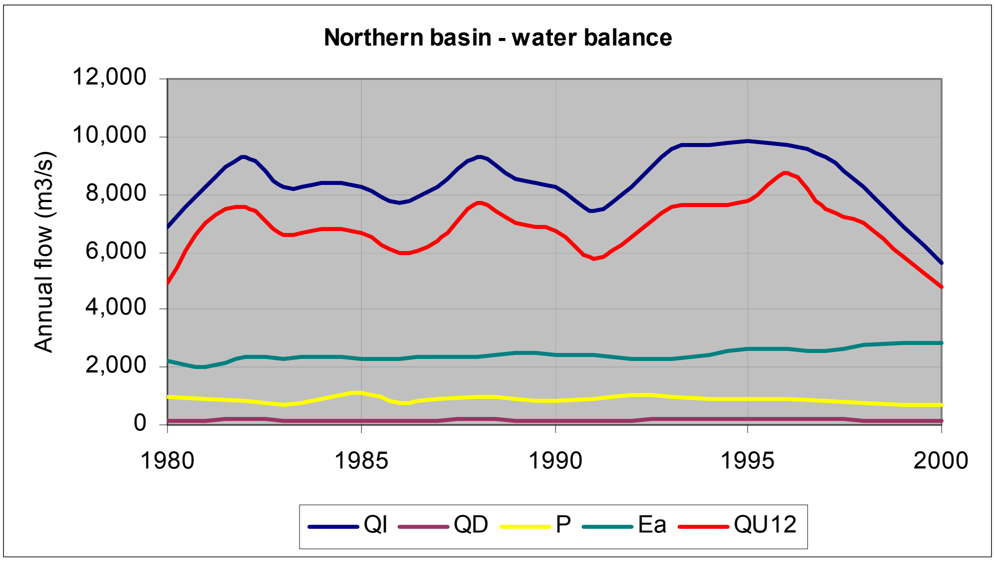


Figure 18, Water balance calculations (time series) for the Northern Basin

The period average/summary of the water balance is presented in *Figure 19*.

Basin water balance

	QI	QD	P	Ea	QU12	
Xi	264	5	27	77	214	km3
In/Out		In sum =	297	Out sum =	291	km3
Storage					6	km3
TDA 2002	254	0.30				
Frolov 2003				80		
TACIS/DHI	247	0.25				
Tw=					1.9	years

Mean hydraulic residence time

Caspian sea water balance

				Check	*Source*	
In						
QI	305		km3	300	TDA	
QD	8		km3			
P	90	**403**	km3			
Out						
Ea	380		km3	396	environmental_baseline_2.pdf ->	975 mm/year
ΔS	23	**403**	km3			

Threshold mean current velocity

D12=	15	m	Average depth at threshold
B12=	40000	m	Effective flow width at threshold
V12=	0.0113	m/s	

Figure 19, Summary results of the water balance

The key results in *Figure 19* are presented in three groups. The first group summarises the water balance for the Northern Basin and compares the results with existing data (yellow highlight). It is seen that there is a good agreement between calculation results and reported data (TDA, Frolov and TACIS). The basin balance is also illustrated in *Figure 20*.

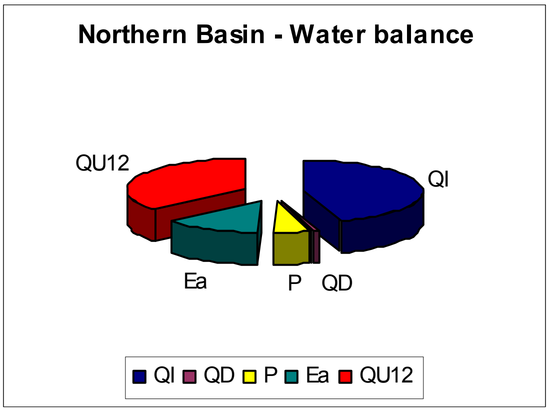


Figure 20, Total water balance for the period 1980-2000. River inflow (Volga and Ural) is the main contributor to the inflow to the Northern basin. Around 2/3 of the inflow passes through the Northern basin and is discharged into the Middle basin and 1/3 evaporates.

The second group in *Figure 19* presents the long-term and overall water balance for the entire Caspian Sea for the period 1980-2000. It is seen that the model results compares well to the previous overall water balance assessments (references given in the table/data sheet).

The third group gives a rough estimate of the mean flow velocity across the compartment boundaries. The effective flow width and depth are estimated and the mean flow velocity is then calculated as the flux divided by the effective flow cross-section area. The average flow velocities calculated in this way (gradient driven only without wind) are between 0.1 cm/sec (between the Middle and Southern basins) and 1 cm/sec (between the Northern and the Middle basins).

In Panin et al. (*Present State of the Caspian Sea*, Moscow NAUKA, 2005, section 2.3) it is reported, based on hydrodynamic modelling, that the current velocities are in the order of 2-4 m/sec in the western part of the Northern basin (generated by the Volga inflow) and 8-15 cm/sec during wind conditions with wind speed of 10 m/sec from varying directions. Hence, it would be expected that the flow velocity between the Northern and Middle basins, in no wind conditions and average flow, would be less than 2-4 cm/sec, which confirms the order of magnitude of the water balance flow estimates.

5.4.2 Mass balance model

It has not been possible to establish time series of TP-concentrations in the inflow sources. Therefore, an average concentration has been assumed for the three main inflow sources. These average concentrations are based on data collected during scattered campaigns and reported in the technical reports referenced earlier and in the MS-Excel model sheet.

Basin data	**1. Northern basin**			
	From Data sheet			
	CXI=	0.33	g/m3	Average concentration in river inflow
	CXD=	0.31	g/m3	Average concentration in direct inflow
	CXP=	0.03	g/m3	Average concentration in precipitation/atmospheric deposition
	ksr=	0.82	E-8 1/s	Average net sedimentation rate (= average NetSed/M)
	VE=	100%	%	Effective volume (H<100m)

Figure 21, Average TP-concentration values in inflow to the Northern basin.

The average net sedimentation rate is, in the actual mass balance model, not an input parameter but a result that can be compared with sedimentation rates from other similar water bodies. The net sedimentation rate is calculated as the ration between the estimated net sedimentation (S_{NET}) and the total mass of TP in the water phase according to the standard net sedimentation model:

$$S_{NET} = k_{sr} M_{TP} = k_{sr} Vc \tag{6}$$

There exist only little and scattered information about the stratification (temperature & salinity) of the Caspian Sea basins. Circulation and hence convective transport and sedimentation take place in the upper part of the basins, that is, above the halo/thermocline. A parameter is introduced in order to obtain an estimate of the effective, or most active in terms of circulation, basin volume. In the Northern basin the water depth is limited and therefore the effective volume is equal to the total volume. In the Middle and Southern basins, the effective volumes are, because of the large and very deep central areas, significantly less than the actual basin volume.

Calculations - mass balance (X)

	1. Northern basin									
	Rivers	Direct	Precipitatio	Net sedime	Outflow					
	g/s	g/s	g/s	g/s	g/s	g	g	g/m3	g/m3	(g/m3)^2
t	**TI**	**TD**	**TP**	**NetSed**	**TU12**	**dM1**	**M1**	**C1sim**	**C1obs**	**dC^2**
1979							1.2E+11	0.216		
1980	2133	42	29	909	1064	7.3E+09	1.3E+11	0.219	0.216	0.0
1981	2672	51	26	998	1525	7.1E+09	1.4E+11	0.228	0.225	0.0
1982	3156	57	25	1291	1714	7.3E+09	1.4E+11	0.234	0.235	0.0
1983	2898	51	21	1215	1548	6.5E+09	1.5E+11	0.242	0.244	0.0
1984	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.6E+11	0.251	0.254	0.0
1985	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.7E+11	0.262	0.263	0.0
1986	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.7E+11	0.264	0.263	0.0
1987	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.8E+11	0.265	0.263	0.0
1988	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.8E+11	0.266	0.263	0.0
1989	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.8E+11	0.265	0.263	0.0
1990	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.8E+11	0.264	0.263	0.0
1991	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.8E+11	0.263	0.263	0.0
1992	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.8E+11	0.247	0.247	0.0
1993	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.7E+11	0.232	0.231	0.0
1994	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.6E+11	0.216	0.214	0.0
1995	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.6E+11	0.202	0.198	0.0
1996	2556	60	26	1425	1764	-1.7E+10	1.4E+11	0.184	0.182	0.0
1997	2230	57	25	1325	1380	-1.2E+10	1.3E+11	0.167	0.166	0.0
1998	1775	51	23	1169	1173	-1.5E+10	1.1E+11	0.151	0.149	0.0
1999	1479	42	21	796	875	-4.0E+09	1.1E+11	0.152	0.149	0.0
2000	1213	35	21	712	726	-5.3E+09	1.0E+11	0.152	0.149	0.0
Average	**2714**	**52**	**26**	**1266**	**1551**					**0.0**
Balance		In	2792	Out	2817	Storage	-26			
				Balance	**-26**	**OK**				

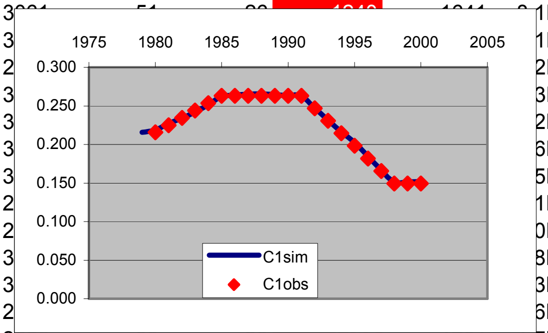


Figure 22, Mass balance model calculations (TP) for the Northern Basin

The mass balance model is, naturally, structured in the same way as the water balance model. The river transport (column 2) is calculated as the inflow (water balance column 2) multiplied by the average inflow concentration. The same is the case for the direct inflow (column 3) and atmospheric deposition (column 4).

The transport out of the Northern basin and into the Middle basin (*TU12* in column 6) is modelled as *TU12*(*t*) = *Q12*(*t*)**C1sim*(*t-1*). The net sedimentation (*NetSed* in column 5) is then calculated as the resulting time series that minimises the sum of the squared deviations (column 11) between simulated (column 9) and observed (column 10) concentration as described in section 3.2.

The time series results of the mass balance calculations for the Northern basin are shown in *Figure 23*. The most noteworthy feature is that the river transport is the far most dominating pollution contribution to the Northern basin.

Furthermore, there has been a significant reduction in the river transport since the peak in the late 1980's. This is also seen, with almost immediate effect, in the observed concentration levels in the Northern basin.

Removal of phosphorus from the basin is done via sedimentation and convective transport further to the Middle basin. These two processes are more or less of equal magnitude and follow the same temporal pattern since they are both directly related to the average concentration in the basin.

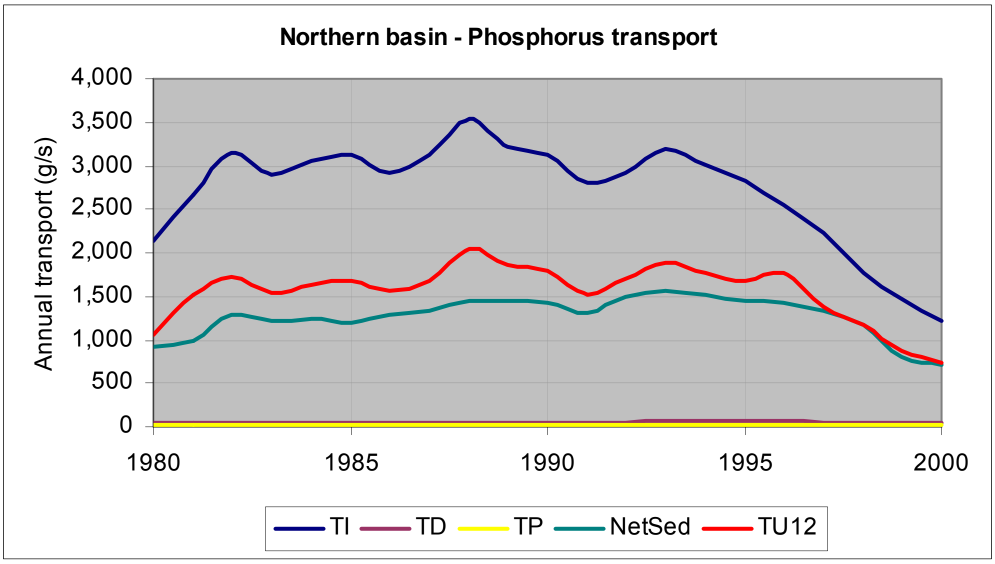


Figure 23, TP mass balance results (time series) for the Northern Basin

The results are summarised in *Figure 24* and *Figure 25*.

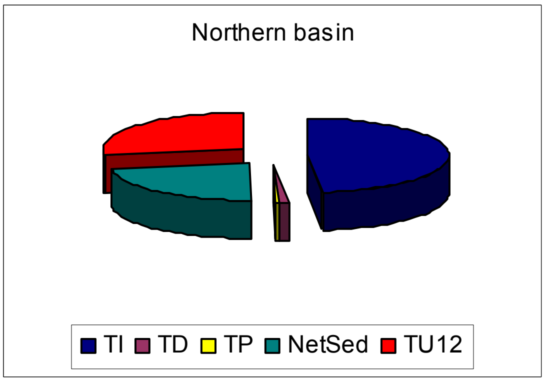


Figure 24, Summary TP mass balance results (1980-2000) for Northern basin

Basin mass balance

	TI	TD	TP	NetSed	TU12	
Xi	85,590	1,625	821	39,929	48,918	ton/year
In/Out		In sum =	88,036	Out sum =	88,847	ton/year
Storage					-812	ton
TDA 2002	83,725	1,625				ton/year
Caspian Sea	37,020					ton/year
TACIS/DHI 2(	85,180	1,617				ton/year

Caspian sea mass balance					*Check*	*Source*
In						
TI	2,885	g/s	**90,988**	ton/year	88,000	TACIS/DHI 2000, table 4.2 page 1:
TD	443	g/s	**13,980**	ton/year	7,000	TACIS/DHI 2000, table 4.2 page 1:
TP	148	g/s	**4,663**	ton/year	800	TACIS/DHI 2000, table 4.2 page 1:
Out						
Tout (1-2 & 2-	2,155	g/s				
S	3,787	g/s	**119,440**	ton/year		No estimates reported

Net sedimentation rate

Remp=	58%
Rest=	45%

Figure 25, Average TP mass balance results (1980-2000)

Like the water balance results presented in *Figure 19*, the mass balance results summary is organised in three groups: (1) the basin mass balance; (2) the overall Caspian Sea mass balance; and (3) simulated and estimated net sedimentation rates.

The data that is used in the actual mass balance modelling are confirmed by the overall assessment made during the TACIS-project reported in the report issued in 2000. The added information provided by the mass balance model is the quantification of transport between basins and the magnitude of the sedimentation.

The third group shows contains two estimates of the net sedimentation rates in the four basins:

1. R_{est} = the average net sedimentation based on the mass balance calculations/optimisation (eq. 6)
2. R_{emp} = an estimate based on an empirical model (eq. 7), which is used to test the validity of the mass balance estimates (R_{est})

Remembering that the net sedimentation time series is found by optimisation/linear programming, it is relevant to test whether the order of magnitude of the sedimentation is comparable to what could be expected using various empirical sedimentation models.

A simple standard empirical model is used to relate the net sedimentation to the hydraulic residence time of each basin:

$$S_{NET} = \frac{1}{1+1/\sqrt{t_w}} T_{IN} = R_{emp} T_{IN} \qquad (7)$$

where t_w is the mean annual hydraulic residence time and T_{IN} is the total external phosphorus load (= *TI*+*TD*+*TP*).

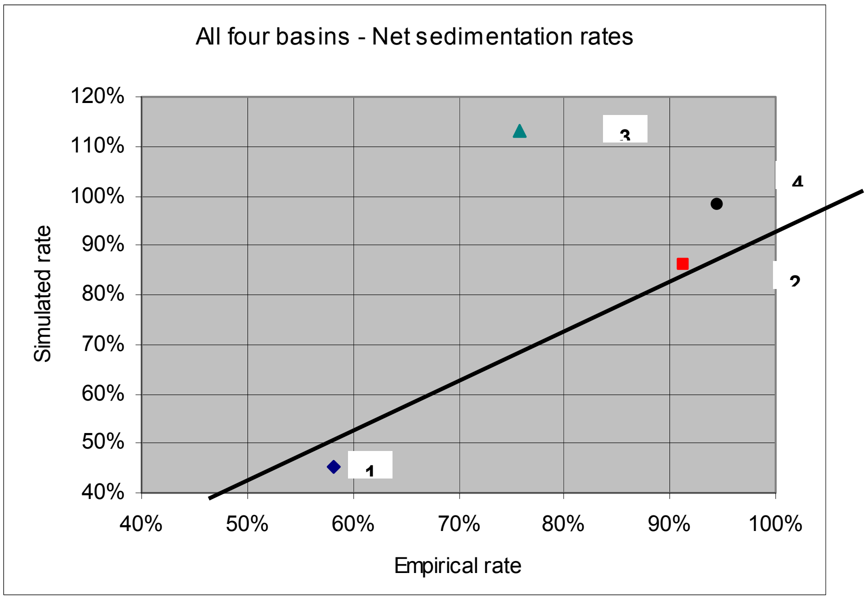
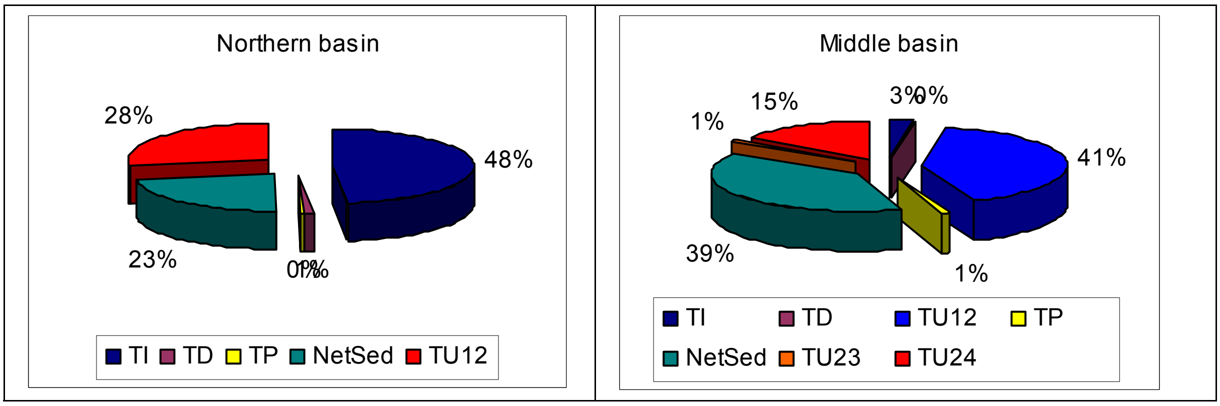


Figure 26, Comparison of simulated and estimated net sedimentation rates. The numbers refer to the four basins (North = 1; Middle = 2; Kara Gol = 3; South = 4). The black line shows the 1:1 relationship.

A comparison of the two net sedimentation rate estimations in the four basins are shown in *Figure 26*. There is a good agreement between the two estimates, except from the Kara Bogaz Gol basin, where the pollution load data generally are scarce. This agreement gives some credit to the data and model used in the present assessment.

The summary pollution transport results, distributed on sources, for all four basins are shown in *Figure 27*.



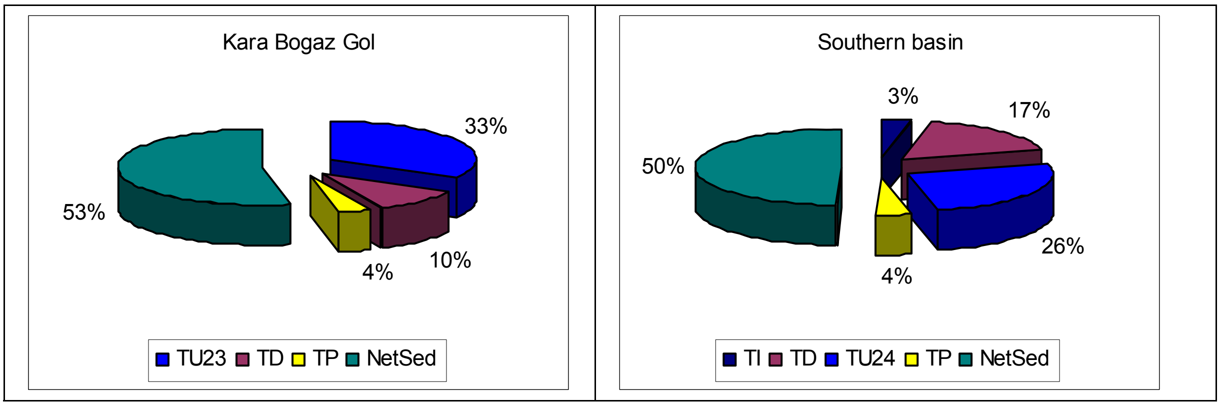


Figure 27, Summary pollution transport results for the Caspian Sea. The percentage labels show the ratio of the individual source to the total mass balance = Input+Output.

It is seen that the river inflow transport (Volga and Ural) to the Northern basin is by far the dominating contribution equal to 48% of the total mass balance, corresponding to around 96% of the inflow transport. The outflow (removal of TP from the Northern basin) is approximately equally distributed between sedimentation (green slice) and transport into the Middle basin (red slice).

In the middle basin, into which only comparatively smaller rivers are discharging, the main inflow transport comes from the Northern basin (light blue slice). Sedimentation, however, is an equally important component, and only a smaller part of the total mass balance (red slice) is discharged further into the Southern basin. Consequently, approximately half of the pollution in the Southern basin originates from the Northern and the Middle basin, and the other half of the pollution is produced within the basin boundaries.

In this way, it has been illustrated how a model can be used to identify and quantify pollution sources in various compartments, which in turn is the first step in the development of future regional pollution action plans.

5.5 Conclusions and recommendations

The model and results presented in this note demonstrates how even a simple model can assist in environmental planning and management. Particularly, pollution source and effect identification and quantification are pivotal in the development of pollution action plans, and in the follow up on such action plans during and after implementation.

In the introduction, it was mentioned that the mass balance model should try, for each of the four basins, to establish:

1. The baseline situation;
2. An estimate of the exchange of pollutants between the neighbouring compartments, incl. assessment of the origin of pollution sources to each compartment; and
3. An estimate of the sedimentation/degradation in each basin.

The results given paragraph 6.4 present an example (water and TP for the period 1980-2000) of how these three questions can be answered. The baseline situation in 2009 can not be directly established based on the simulation results in 2000. Yet, since the coordinated data collection in the Caspian Sea ended in the beginning of 1990, it will be necessary to use physically-based models to estimate the present situation, in the Caspian Sea as well as the pollution inflow.

The second step in the pollution source identification is to make, for each box/basin, a separation between (1) how much pollution is generated from sources within the box (including catchment area and land based sources); and (2) how much can be attributed to external sources, i.e. inflow from the neighbouring boxes. This has been done by calculating the otherwise unknown flow between basins, thereby facilitating estimation of pollution transport from one basin to the other. Having done that, an estimate of the sedimentation can be made and compared with empirical data from other water bodies. This has been done and the model results are generally confirmed.

The model is furthermore indented to function as an overall framework for subsequent activities:

1. More detailed hydrodynamic and water quality modelling;
2. Planning and interpretation of future monitoring/surveys; and
3. Quantification of land based pollution sources.

Item 1 and 2 are briefly commented in the following sections. As for the quantification of LBS, this is an important activity to be continued.

5.5.1 The next modelling steps

This note describes a simple 4-compartment box-model that includes water and total phosphorus. The next steps would be to follow a two-step approach:

1. Further develop the overall box-model by incorporating more pollutants (indicator parameters), if the data allows so;
2. Set-up a distributed 2D HD/AD model (e.g. MIKE21) for the coastal zone (say, 0 – 10 m water depth), see *Figure 28*.

It is estimated that such a combination will be sufficient to establish receptor quality plans for a number of main compartments. For each compartment, the maximum allowable concentrations will be estimated and compared with the actual pollution sources. The difference between actual and targeted concentrations will immediately assist in identification of the revised areas of main pollution concern - and suggest which mitigation measures to be devised for each compartment.

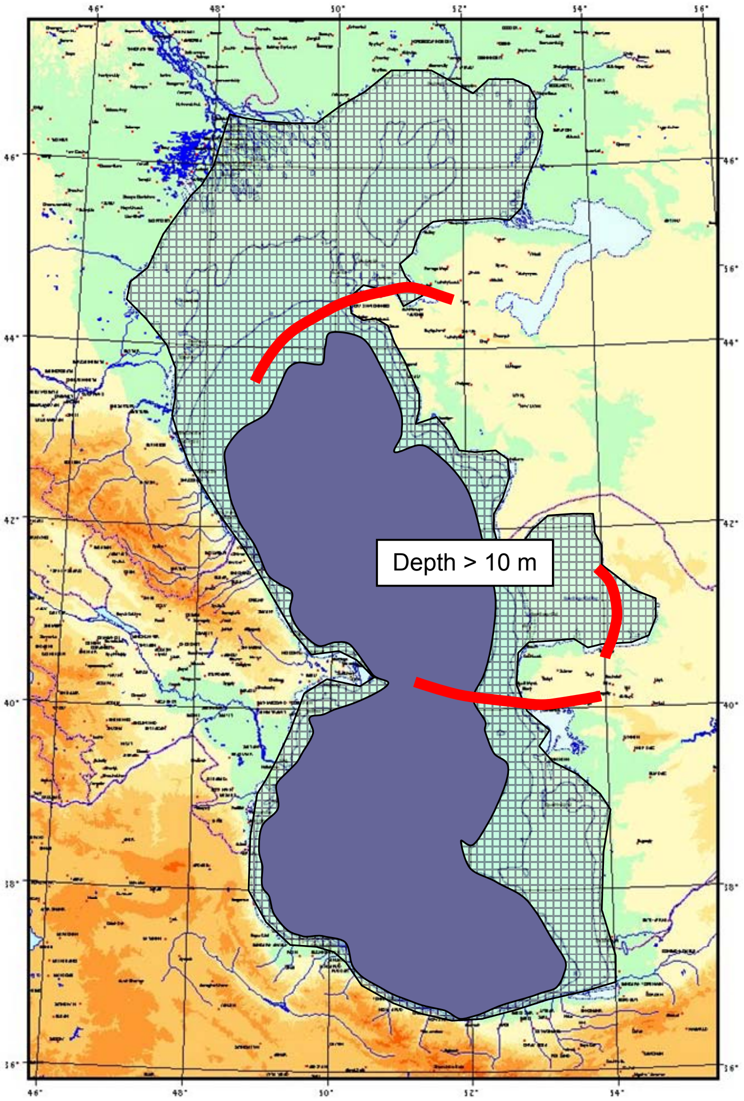


Figure 28, Possible model set-up where a detailed 2D-model should be implemented for the coastal areas in order to assess the effect of LBS. A simpler model could be set-up for the deeper parts of the sea in order to estimate the relationship between external load and sediment/depth interactions.

The distributed 2D AD/HD model shall be used to identify influence zones for the selected hot-spots along the coastline. In order to assess the impact of the hot spots on the Caspian Sea environment, it is necessary to establish a connection between the land-based sources (LBS) and the water and sediment environment in an area around the hot spot. The size of this area (the influence zone) is determined by the local bathymetry, wind and current patterns. Model simulations shall be verified by setting up targeted monitoring programs for the relevant indicator parameters (current, depth and pollutants) in the water phase as well as in the sediment.

5.5.2 Links with monitoring and proposed future monitoring program

A physically-based model can be regarded as an intelligent data base, where data and information is organised according to natural laws and logical relationships. In this way the model will also provide documented information as to where additional data is required and it supports the design (parameters, location, frequency, etc.) of supplementary data collection/monitoring programmes.

Hot spots

The present project has identified a number of hot spots, or land based sources (LBS) within a 100 km wide band along the coast line. The hot spots represent a broad variety of pollution problems from industrial discharges, oil/gas production, urban pollution, river inflow and agrochemical residue products.

It is not possible to pay full attention to all hot spots (or Areas of Pollution Concern = APCs) and all problem areas during the present project. It was therefore decided to follow a project approach that will discuss, present and propose appropriate methodologies for:

- Mapping and estimation of major pollution sources (APCs);
- Proposals for typical/demonstration pollution control and remediation actions/feasibility studies; and
- Impact/effect monitoring.

This approach will serve the two main purposes of the current project, namely to address the most significant pollution sources (BIR) and to demonstrate how amelioration projects can be designed for the various key types of pollution problems (RPAP).

The impact monitoring procedure is demonstrated by taking the Khazar oil lake (mazut) as an example of how the interactive modelling and monitoring procedure should be implemented (ref to the PFS-report - *4.6 PFS Mazut Lake Khazar-Chelekan.doc*).

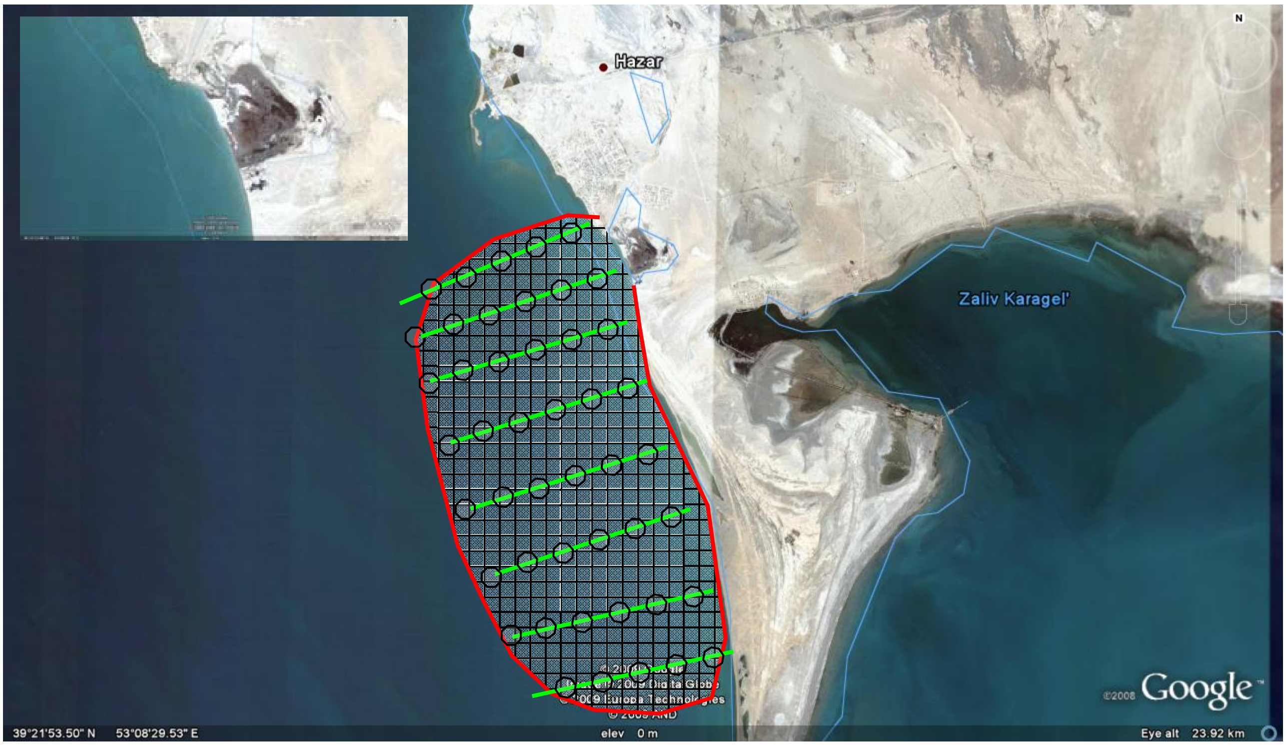


Figure 29, Feasibility project location and example monitoring grid

On the territory of Khazar/Cheleken region there are several areas polluted with crude oil (mazut). Khazar is situated in the coastal zone of the Caspian Sea on the Turkmen side in the territory of Balkan region in the western part of the country. The polluted lake is bordering directly to the coast line (see Figure 29).

Oil-and-gas exploitation and chemical industry are basic economy sectors for this region of Turkmenistan. On the area adjoining to Khazar / Cheleken there are lands and wetland areas polluted with oil. The sites' pollution with oil poses a risk to the coastal zone and leads to the deterioration of ground structure, its acidity rises, the pathogenic germs are accumulated in the soil and a degradation of micro-biologic life takes places.

A full evaluation of the pollution degree of the land areas has not yet been conducted. However, as part of the pre-feasibility study (PFS) it is proposed to carry out an impact assessment and remediation follow-up procedure based in an iterative modelling and monitoring program.

First step in the modelling and monitoring program is to quantify the potential pollution (the extent/volume and character of the source) and the expected influence zone should it happen that the retained oil and chemical residue is discharged to the sea.

Dependent on bathymetry and local wind/current conditions the pollution will be spread over an area around the source. Generally, the concentration will reduce as the mixing over larger and large volumes take place until it reaches the detection level, which then defines the border of the influence zone. For this purpose, a 2D hydrodynamic and water quality model should be applied, using existing bathymetry data and selected scenarios of wind speed and direction. An example of how such an influence could look like is indicated in Figure 29.

The main current direction in this area is from north to south so that the influence area will be asymmetrical and directed towards the southern part of the coastal zone. The waters along the coastline are shallow with a distance to the 5-m depth contour line of 5-10 km. Assuming a significant wave height of 2.2 m off the coast, the closure depth would be in the order of 3-4 m and the distance to the closure depth would be in the order of 3-5 km perpendicular to the coastline as indicated in the figure. Beyond this point pollution will only be transported further away via diffusion. The expected pollution plume in the along shore direction will, however, extent further dependent on the long-shore current conditions as mentioned above. This should, of course, be verified using a calibrated hydrodynamic model.

Once the influence area/volume is determined and the amount of oil and other chemicals estimated (the load), the expected maximum pollution impact (concentration in water and sediment phases) can be estimated by calculating the concentration pattern in the case where all the stored oil and chemicals are discharged into the sea.

Second step is to determine the baseline situation, given that the expected maximum pollution impact is considered critical/significant. The baseline situation shall be based on surveys and monitoring of currents, concentration levels in the water phase and in the sediment, and in varying weather conditions, e.g. one campaign in calm weather and during moderate wind conditions over a period (e.g. 10 m/sec after 8 hours). The location of stations (example shown in the figure) shall be determined from the initial model setup and the parameters (type and frequency) shall, of course, be linked to the type of pollution threat, in this case primarily phenols, TPH and heavy metals.

Third step is to determine the maximum allowable concentration (MAC) level for each of the critical pollutants. These MACs shall be linked to biological/ecological indicators so that also external ecological effects can be taken into account, e.g. if the area is an important spawning ground for various fish species.

Fourth step is to design the remediation actions so that the maximum pollution risk, should it happen, will cause only minor negative impacts, i.e. lead to concentrations below the maximum allowable levels.

Finally, the model and the monitoring program shall be continued during remediation/construction – and in a period after – in order to follow up on the project impact. This important for at least two reasons: (1) control that the project follows the design and functions as planned (and devise correcting measures if required); and (2) collect valuable information and experiences that can be used for similar problems/projects in other locations.

Regional action plan follow up

Development of a regional pollution action plan requires completing a generic set of activities. It is proposed that action plans be prepared for each of the four basins, and the action plans shall cover the following:

1. The baseline situation
2. An assessment of the land-based (coastal zone) pollution load
3. An assessment the exchange of pollutants between the neighbouring compartments, and sedimentation/degradation
4. The maximum allowable concentrations of a set of key indicator pollutants (to be selected during or immediately after the Inception Phase), i.e. the compartment receptor water quality limits
5. An action plan for mitigation of the excess pollution load – given that the external pollution load exceeds the maximum allowable pollution load

The challenge here is to establish the exchange of pollution between compartments and have all five littoral states agree to the size of the actual external pollution load, and to the maximum permissible pollution loads to each compartment. If such agreements can be achieved, then there is a sound and documented basis for actually implementing the action plans identified.

From the modelling presented in this note, it can be concluded that a monitoring program should be systematically designed in order to close the now known information gaps. The water balance is generally well-documented. What is important, though, is to verify the flow (and therefore also flux of pollutants) across the borders between the basins.

One part of an updated monitoring program should therefore be to carry out survey/monitoring campaigns with the purpose of measuring the flow velocity profiles in a number of representative points along the basin boundaries, e.g. 4 between Northern and Middle basin, 3 between Middle and Southern basin, and 2 between the Middle basin and Kara Bogaz Gol, see Figure 30. The current velocity should be measured in 5-10 points in the vertical and in minimum two campaigns: one during calm weather and one during medium wind (e.g. 10 m/s), and in the period from September – October.

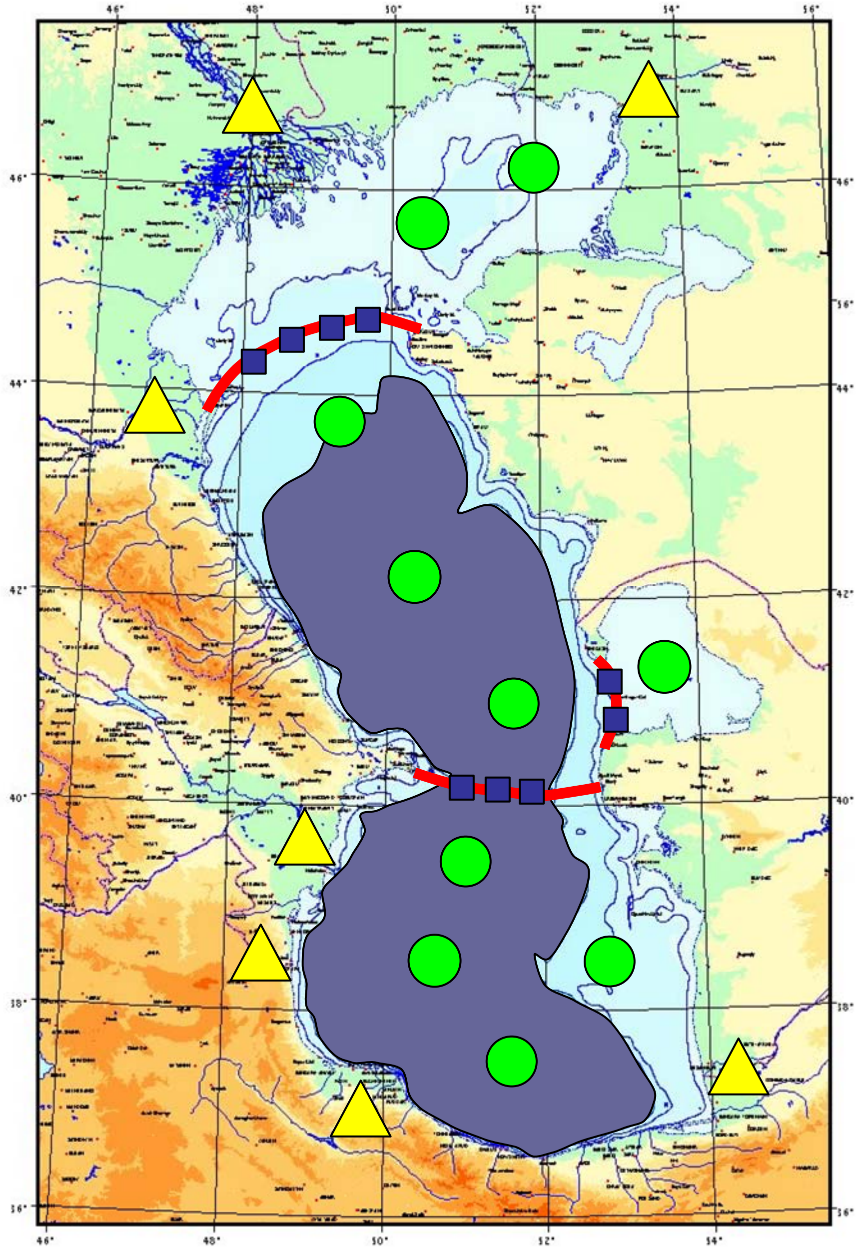


Figure 30, Proposed future monitoring programme for the RPAP. Blue squares indicate locations where the velocity profiles should be measured. Green circles indicate locations for water quality sampling. Yellow triangles indicate location of river stations.

For the purpose of verifying mass balance calculations/modelling, it is proposed that a coordinated monitoring be designed and implemented. This monitoring programme shall concentrate on collecting river data (flow and a set pollution indicators) in the major river tributaries, as close as possible to the outlet into the Sea/basin. Flow and water quality should be measured 4 times over a period of one year: 1 time during high flow, 1 time during low flow and 2 times during average flow.

In parallel, water quality (for the same set of indicator parameters) should be monitored in the four basins (2 stations in the Northern basin, 3 stations in the Middle basin, 1 station in Kara Bogaz Gol and 4 stations in the Southern basin). Water quality samples shall be taken in the same depths and at the same time as the flow measurements (2-4 times per year). It is proposed to focus on the following indicator parameters:

1. Biological Oxygen Demand (BOD) – indicator of organic material
2. Total Phosphorus (TP) – indicator of nutrients
3. Copper (Cu) – indicator of heavy metals
4. Total Petroleum Hydro Carbons (TPH) – indicator of oil products
5. Radon (Ra) – indicator of radio-active substances

It is assumed that meteorological data (precipitation, evaporation, temperature) is collected via the national meteorological monitoring programmes and made available to the future monitoring and modelling program.

Conclusion

The main objective of the modeling exercise has been to demonstrate the usefulness and need of modeling for decision makers around the Caspian Sea. Modeling is an essential tool, complementary to water quality monitoring, in the identification of the impact of pollution sources. It is also a pragmatic tool for monitoring design and feedback, where it can serve as a tool to optimize sampling locations and parameters.

A simple mass balance has been set up by the Caspianmap project. A **model** is only as good as the **data** put into the **model**. The model the project developed had very basic data at its disposal, and can only serve to demonstrate basic concepts. Towards the end of the project the project received further data through its experts from the Institute of Water Problems (Academy of Sciences), Moscow. These data are included in annex 6, and can serve to further refine the model and its assumptions.

6 ACTION PLANNING AND PROTOCOL

6.1 Recommended measures

All Caspian countries are invited to endorse the RPAP as the outcome of the CaspianMAP project, and to take into account its recommendations when updating or reviewing NCAPs or similar policy and programming documents. Countries are also invited to use the RPAP when further developing the Protocol on Land Based Sources under the Tehran Convention

Ideally the scope of the RPAP should include the entire water basin. From practical point of view and as delineation discussed and agreed upon during First Regional Workshop, February 2008, in Ashgabat. The project delineated the geographical scope to a 100 km-zone. However exceptions are made were pollution loads are potentially coming from outside of the 100 km-zone, in such cases the project used the scope of the draft protocol on LBS May 2008: to include all emissions which reach the marine environment through rivers, canals or other watercourses, including groundwater flow, coastal disposals and outfalls, disposal under the seabed with access from land, or through run-off.

Table 10, Delineation of the project, as discussed and agreed upon at First Regional Workshop held February 2008 in Ashgabat.

Regional Pollution Action Plan (RPAP)
Land based pollution sources √ **Point sources:** o **Imported from rivers >100 km upstream from coastline;** o **Generated within the coastal zone, <100 km from coastline:** • **Industrial sources, e.g.:** -**Food and beverage, sector 31** -**Petrol (chemicals, refineries, coal and rubber); sector 35** -**Basic metal industries; sector 37** -**Other manufacturing industry; sector 39** • **Municipal sources (wastewater, sector 40)** • **Land based port and shipyard operations** • **Leakage and flooding of landfills and dumpsites** • **Inherited pollution from land based sources** √ **Non-point sources:** o **Agriculture and storm water runoff** o **Atmospheric deposition** o **Erosion of land** o **Natural pollution sources (volcanoes, etc.)**
√ **Sea borne sources:** o **Oil and gas off shore activities with risks for**

incidents and accidents, including pipelines o Shipping with risks for incidents and accidents

Blue not included, red included

Measures recommended based on the BIR

For the inventoried sources of land based pollution sources, conducted in the Baseline Inventory with participation of national experts, the following activities/measures are strongly recommended: Table 11.

Generally, it is necessary to further quantify the pollution loads. The lack of data sharing and public availability of data on pollution loads, restricted the project in its assessment. Potential pollution sources are therefore identified rather than pollution loads characterized.

Table 11, Measures in the RPAP

Develop harmonised action programmes for the reduction of pollution loads from municipal and industrial point and diffuse sources, including agriculture, urban and other runoff.		
Objective	**Output**	**Activities**
1. Reduction of pollution entering the Caspian **from point sources within 100 km zone:**		
1.1. **Generated within the coastal zone, <100 km from coastline**		
1.1.1. Municipal sources (wastewater)	**SCAP 2.2.2. Pollution prevention, monitoring and control measures** o Reduce untreated discharges from coastal municipal sources.	Municipal sources have been inventoried by project in Baseline inventory report. Below additional recommended activities:

<table>
<tr><td colspan="3">Develop harmonised action programmes for the reduction of pollution loads from municipal and industrial point and diffuse sources, including agriculture, urban and other runoff.</td></tr>
<tr><th>Objective</th><th>Output</th><th>Activities</th></tr>
<tr><td>[list from Baseline Inventory]
Municipal sewerage systems with more than 100 t/yr BOD discharges to the Caspian Sea:
1. RU-DAG: MUE «Sewage treatment facilities» of Makhachkala-Caspiysk town: 610 t/yr
2. RU-DAG: MUE «Buynaksky Vodokanal», Buinaks town: 520 t/yr
3. RU-DAG: MUE «Drainage Sewage Treatment Facilities», Hasavyurt town: 440 t/yr
4. RU-DAG: MUE «Derbentgorvodokanal», Derbent town: 292 t/yr
5. RU-DAG: MUE «City Sewage Treatment Facilities», Izerbash town: 186 t/yr</td><td></td><td></td></tr>
<tr><td>1.1.2. Industrial sources, e.g.:
▪ Food and beverage, sector 31
▪ Petrol (chemicals, refineries, coal and rubber); sector 35
▪ Basic metal industries; sector 37
▪ Fabricated Metal Products; sector 38
▪ Other manufacturing industry; sector 39</td><td>SCAP 2.2.1. Regional strategies for pollution reduction
o Undertake a comprehensive regional inventory of pollution emissions from land-based sources.
o Reduce pollution from existing and decommissioned onshore oil and gas installations causing significant pollution.
o Utilize or promote BAT and BEP, together with the application of, access to and transfer of environmentally sound technology, including cleaner production.</td><td>Inventoried by project in Baseline inventory report

BAT and BEP are promoted during the National Sectoral Workmeetings in Ashgabat, by the project international experts.</td></tr>
</table>

Develop harmonised action programmes for the reduction of pollution loads from municipal and industrial point and diffuse sources, including agriculture, urban and other runoff.		
Objective	**Output**	**Activities**
[priority list Baseline Inventory] ***Industrial wastewater discharge sources with more than 10 t/yr BOD:*** 1. TM: Turkmenbashi Oil Refineries Complex: BOD 829 t/yr (into Soimonov Bay, currently under remediation))		Industrial sources are limited, see Baseline Inventory, or in a regional context less significant 1.TRC is under remediation Annex 4 of the BIR provides proposals for waste water discharge standards
1.1.3. Leakage and flooding of landfills and dumpsites	**SCAP 2.2.1. Regional strategies for pollution reduction** o Undertake by each Caspian State in its coastal zone a survey of the coastal zone with the purpose to identify and characterize major contaminated land sites, and a strategy of pollution mitigation and remediation for areas where the pollution creates concern, for the purposes of the regional strategies of pollution reduction.	o waste disposal/obsolete OGPP are widespread around the Caspian. In several countries remediation projects are ongoing. o The baseline Inventory and RPAP presented potential pilot project for the Cheleken Lake, which could act as an example for the region.
1. KZ: Abandoned and partly submerged oil fields in shallow water at Mangystau oblast 2. TM: Soimonov Bay (cleanup of abandoned waste dumps and rehabilitation of the bay) 3. KZ: Tuhlaya Balka sedimentation tank and infiltration field (industrial wastewater and sludge deposit with ammonium salts, heavy metals, oil products and phenol) 4. KZ: Tengiz oil field, Mangystau oblast: Oily waste and masuted land		Develop feasibility studies, and implement remediation project, based on the proposed pilot project, Capsianmap project

Develop harmonised action programmes for the reduction of pollution loads from municipal and industrial point and diffuse sources, including agriculture, urban and other runoff.		
Objective	**Output**	**Activities**
5. KZ:Karazhambas oil field, Mangystau oblast: Oily waste (16.000 ha, 82,292 m3) 6. RU-DAG: Administration of Derbent city; Municipal Solid Waste polygon : 1,236,000 ton, 4 ha 7. TM: Oil-contaminated ('masutted') land at Hazar/Cheleken 8. RU-DAG: LTD NK Rosneft – Dagneft; Oily waste: 1596 ton at 9 locations; Karabudahkentskiy region, Mahachkala, OGPD 9. RU-DAG:OSA Plant "Dagdiezel" at Kaspiisk: Storage of industrial waste on the territory of the plant (779 ton on territory of the plant 0.05 ha)		Cleanup expected, construction of dyke to halt further erosion, Develop feasibility studies, and implement remediation project, based on the proposed pilot project, Capsianmap project, Remediation project foreseen for summer 2009 by Wet International
1.1.4. Land based port operations		Initiated by the project, however not enough information provided Recommended to assess this in a regional context, and to provide recommendations for environmental sound operations
1.1.5. Inherited pollution from land based sources		Not in scope of project,
1.2. Imported from rivers >100 km upstream from coastline as a lump sum input;	**Recommendations are out of scope Tehran Convention**	The project faced a knowledge gap on this subject. The countries are recommended to gather information on the pollution loads coming from their rivers and to establish a river basin management plan for each river.

Develop harmonised action programmes for the reduction of pollution loads from municipal and industrial point and diffuse sources, including agriculture, urban and other runoff.		
Objective	**Output**	**Activities**
	- River basin management plan for Volga river	Mapping pollution sources Reduction and mitigation actions
	- River basin management plan Kura-Araks river	Idem, with international donor help on its way
	- River Basin management plan Ural river	Idem
	- River basin management plan Samur	Idem
	- River basin management plan Terek	Idem
	- River basin management plan Iranian rivers	Idem
2. Non-point sources:		
2.1. Agriculture and storm water runoff	**Scap 2.2.3: Environmentally sound agricultural practices** o Establish and promote best practice recommendations for the use of agrochemicals, including application times and rates, handling, storage and disposal. o Demonstrate through pilot projects environmentally sound agricultural practices such as soil conservation, protection of surface and groundwater, use of natural fertilizers and use of pest resistant crop strains. o Combat eutrophication in sensitive coastal zones by controlling soil and water contamination from agriculture and other nutrient sources.	
2.2. **Persistent toxic substances (PTS)**	**SCAP 2.6.1. Regional strategies for pollution reduction** o Develop and implement a Regional POPs/PTS Programme, which is to be coordinated with POPs enabling activities in Stockholm Convention signatory states.	Updating Existing programme of Oct 2006 PTS action plan Implemented and incorporated in Nation Plans,

Develop harmonised action programmes for the reduction of pollution loads from municipal and industrial point and diffuse sources, including agriculture, urban and other runoff.		
Objective	**Output**	**Activities**
2.3. Radioactive	Not in scope of Tehran Convention, **to address it as a gap in TC**	Inventory initiated however not from all countries information received. There is a need to assess the radioactive sources of pollution in a regional context.
2.4. Atmospheric deposition	**SCAP 2.2.1. Regional strategies for pollution reduction** o Undertake a comprehensive regional inventory of pollution emissions from land-based sources.	Initiated by the project based on raps, however not assessed in detail due to lack of sufficient information (outdated). There is a need for further inventory
2.5. **Erosion of land**		Not assessed
2.6. Natural pollution sources (volcanoes, etc.)		Not assessed

Develop harmonised action programmes for the reduction of pollution loads from municipal and industrial point and diffuse sources, including agriculture, urban and other runoff.		
Objective	**Output**	**Activities**
3. Sea borne sources:	**Scap 2.3 Pollution from seabed Activities** o Draft and adopt ancillary instruments to the Tehran Convention on the Regulation of Seabed Activities. **2.4. Pollution from Vessels** o Develop port waste management plans for all ports. o Provide adequate vessel waste reception and treatment facilities in all main ports in accordance with port waste management plans. o Reduce pollution from existing and abandoned off-shore oil and gas installations. **2.5. Pollution Caused by Dumping** o Draft and adopt ancillary instruments to the Tehran Convention on dumping at sea by vessels and aircraft Review and report on the occurrence of dumping from vessels and aircraft in the Caspian Sea.	Not in scope of the project
3.1. Oil and gas off shore activities with risks for incidents and accidents, including pipelines	**SCAP 2.4. Pollution from Vessels** o Reduce pollution from existing and abandoned off-shore oil and gas installations.	Inventory of abandoned platforms initiated by the project, no reliable data received.
		Apply zero-discharge principle, drilling mud transported onshore. Azerbaijan collects and treats, but not applied in Dagestan (pilot) and Turkmenistan
3.2. Shipping with risks for incidents and accidents	**SCAP 2.8 Environmental Emergencies** [..]	

Develop harmonised action programmes for the reduction of pollution loads from municipal and industrial point and diffuse sources, including agriculture, urban and other runoff.		
Objective	**Output**	**Activities**
3.3. **Sea borne port operations**		

6.2 CONCLUSIONS

The project inventoried the main Land Based Sources according to delineation given above.

Municipal, industrial and Leakage and flooding of landfills and dumpsites were listed and prioritized. From the short list pilot projects were selected.

Form the Baseline Inventory can be learned that:

- Imported pollution from upstream rivers (>100 km); the largest factor by far.
- Discharge of urban wastewater; the second largest factor.
- Some industrial waste water discharges, actually only in AZ; a quite minor factor.
- Polluted groundwater migration to the sea (mainly oil layers on the groundwater tables at refineries); unknown extent, a factor of questionable relevance.
- Flooding of dumpsites of oily wastes, oil-soaked ('masutted') land, and obsolete oil & gas exploration sites; a big risk and a substantial potential factor.

The project further tried to initiate a wider inventory, including PTS / Airborne and Radioactive substances. However was due to a lack of information and time not able to assess those substances in detail.

General Conclusion on PTS/Airborne/Radioactive

- Lack of information on implementation of PTS action plan of 2006
- Lack of reliable data on Airborne, RAPS give limited and inconsistent information, need for full inventory based on reliable harmonized data from countries (raps not consistent)
- Radioactive, likely not of regional importance, limited sources, all assessed sources are included in State Programmes

Further the project lacked sufficient information of the pollution from ports, which likely were of importance in the selection of the Areas of Pollution Concern, due to its potential as pollution sources.

Also the project could not assess in detail the pollution loads coming from rivers. Generally know are the large inputs of pollutants from Terek, Volga and Kura-Araks.

For the updating of the Areas of Pollution Concern the above mentioned shortcoming limited the experts.

The project appeals to link the sources to impacts, herefore:

- to update the inventory on pollution loads
- to implement a national and regional monitoring programme
- to link those through modelling

To further develop Modelling the following recommendations:

- The baseline situation (monitoring)
- An assessment of the land-based (coastal zone) pollution **load**
- An assessment the exchange of pollutants between the neighbouring compartments, and sedimentation/degradation (monitoring&modelling)
- The maximum allowable concentrations of a set of key indicator pollutants [insert], i.e. the compartment receptor water quality limits
- Further development of the Action Plan for mitigation of the excess pollution load - given that the external pollution load exceeds the maximum allowable pollution load

For the regional strategies, we linked them to the SCAP and future protocols.

Further step has to be made to quantify the pollution loads, rather than qualify sources of pollution, required is:

- facilitation data sharing
- Improvement of National inventories
- Improvement of national control monitoring (capacity building of governmental institutions)

6.3 RECOMMENDATIONS AND KNOWLEDGE GAPS PUT FORWARD IN EARLIER STUDIES:

In the past the following knowledge gaps were identified, the project would like to recall them:

The Transboundary Diagnostic Analyses (TDA), 2002/2007 stated the following findings:

- Low level of information available,
- Lack of sufficient reliable data to assess Water Quality
- Sources of pollution poorly characterized
- Need for monitoring (fisheries, pollution, oceanography)
- River fluxes (desk studies 2006-2007 (Kura-Araks, Volga, Terek) poorly quantified
- Inputs diffuse sources incl. atmosphere, poorly understood
- No comparable estimates of pollution loads and fluxes possible

RAPS/GIWA 2007

- Main effects on habitat and modifications are:
    - Pollution as a result of oil spills and agricultural discharges;
    - Introduction of invasive species
    - Poaching of valuable species
    - Damming and regulation of stream flow of rivers

- Most important sectors
    1. Agriculture (wash in of fertilizers and pesticides into the water bodies and the water withdrawn for irrigation systems
    2. Industrial and transport branches
    3. Energy production

- The causes
    - Poor equipments (old oil wells and pipelines)
    - Availability of cheap and obsolete insecticides and absence on the local market of environmentally acceptable alternatives
    - Absence of facilities to decontaminate ship ballast water tanks and ship hulls
    - Poor expert advice on fish quotas, inadequate laws and administrative regulation and equipment for the above mentioned sectors:
    - Failure to consider environmental factors when regulating the flow of stream and dams;
    - Water withdraws

It's obvious that the countries in a regional context should work on the reduction of the impacts those causes generated.

Review study status of pollution information/institutions in the Caspian region state the following:

- **No well defined ambient contaminant monitoring POPs/PTS**
- QA/QC practice need to be improved, lack of capacity
- Compliance monitoring and pollution control very poor for oil and gas sector
- Biomarker technique not applied
- **Absent or early stage of clean up, monitoring, prevention and control activities**
- No clear organization structure for ambient and compliance monitoring, point and diffuse source pollution control

6.4 Regional elements

Regional aspects of harmonization of approaches and policy/legislation toward prevention, monitoring and compliance/control are briefly summarized below.

Policy/Legislation (addresses prevention, monitoring and control)

1. Gap analysis of the Convention and the Strategic Action Programme

Gaps in the provisions (as well as Annexes and protocols) of the Tehran Convention should be identified, in close cooperation with the countries and project partners. In order to aid in the identification of gaps, lessons learned from other Conventions such as the Helsinki, Barcelona and Black Sea Conventions, as well as the United Nations Convention on the Law of the Non-Navigational Use of Water Courses, should be taken into account.

Final results of the regional assessments should be reported in a report to each of the involved countries in the official languages.

2. Gap analysis of the national legislation as it relates to the Convention and SAP

The existing relevant national legislation, secondary laws and regulations should be reviewed and assessed on their effectiveness.

Following the review and assessment of the national legislation, reviews and assessments of the National SAPs should be carried out in order to make appropriate adjustments in line with the findings of the review of the regional SAP and the national legislative results.

Initially, the review and assessment should make selections of laws and other legal instruments which are currently in force and are relevant. Some of the legislation may be conflicting or overlapping; as such, the legislation must be examined piece by piece, but also as to how the pieces fit together as a whole..

This legislation should also be examined in the context of other pieces of related legislation (those that secure the enforcement of environmental law and of a criminal or administrative nature) in terms of its enforcement and enforceability. Implementation and enforcement of the legislation is largely delegated to the regional governments; as a result, this review and assessment must address these as well.

The final results of the national assessments should be produced in a national report for each country in the official languages.

6.5 Recommendations for harmonizing the legislative basis between the countries or to amend the national requirements to conform to international aspects

Below, recommendations are provided for harmonizing the legislative basis between the countries and for amending the national requirements to mesh with international aspects. The harmonisation recommendations concern i) facilitating the limitation of pollution emissions (prevention); ii) keeping track of the modifications in the Caspian aquatic environment (monitoring); and iii) checking programme(s) for the polluters and ensuring compliance with the permitted emissions (control).

Tehran Convention

The Tehran convention is currently the main regional framework addressing pollution issues.
The Teheran convention dedicate several articles to prevention, reduction and control of pollution: listed below.

Tehran convention

III. PREVENTION, REDUCTION AND CONTROL OF POLLUTION

Article 7. Pollution from Land-Based Sources

1. The Contracting Parties shall take all appropriate measures to prevent, reduce and control pollution of the Caspian Sea from land-based sources.

2. The Contracting Parties shall co-operate in the development of protocols to this Convention prescribing additional measures for prevention, reduction and control of pollution of the Caspian Sea from land-based sources. Such protocols may include, *inter alia*, the following measures:

(a) the emission of pollutants is prevented, controlled and reduced at source through application, *inter alia*, of low- and non-waste technology;

(b) the pollution from land-based point sources is prevented, reduced and controlled through licensing of waste-water discharges by competent national authorities of the Contracting Parties;

(c) licensing of waste-water discharges is based on promoting the use of environmentally sound technology;

(d) requirements stricter than those provided in sub-paragraphs (b) and (c) of this Article, are imposed according to additional protocols to this Convention when the quality of the receiving water or the affected ecosystem of the Caspian Sea so requires;

(e) various treatments are to be applied to municipal waste water and, where necessary, in a step-by-step approach;

(f) in order to reduce organic substances inputs from industrial and municipal sources, the best available environmentally sound technology is to be applied;

(g) appropriate measures based on best environmental practices are to be developed and implemented for the reduction of inputs of organic substances and hazardous substances from non-point sources, including agriculture;

(h) measures on their conservation and full liquidation should be taken for some coastal sources of pollution that continue to have negative impact on the Caspian Sea.

3. If the discharge from a watercourse, flowing through the territories of two or more Contracting Parties or forming a boundary between them, is likely to cause pollution of the Caspian Sea, the Contracting Parties shall co-operate in taking all appropriate measures to prevent, reduce and control such pollution, including, where appropriate, the establishment of joint bodies responsible for identifying and resolving potential pollution problems.

Article 8. Pollution from Seabed Activities

The Contracting Parties shall take all appropriate measures to prevent, control and reduce pollution of the Caspian Sea resulting from seabed activities. They are encouraged to co-operate in the development of protocols to this Convention to that effect.

Article 9. Pollution from Vessels

The Contracting Parties shall take all appropriate measures to prevent, reduce and control pollution of the Caspian Sea from vessels and shall co-operate in the development of protocols and agreements to the Convention prescribing agreed measures, procedures and standards to that effect, taking into account relevant international standards.

Article 10. Pollution Caused by Dumping

1. The Contracting Parties shall take all appropriate measures to prevent, hindrance, reduce and control pollution of the Caspian Sea caused by dumping from vessels and aircraft registered in their territory or flying their flag.

2. The Contracting Parties shall co-operate in the development of protocols to the Convention prescribing agreed measures, procedures and standards to that effect.

3. The provisions of paragraphs 1 and 2 of this Article shall not apply when a vessel or aircraft at sea is threatened by the complete destruction or total loss of the vessel or aircraft or in any case which constitutes a danger to human or marine life, if dumping appears to be the only way of averting the threat, and if there is every probability that the damage consequent upon such dumping will be less than would otherwise occur. Such dumping shall be so conducted as to minimise the likelihood of damage to human or marine life or hindrance to legitimate uses of the sea in accordance with the applicable international and regional legal instruments. Such dumping shall be reported to the Contracting Parties.

Article 11. Pollution from Other Human Activities

1. The Contracting Parties shall take all appropriate measures to prevent, reduce and control pollution of the Caspian Sea resulting from other human activities not covered by Articles 7-10 above, including land reclamation and associated coastal dredging and construction of dams.

2. The Contracting Parties shall take all appropriate measures to reduce the possible negative impact of anthropogenic activities aimed at mitigating the consequences of the sea-level fluctuations on the Caspian Sea ecosystem.

Article 12. Prevention of Introduction, Control and Combatting of Invasive Alien Species

The Contracting Parties shall take all appropriate measures to prevent the introduction into the Caspian Sea and to control and combat invasive alien species, which threaten ecosystems, habitats or species.

Article 13. Environmental Emergencies

1. The contracting Parties shall take all appropriate measures and cooperate to protect human beings and the marine environment against consequences of natural or man-made emergencies. To this end, preventive, preparedness and response measures, including restoration measures, shall be applied.

2. For the purpose of undertaking preventive measures and setting up preparedness measures, the Contracting Party of origin shall identify hazardous activities within its jurisdiction, capable of causing environmental emergencies, and shall ensure that other contracting Parties are notified of any such proposed or existing activities. The Contracting Parties shall agree to carry out environmental impact assessment of hazardous activities, and to implement risk-reducing measures.

3. The Contracting Parties shall cooperate for the setting up of early warning systems for industrial accidents and environmental emergencies. In the event of an environmental emergency, or imminent threat thereof, the Contracting Party of origin shall ensure that the Contracting Parties likely to be affected, are, without delay, notified at appropriate levels.

4. The Contracting Parties shall take all appropriate measures to establish and maintain adequate emergency preparedness measures, including measures to ensure that adequate equipment and qualified personnel are readily available, to respond to environmental emergencies.

Further Regional strategies related to pollution as listed in the Strategic Caspian Action Plan under the Tehran Convention are reproduced in annex 7.2, as well ass given as output in table.4

Acceptance and effective implementation of the Tehran Convention's Strategic Convention Action Programme (SCAP) will be essential in striving towards harmonisation in the Caspian littoral states on approach.

Overall, there are two distinct prescriptions to be discerned from the analysis of regional cooperation (1) the need for increased standardization across the region as measures, methods, and legal standards must be harmonized across the region in order to increase the efficiency of governance institutions; and (2) the need to support increased public involvement mechanisms in the decision making process as public involvement may be satisfactorily permitted in that it is provided for legally, but the saliency of environmental issues must be addressed by raising public awareness if the public is to become actively engaged in the decision making process.

It is clear that steps need to be taken in terms of harmonising for the region in the following fields:

- Facilitating the limitation of pollution emissions (prevention)
- Keeping track of the modifications in the Caspian aquatic environment (monitoring)
- Checking programme(s) for the polluters and ensuring compliance with the permitted emissions (control).

In order to implement solutions to these issues on a regional basis, it is recommended that those involved with implementing the Tehran Convention and the SCAP should emulate the approaches taken by organisations attempting similar challenges in other regions. Examples of good practice are put forth below, in the form of approaches taken and set-up of the Black Sea Commission and the Rhine Commission.

6.6 PROTOCOLS

Under the Tehran Convention a number of protocols are being developed, including a Protocol for the Protection of the Caspian Sea against Pollution from Land-based Sources, which aims to prevent, control, reduce and to the maximum extent possible eliminate pollution of the marine environment from land-based sources and activities in order to achieve and maintain a sound environmental status of the Caspian Sea.

The protocol takes note of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, adopted in Washington, D.C , on 3 November 1995, which is designed to assist states in taking actions individually or jointly within their respective policies, priorities and resources, which will lead to the prevention, reduction, control and/or elimination of the degradation of the marine environment, as well as to its recovery from the impacts of land-based activities.

The protocol is still under discussion. The project expects that this document and the work under the Caspianmap project contribute to the further development and implementation of the protocol.

6.7 EXAMPLES/MODELS OF THE BLACK SEA COMMISSION AND RHINE COMMISSION

International organisations which have shown success in undertaking the coordination of several littoral or riparian states to improve environmental conditions include the Black Sea Commission (BSC) and the Rhine Commission. Below, their approaches, key ideas and organisational set-ups are outlined as examples for further harmonisation in the Caspian littoral states. These organisations, which are all about coordination and cooperation, may be able to cooperate on technical support, such as model support for harmonization of pollutions discharge and emission as related to water quality standards.

The set-up of the organisations and their respective working groups is worth noting, as these working groups bring together experts in the fields in question and address the issues on a regular basis and usually meet in person on an annual basis. The organisations have new work plans drawn up every 1-2 years to ensure that their policy developments are continually translated into priority concrete actions. To name a few specifically, the Advisory Group on Pollution Monitoring and Assessment coordinated by the Activity Center Pollution Monitoring and Assessment in Odessa, Ukraine, as well as the Activity Centre on Land-Based Pollution Sources (LBS) in Istanbul, Turkey, of the BSC, would certainly provide useful to an analogous group to be set up for the Caspian.

Such organizations may also be able to aid in the necessary set-up of a Caspian regional plan for strengthening discharge licensing, compliance monitoring and enforcement of pollution control.

Black Sea Commission (BSC)

The Black Sea Commission (BSC) was established with the signing of the Bucharest Convention in 1995; its permanent secretariat became operational in 2000. This cooperation was strengthened with the signing of the Odessa Ministerial Declaration and the Strategic Action Plan on the Rehabilitation and Protection of the Black Sea (BS-SAP).

The main function of the BSC is to coordinate the concerted actions of the Contracting Parties to the Bucharest Convention to safeguard the Black Sea and improve the status of its ecosystem.

The objectives of the Commission in the implementation of the Convention are in particular:

- To prevent pollution by hazardous substances or matter;
- To prevent, reduce and control the pollution from land-based sources;
- To prevent, reduce and control the pollution of the marine environment from vessels in accordance with the generally accepted rules and standards;
- To prevent, reduce and control the pollution of the marine environment resulting from emergency situations;
- To prevent, reduce and control the pollution by dumping;
- To prevent, reduce and control the pollution caused by or connected with activities on the continental shelf, including exploration and exploitation of natural resources;
- To prevent, reduce and control the pollution from or through the atmosphere;
- To protect the biodiversity and the marine living resources;
- To prevent the pollution from hazardous wastes in transboundary movement and the illegal traffic thereof; and
- To provide the framework for scientific and technical co-operation and monitoring activities.

Although the lack of clear environmental targets has been well recognized as a negative aspect of the Convention and the BS SAP, the Commission has established the main targets for Black Sea rehabilitation within the Danube/Black Sea process and the relevant MoU (Brussels, November 2001) which are as follow:

- Strategic target: to achieve environmental conditions in the Black Sea similar to those seen in the 1960s.
- Intermediate target: to prevent the increase of pressures from human activities when transitional economies of the Black Sea coastal states begin to recover.

The BSC has granted the EU observer status in the Bucharest Convention, with the idea being for the EU to become a full member of the Convention in the medium term. International support has also occurred through the Black Sea Environmental Programme (BSEP, 1993) and the Black Sea Recovery Project (BSERP, 2002), funded by the Global Environment Facility (GEF), EU and other partners.

The beneficiary countries are all members of the International Maritime Organisation (IMO). Georgia became a member in 1993; Moldova in 2001; Ukraine in 1994, and the Russian Federation in 1958. The IMO puts forth new pieces of legislation which should be implemented by its member countries, such as the new Convention on the discharge of ballast water.

The BSC cooperates with its regional institutional framework of six Regional Activity Centres (RACs):

- Environmental Safety Aspects of Shipping (Varna, Bulgaria)
- Biological Diversity (Batumi, Georgia)
- Environmental Aspects of Management of Fisheries and Other Living Resources (Constanta, Romania)
- Integrated Coastal Zone Management (Krasnodar, Russia)
- Control of Pollution from Land-Based Sources (Istanbul, Turkey), and
- Pollution Monitoring and Assessment (Odessa, Ukraine).

Seven Advisory Groups and three ad-hoc Working Groups are also involved in Black Sea work at present.

Advisory Groups (AG)

- **ESAS**: AG on the Environmental Safety Aspects of Shipping
- **PMA**: AG on Pollution Monitoring and Assessment
- **LBS**: AG on Control of Pollution from Land-Based Sources
- **IDE**: AG on Information and Data Exchange
- **ICZM**: AG on the Development of Common Methodologies for ICZM
- **CBD**: AG on Conservation of Biological Diversity
- **FOMLR**: AG on Environmental Aspects of Fisheries and Other Marine Living Resources

Ad-hoc Working Groups (WG)

- WG on the Water Framework Directive
- Danube/Black Sea Joint Technical WG
- State of the Environment WG

The basis for wider cooperation is provided for in the BS-SAP; cooperation currently includes:

- Cooperation between the BSC and the International Commission for the Protection of the Danube River (ICPDR);
- Participation in the Danube-Black Sea Task Force (DABLAS);
- Cooperation with the European Environmental Agency (EEA);
- Acting as Coordination Unit for the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS);
- Cooperation with the Helsinki Commission (HELCOM);
- Cooperation with the EU Joint Research Centre (JRC) in Italy, and
- Cooperation with United Nations Environment Programme, Global Plan of Action (UNEP GPA).

The main strengths of the BSC are in its official status, well developed rules and procedures (although some need further development), well-established links and connections with the expert community in the region, developed network of subsidiary bodies (optimization needed), its financial sustainability and hence – its independence, its relations with the major players on the international environmental field, and the opportunities (not always realised, but they still exist) provided by the created partnerships.

Black Sea Strategic Action Plan (BS-SAP)

The Black Sea Strategic Action Plan (BS-SAP), signed in 1996 by the Ministers of the Environment of the Black Sea states is a comprehensive document laying out priority activities for the rehabilitation and protection of the Black Sea. It is a result of political will at the highest level for protecting the Black Sea and has proven to be an important milestone for joint activities in the Black Sea area. The Strategic Action Plan sets objectives related to reduction of pollution from land-based sources, riverine inputs and maritime pollution; recovery of the Black Sea Eco-system and sustainable development of the coastal states. The implementation of the BS-SAP is an enormous challenge for the Black Sea countries as it requires political will, supported by improved administrative capacity and considerable investments in the environment sector. Success also depends on combining basin wide efforts with national activities in the Black Sea states, as well as support by recognized international organizations

and financial institutions.

Rhine Commission (ICPR)
For the benefit of the Rhine and of all waters running into the Rhine, the members of the International Commission for the Protection of the Rhine (ICPR) – Switzerland, France, Germany, Luxemburg, the Netherlands and the European Commission successfully co-operate with Austria, Liechtenstein and the Belgian region of Wallonia as well as Italy. Nine states and regions in the Rhine watershed closely co-operate in order to harmonize the many interests of use and protection in the Rhine area. Focal points of work are sustainable development of the Rhine, its alluvial areas and the good state of all waters in the watershed.

Working- and expert groups with clearly defined mandates work on all relevant technical issues arising from the implementation of the Convention on the Protection of the Rhine and from European law. Decisions are taken in the annual plenary assembly. The Conference of Rhine Ministers takes decisions in matters of political importance and establishes the basis for coherent, co-ordinated programmes of measure.

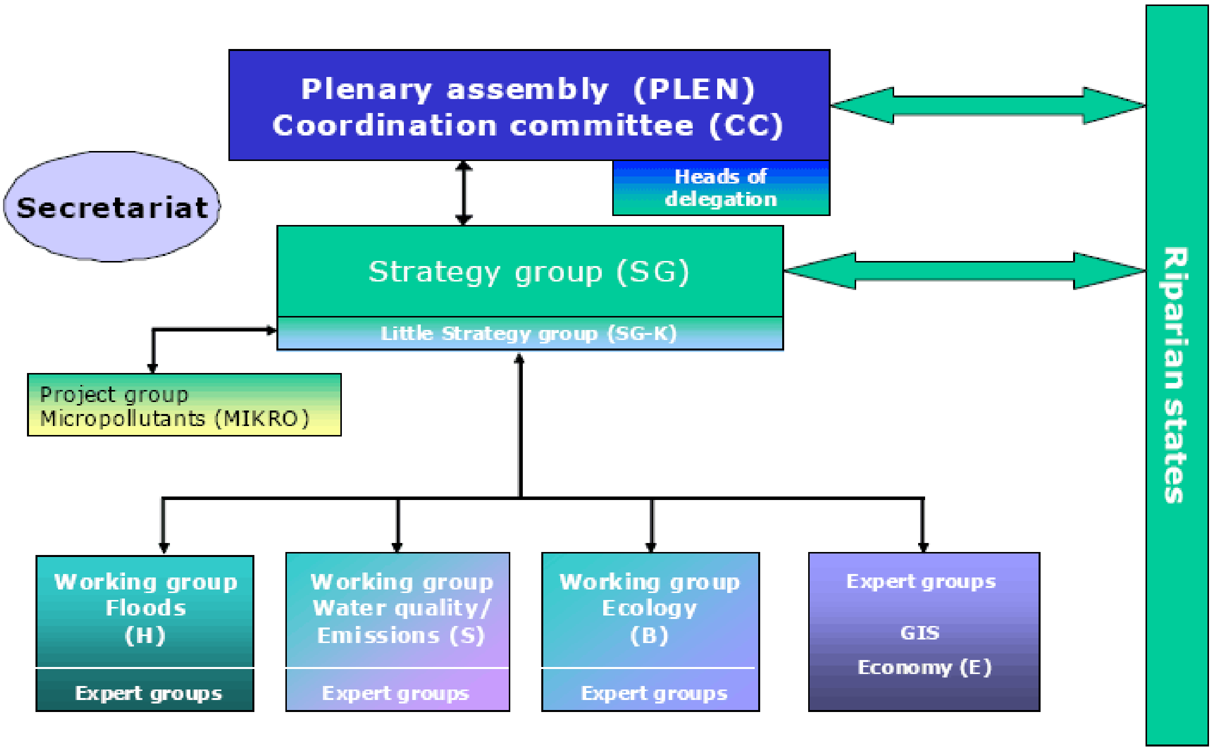


Figure 31, Organogram of the Rhine Commission

6.8 POLICY OPTIONS AND RELEVANT EU LEGAL FRAMEWORK

EU legal framework could act as an example of regional cooperation and provide the countries with policy options to come to a cleaner Caspian Sea.

The **policy options** recommended to reduce negative impacts in the Caspian region can be grouped into a few clusters.

- Establishing and strengthening regulations to control environmentally damaging activities in the region

- Establishing and/or strengthening the control of the sale of prohibited chemicals on the local market;
- Strengthening the control of leaks from active and blocked oil wells and oil pipelines
- Re-organizing and strengthening organizations responsible for regulation of fishing activities in the region.

For this cluster, national and local authorities are responsible and should supply finances to come from national and local budgets.

- Creation or refurbishment of facilities
    - Refurbishment of old oil wells and pipelines;
    - Renovation of old water purification systems;
    - Creation of special sanitary facilities for decontamination of vessels.

EU Water Initiative (EUWI)

At the 2002 World Summit for Sustainable Development in Johannesburg (WSSD), the EU launched a Water Initiative (EUWI) designed to contribute to the achievement of the Millennium Development Goals (MDGs) and WSSD targets for drinking water and sanitation, within the context of an integrated approach to water resources management. The EUWI is conceived as a catalyst and a foundation on which future action can be built to contribute to meeting the water and sanitation MDGs. It is not a funding mechanism. It has a series of aims:

- Reinforce political commitment to action
- Improve efficiency through co-ordination of existing and future activities
- Make water governance effective, by building institutional capacity, providing expertise and knowledge, promoting new partnerships, involving all stakeholders
- Support regional co-operation and action programs to stimulate sustainable development and conflict prevention
- Identify additional financial resources and mechanisms and ensure sustainable financing.

The EUWI uses a modular or building block approach. It puts together a cluster of building blocks that assist in bringing different stakeholder activities within a common framework. The EUWI aims to add value to ongoing activities within the EC and EU Member States to improve collaboration with partners in other regions. It seeks to provide an enabling environment for complementary actions within the thematic areas. A set of demonstration projects helps to provide examples of good practice.

The EUWI is based on a participative multi-stakeholder approach. Various strategic partnerships in specific regions draw together government, civil society, private sector and other stakeholders. A number of working groups has been established. Working groups have either a regional/thematic focus (e.g. Water Supply and Sanitation in Africa) or they concentrate on cross-cutting issues (e.g. Research, Finance). An advisory board and a steering group ensure coherence of all EUWI activities.

The EUWI is an innovative attempt to focus increased attention on water-related issues, embracing a broad selection of stakeholder interests and concerns, for purposes of social and economic development and protection of the environment. Its immediate actions are to:

- develop an overview of the situation of different regions and countries with an analysis of major gaps and accompanying organisational, knowledge and financial needs,
- prepare a coordinated action programme with a long term-financial strategy providing concrete benchmarks and building blocks until 2015,
- establish a monitoring and reporting mechanism to measure progress in implementation and to steer further action, and
- prepare a work programme for the following years, with specified targets and responsibilities.

The "EU Water Initiative – EECCA Component" is a partnership that seeks to improve the management of water resources in the EECCA region (Eastern Europe, Caucasus and Central Asia). The partnership was established between EU and the EECCA countries at the World Summit for Sustainable Development in 2002.

The partnership is intended to build on and reinforce existing partnerships and bilateral and regional programmes by bringing partners with related water activities together within a common framework. It is open to all stakeholders – governments, inter-governmental organisations, NGOs, academia, financing institutions, the private sector, and others.

6.9 RECOMMENDATIONS

The planning of the regional measures for water quality improvement in the Caspian Sea requests reliable estimates of expected effects of emission control on water quality improvement. Recovery of the ecological status in regional scale can be only achieved if the pollution loads are less than recipient capacity in the compartments of the sea. Therefore the CaspianMAP recommends the measures as follows

1. The Caspian Sea should be divided into subdivisions for ambient monitoring purposes. The subdivision must be based on physical-geographical conditions as well as ecological sensitivity and regional importance for bio-reproduction and bio-diversity.

2. The maximum allowable pollution concentrations in the subdivided sections must be assessed and agreed by the countries based on the recipient capacities of the sea sections.

   Set of key pollutant indicators for regional assessment of the ecological state of the water body can be

   Biological Oxygen Demand (BOD) – indicator of organic material
   Total Phosphorus (TP) – indicator of nutrients
   Copper (Cu) – indicator of heavy metals
   Total Petroleum Hydro Carbons (TPH) – indicator of oil products
   Radon (Ra) – indicator of radio-active substances

3. The list of pollution sources of regional concerns incl. the major parameters of the pollution loads should be continuously updated. The list of pollution sources should be subdivided according the Caspian Sea sections.

   The regular quantitative update of areas of regional pollution concern should cover at least

   Land based pollution sources

   Point sources as
   - Transported by rivers from reaches beyond the 100 km zones upstream from coastline;
   - Generated within the 100 km coastal zone
     - Industrial sources, e.g.
     - Municipal sources
     - Land based port and shipyard operations
     - Leakage and flooding of landfills and dumpsites
     - Inherited pollution from land based sources

   Non-point sources as
   - Agriculture
   - Storm water runoff
   - Atmospheric deposition
   - Erosion of coastal zone
   - Natural pollution sources

Sea borne sources as

- o Oil and gas off shore activities with risks for incidents and accidents, including pipelines
- o Shipping with risks for incidents and accidents

4. The regular quantitative evaluation and follow-up of the water quality status of the Caspian Sea should go along the procedure as below

   4.1. Quantifying the pollutions (the extent/volume and character of the source) and the expected influence zones

   4.2. Determining the baseline situation, given that the expected maximum pollution impact is considered critical/significant. The baseline situation shall be based on surveys and monitoring of currents, pollution concentration levels in the water phase and in the sediment.

   4.3. Setting up the maximum allowable concentration (MAC) level for each of the critical pollutants. These MACs shall be linked to biological/ecological indicators so that also external ecological effects can be taken into account, e.g. if the area is an important spawning ground for various fish species.

   4.4. Designing the remediation actions assuming maximum pollution risks.

   4.5. Continuing the evaluation program during remediation/construction phase and after in order to follow up on the project impact. The follow-up assessment necessary (i) to control that the project follows the design and functions as planned (and devise correcting measures if required); and (ii) to collect valuable information and experiences that can be used for similar problems/projects in other locations.

5. Monitoring program should be systematically designed in order to cover

   5.1. water balance elements such as river runoff, precipitation, evaporation

   5.2. flow and fluxes of pollutants between the sea compartments:
      5.2.1.1. surveying / monitoring campaigns with the purpose of measuring the flow velocity profiles in a number of representative points along the compartments
      5.2.1.2. measuring the current velocity in 5-10 points in the vertical and in minimum two campaigns: one during calm weather and one during medium wind (e.g. 10 m/s), and in the period from September – October.

6. Methodological developments are necessary in order to assess the impact of pollution sources on environment in the Caspian Sea, recipient capacities and the relation between the land-based sources (LBS) and the water and sediment quality. The application of assessment methods should progress from simplified models to more advanced systems in parallel with the access to an expanding and adequate database as well as in harmony with the competence development of personnel being able to handle advanced system.

7. Cooperation in methodological development and quantitative assessment works should be structured incl.

   7.1. The cooperation plan should be developed and agreed incl. objectives, organizational pattern and time schedule.

   7.2. The cooperative institutional partners in the Caspian countries must be appointed.

   7.3. Leading institute for developing the methods and models as well for managing the database and handling the assessment works must be appointed in one of the Caspian Countries.

7 CONCLUSIONS

This study, which is the Regional Pollution Action Plan for the Caspian Sea (RPAP), has been prepared within the project "*Caspian Water Quality Monitoring and Action Plan for Areas of Pollution Concern's (CaspianMAP)".*

The overall objective of the current project is to achieve improved quality of the marine and coastal environment of the Caspian Sea. In particular, the RPAP (current Report) provides recommendations to regional strategies for pollution reduction, with a focus on the identified *Areas of Pollution Concern* while the other particular aim of the project was to support the development of a regionally coordinated water quality monitoring program.

As a first phase of the RPAP works, the earlier studies were analyzed for purpose inter alia to reveal the trends in environmental state vs. pollution loads in the Caspian Sea. The main regional studies were Rapid Assessment of Pollution Sources (RAPS) and Trans-boundary Diagnostic Analysis (TDA) along with some other studies.

The RAPS explored the main sector activities and root causes responsible for pollution in the coastal waters of the Caspian Sea and its freshwater deltas. RAPS revealed that one of the primary immediate causes of habitat and community modification in the Caspian Sea. Pesticides are considered the most deleterious pollutants and "**hot spots**" can be found in the dense agricultural areas of river deltas and along the coast of Iran. Oil pollution is currently a localized problem but could become a significant threat in the future due to the expanding oil exploration activities in the Caspian.

The Transboundary Diagnostic Analysis (TDA) assessed the water-related environmental issues and problems of the Caspian Sea region and then identified and quantified, their causes and also analyzed both environmental and economic their impacts. The analysis involved an identification of causes and impacts at national, regional, and global levels and the socio-economic, legal, political and institutional context within they occurred and provided the technical basis for the development of the National Caspian Action Plans (NCAPs) and the Strategic Action Programme (SAP). There were two TDA studies made (2002 and 2007).

A revision of the TDA of 2002 was completed at the end of 2007. The revision concluded that the decline in biodiversity was continuing and the transboundary issue of decline in environmental quality remains a priority concern. It was also concluded that little information was available, despite the existence of this information within some government sectors and the regional scientific community. Other studies (e.g, "Status of Pollution Information / Institutions in the Caspian Region prepared by Reza Sheikholeslami in 2005) concluded that more information was needed for a better assessment of Status of Pollution Information and Institutions in each Caspian littoral states. When TDA was revised in 2006-2007, some progress has been achieved in this respect by preparing some desk studies for the Kura-Araks, Volga and Terek River. However, these studies cover neither the Ural nor Iranian rivers and these gaps in TDA exist even today.

While considering the rivers as point sources of pollution in the assessment it could be concluded that pollution load from rivers is a mayor factor.

The current RPAP noted that environmental impacts of oil and gas activities were seen as negative in the past with pollution and risks human health and for biota. The historical observations commonly showed high levels of hydrocarbons, particularly phenols, in the water column but recent analysis cannot verify these earlier values, and in general the water quality has reached an internationally acceptable level in most parts of the Caspian Sea. However, hot spots can occur at locations such as in

- vicinity of leaking capped oil wells;
- areas where water level rise has encroached on well oiled soils;
- Baku Bay, where major spills have occurred over a century;
- Hazar, in Turkmenistan where near-shore activities date back to more than 100 years;
- Makhachkala, where oil transport and storage takes place; and some other locations.

Persistent Toxic Substances (PTS) in the Caspian Sea represents a potential threat to the environment. Under the auspices of the CEP a Regional PTS Action Plan was prepared in October 2006, as it was one of the four major transboundary areas of environmental concerns identified in the first phase of CEP with regards to the anthropogenic impacts on the Caspian waters.

The CaspianMAP team initiated an inventory of radioactive substances and airborne pollutants. This initiative has reached a limited success due to lack of up-to-date information because beside the RAPS of 2005 no inventory in a regional context on airborne pollution has been carried out. Thus, there is a need for a regional inventory of radioactive substances. The delegates of Russian Federation proposed during the Final Workshop held in July 28-29th 2009 in Ashgabat, not to present the basic inventory on airborne sources due to the outdated data.

The CaspianMAP project has made a review of Land Based Sources of pollution, building upon the results of activities already carried out in the CEP and other initiatives, and making use of the PRAG network that was initially established under the CEP. The output of this exercise is to become a contribution to the further development of the protocol on Land Based Sources of the Tehran Convention.

A desk Baseline Inventory of the land-based pollution sources in the Azerbaijan, Kazakh, Russia and Turkmen sectors has been conducted based on the recent RAPS Reports (2007). Contributions and reviews were given by designated National Experts (LSE). The Baseline Inventory summarized the identified pollution sources of the BIR and added information on current programmes aiming to reduce the pollution impact or elimination as a pollution source. It also added the CaspianMAP expert view on the need for further investigation, including recommendations.

The Priority Investment Programme developed under the CaspianMAP project was limited to land-based point sources of pollution concern by agreement with the client (EU TACIS) and the beneficiaries (country representatives of the riparian states) on delineation of activities. List of major sources of pollution was identified per riparian country based on the previous CaspianMAP Baseline Inventory Report. Out of this list a shortlist of ranked regional priority pollution sources was distilled on basis of which a priority investment programme was established.
The investment programme includes some identified ‘Hotspots’ as well as some smaller but exemplary cases of pollution of concern which can act as examples for similar pollution sources scattered all over the coastal zone of the Caspian Sea. The selected pollution sources are worked out as pilot projects at pre-feasibility level to enable further development and possible international financing. The listed projects have been discussed and agreed with the local counterparts of the CaspianMAP by the National Experts assigned under the project. An assessment of the capital investment cost and service costs was made.

CaspianMAP noted that the quantitative assessments of pollution in regional scale ceased at the time break up of the Soviet Union. As a consequence, all the others activities (monitoring, implementation of assessment methods and development competence), which could make possible fulfilling such works also were terminated. At the same time, different projects performed AND internationally financed during the last decennium made a number qualitative / descriptive studies of pollution loads in the Caspian Sea. The CaspianMAP project considered that the next phase should already focus on qualitative assessments, which could give base for planning of monitoring, assessing the effects of potential protection measures and revealing the major points for regional co-operations. Therefore, it was decided apply a conceptual method, which can work with extremely limited database, easy to set up and simply to use.

The ultimate objective of the numerical modelling was to demonstrate applying a preliminary simple water and mass balance model for the Caspian to check the consistency of exiting data, to highlight the main points of the future regional monitoring and to draw the attention of the national experts to the usefulness of numerical assessments. The current (demo) assessment work was divided into five phases:

- preparing data input
- augmenting missing data
- setting up the model
- numerical modelling
- evaluating the results

The model and results presented that even a simple model can assist in environmental planning and management. Particularly, pollution source and effect identification and quantification are pivotal in the development of pollution action plans and in the follow up on such action plans during and after implementation.

The CaspianMAP project has identified a number of hot spots, or land based sources (LBS) within a 100 km wide band along the coast line. To update the list of hotspots, the identified pollution sources (BIR 2009) have been verified against existing state programmes, as given by National Experts. An extended table summarized the identified pollution sources of the BIR and adds information on current programmes aiming to reduce the pollution impact or elimination as a pollution source. It also contained the CaspianMAP expert view on the need for further investigation, including recommendations: The hot spots represent a broad variety of pollution problems from industrial discharges, oil/gas production, urban pollution, river inflow and agrochemical residue products. However, it was not possible to pay full attention to all hot spots (or Areas of Pollution Concern = APCs) and all problem areas during the present project. It was therefore decided to follow a project approach that will discuss, present and propose appropriate methodologies for:

- Mapping and estimation of major pollution sources (APCs);
- Proposals for typical/demonstration pollution control and remediation actions/feasibility studies; and
- Impact/effect monitoring.

This approach served the two main purposes of the current project, namely to address the most significant pollution and to demonstrate how amelioration projects can be designed for the various key types of pollution problems (RPAP).

Development of a regional pollution action plan requires completing a generic set of activities. It is proposed that action plans be prepared for each of the four basins, and the action plans shall cover the following:

6. The baseline situation
7. An assessment of the land-based (coastal zone) pollution load
8. An assessment the exchange of pollutants between the neighbouring compartments, and sedimentation/degradation
9. The maximum allowable concentrations of a set of key indicator pollutants (to be selected during or immediately after the Inception Phase), i.e. the compartment receptor water quality limits
10. An action plan for mitigation of the excess pollution load – given that the external pollution load exceeds the maximum allowable pollution load

The challenge here is to establish the exchange of pollution between compartments and have all five littoral states agree to the size of the actual external pollution load and to the maximum permissible pollution loads to each compartment. If such agreements can be achieved, then there is a sound and documented basis for actually implementing the action plans identified.

From the modelling presented, it can be concluded that a monitoring program should be systematically designed in order to close the now known information gaps. The water balance is generally well-documented. What is important, though, is to verify the flow (and therefore also flux of pollutants) across the borders between the basins.

For the inventoried sources of land based pollution sources, conducted in the Baseline Inventory with participation of national experts, were strongly recommended to further quantify the pollution loads, to promote sharing and public availability of data on pollution loads, to identify continuously update potential pollution sources, to develop harmonised action programmes for the reduction of pollution loads from municipal and industrial point and diffuse sources, including agriculture, urban and other runoff. The specific measures recommended are placed in extended table of the RPAP.

The RPAP – before the Recommendations – presents some international organizations as well as EU directives as well as policy options, which experiences of could be applied in the Caspian Sea region – of course – modifying to the specifics of the region.

8 COLOPHON

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Caspian Water Quality Monitoring and Action Plan for Areas of Pollution Concern
TACIS/2005/109244

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APPENDIX 1 Reproduction of the PTS action Programme

	Objective / actions to meet the objective	2007	2008	2009	2010	Costs US$
1	**Create and implement a regional legal instrument on PTS**					
1.1	Analyse text of the draft Protocol on Protection of the Caspian Against Pollution from LBS and identify existing gaps with regard to its capacity for PTS management					5,000
1.2	Draft additional text to be included in the Protocol					5,000
1.3	Negotiate and adopt the amendment to the Protocol					50,000
1.4	Launch implementation of the Protocol in the five littoral countries					200,000
						260,000
2	**Prevent / mitigate PTS releases from large industrial pollution sources with major potential to pollute the Caspian sea**					
2.1	Analyze relevant BAT & BEP documents and the reachable performance levels for PTS emissions					5,000
2.2	Propose PTS emission limits, based on BAT&BEP and /or BAT& BEP to be used, and draft additional text to be included in the LBS Protocol					10,000
2.3	Negotiate and adopt the amendment to the Protocol					50,000*[i]
2.4	Launch implementation of the Protocol in the five littoral countries					200,000*
						15,000
3	**Prevent / mitigate releases from PCBs containing equipment located in the near Caspian region**					
3.1	Analyse text of the draft Protocol on Protection of the Caspian Against Pollution from LBS and identify existing gaps with regard to its capacity for PCBs management					5,000
3.2	Draft additional text related to PCBs /PCBs containing equipment to be included in the Protocol					5,000
3.3	Negotiate and adopt the amendment to the Protocol					50,000*
3.4	Launch implementation of the Protocol in					200,000*

[i] Costs, which are markrd with an asterix* are included in an another action programme

	Objective / actions to meet the objective	2007	2008	2009	2010	Costs US$
	the five littoral countries					
3.5	Implement targeted awareness raising activities in countries where the awareness on the PCBs issue is still low					20,000*
3.6	Regional capacity building activities to manage PCBs and PCBs containing articles in environmentally sound manner					100,000*
3.7	Feasibility study on possible regional approach for final disposal of PCBs[ii]					250,000
						260,000
4	**Prevent / mitigate impact of shipborne pollution and accidents at sea**					
4.1	Initiate activities to negotiate a Protocol to the Framework Convention to Prevent / Mitigate Impact of Ship-born Pollution and Accidents at Sea					20,000
4.2	Analyze appropriate international standards and IMO Conventions					30,000
4.3	Draft text of the Protocol					30,000
4.4	Negotiate and adopt the Protocol					50,000
4.5	Launch implementation of the Protocol in the five littoral countries					200,000
						330,000
5	**Strengthen / equalise capacity in the region related to PTS issues**					
5.1	Capacity building on Industrial pollution prevention and control					100,000
5.2	Capacity building on safe management of PCBs and PCBs containing equipment					100,000
5.3	Capacity building on best practices to safeguard stores of obsolete pesticides and for environmentally sound destruction/disposal of POPs pesticides					100,000
5.4	Capacity building on risk assessment and risk management of contaminated sites					100,000*
5.5	Capacity building on environmentally sound decontamination / clean up options for contaminated sites and the respective decision making process					100,000*
5.6	Capacity building on POPs monitoring					100,000
5.7	Capacity building on set up of a centralized PTS database and information management system					50,000

[ii] Should be implemented together with action 8.6 Feasibility study on possible regional approach for final disposal of POPs pesticides

	Objective / actions to meet the objective	2007	2008	2009	2010	Costs US$
5.8	Capacity building on public awareness	■				100,000*
						450,000
6	**Create and implement a regionally agreed PTS monitoring program**					
6.1	Agree on a minimum set of core data to be obtained from all regions and used as the baseline	■				50,000
6.2	Elaborate and put in place guidelines on standard procedures for sampling, sample treatment, analysis and reporting of the core data	■				50,000
6.3	Secure that core baseline data are obtained in compliance with this guidelines		■			500,000
6.4	Identify laboratories in all littoral countries to be part of the regular regional PTS monitoring programme and strengthen their capacity as necessary		■			100,000*
6.5	Obtain commitment of all littoral countries for sustainable funding of regular monitoring of the identified core data as a minimum		■			50,000
6.6	Maintenance of the centralized PTS database		■			30,000
6.6	Implement QA/QC procedures for the monitoring programme and identify reference laboratory(ies) to organize inter-laboratory testing		■			100,000
						780,000
7	**Prevent illegal use and trade with POPs pesticides**					
7.1	Initiate cooperation of customs authorities on prevention of unauthorised imports and use of POPs pesticides	■				50,000
7.2	Propose effective measures to prevent unauthorised imports and use of POPs pesticides	■	■			30,000
7.3	Launch implementation of measures to prevent unauthorised imports of POPs pesticides	■				50,000
7.4	Identify minimum measures and best practices to safeguard stores of obsolete pesticides to prevent unauthorized entrance	■				100,000*
7.5	Implement pilot projects to render obsolete pesticide stores safe		■	■	■	500,000*
7.6	Implement targeted awareness raising	■	■			120,000**

	Objective / actions to meet the objective	**2007**	**2008**	**2009**	**2010**	**Costs US$**
	activities on possible hazards connected with use of illegal pesticides					
7.7	Promote integrated pest management					60,000**
						130,000
8	**Clean up of stores of obsolete POPs agrochemicals located in the near Caspian region and ESD of the obsolete stocks**					
8.1	Draft additional text to be included into the LBS Protocol as reference to stores of obsolete pesticides					5,000
8.2	Negotiate and adopt the amendment to the Protocol					50,000*
8.3	Develop regional criteria for prioritizing of the stores					50,000
8.4	Identify minimum measures and best practices to safeguard stores of obsolete pesticides to prevent unauthorized entrance[iii]					100,000
8.5	Implement pilot projects to render obsolete pesticide stores safe					500,000
8.6	Feasibility study on possible regional approach for final disposal of POPs pesticides[iv]					250,000
						905,000
9	**Clean up sites contaminated with PTS having major potential to pollute the Caspian Sea**					
9.1	Develop regional criteria for prioritizing of the sites and identify regional priority sites					50,000
9.2	Implement capacity building activities targeted to risk assessment and risk management of priority contaminated sites					100,000
9.3	Implement capacity building activities on environmentally sound decontamination / clean up options and on the respective decision making process					100,000
						250,000
10	**Raise awareness about potential hazards due to PTS in the general public**					
10.1	Elaborate awareness raising module on hazards connected with stores of obsolete pesticides and how to avoid them					5,000
10.2	Elaborate awareness raising module on					5,000

[iii] FAO documents and guidelines may be used
[iv] Should be implemented together with action 3.7 Feasibility study on possible regional approach for final disposal of PCBs

	Objective / actions to meet the objective	2007	2008	2009	2010	Costs US$
	hazards connected with contaminated sites and how to avoid them					
10.3	Elaborate awareness raising module on hazards connected with transformer oils and how to avoid them					5,000
10.4	Elaborate awareness raising module on hazards connected with uncontrolled burning of waste and how to prevent them					5,000
10.5	Elaborate awareness raising module on legal framework and practical policies for prevention and control of PTS (for policy makers, local and regional authorities)					10,000
10.6	Elaborate awareness raising module on appropriate managerial procedures for safe handing of PTS (for managers)					10,000
10.7	Training of trainers to implement the above modules on national levels					60,000
						100,000
11	**Establish infrastructure for environmentally sound storage and destruction / disposal of POPs**					
11.1	Elaborate regional criteria and guidance for environmentally sound temporary storage of POPs waste					60,000
11.2	Elaborate feasibility study[v] to explore possibilities of regional approach for POPs disposal, considering obsolete POPs pesticides and PCBs					100,000
11.3	Elaborate a project proposal for regional approach to environmentally sound temporary storage and final disposal of POPs waste (pesticides, PCBs) in the Caspian Region					200,000
11.4	Seek international donors for implementation of the above project					
11.5	Capacity building on environmentally sound storage and destruction/disposal options of POPs waste and the decision making process on the above					80,000
						440,000
12	**Prevent / mitigate impact of large oil spills from exploitation, transport, processing and accidents**					
12.1	Analyse text of the draft Protocol on					8,000

[v] Also the feasibility studies elaborated in 3.7 and 8.6 should be considered

	Objective / actions to meet the objective	2007	2008	2009	2010	Costs US$
	Protection of the Caspian Against Pollution from LBS and the Protocol concerning regional preparedness, response and cooperation in combating oil pollution incidents, and identify existing gaps with regard to their capacity for oil pollution prevention and mitigation					
12.2	Draft additional text to be included in the respective Protocols					8,000
12.3	Capacity building					80,000
						96,000
	GRAND TOTAL					**4,016,000**

Appendix 2. Baseline Inventory Report

Caspian Water Quality Monitoring and Action Plan for Areas of Pollution Concern

Baseline Inventory Report

Land-based point and non-point pollution sources in the Caspian Coastal Zone

Contract No.: TACIS/2005/109244
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Author: Ary de Koning

Position: KE4, Industrial Engineer

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CONTENTS **PAGE**

ABBREVIATIONS AND ACRONYMS

ACL	Admissible Concentration Limit
AE	Associate Expert
AZ	Azerbaijan
BAT	Best Available Techniques
BOD	Biological Oxygen Demand
CCPC	Caspian Centre for Pollution Control
CEP	Caspian Environment Program
COD	Chemical Oxygen Demand
CTIW	Complex Treatment of Industrial Waste
DPSIR	Driving forces, Pressures, States, Impacts and Responses
EIA	Environmental Impact Assessment
ELV	Emission Limit Value
EU	European Union
GIS	Geographic Information System
GIWA	Global International Waters Assessment
IA	Industrial Association
IR	Iran
IRR	Internal Rate of Return
KE	Key Expert
KZ	Kazakhstan
LE	Local Expert
LSE	Local Sector Expert
MAD	Maximum Allowable Discharge
MBAS	Methylene Blue Active Substance
mcm	million cubic meters
MSW	Municipal Solid Waste
MUE	Municipal Utility Enterprise
MUP	Municipal Utility Plant
NCAP	National Caspian Action Plan
OGPA	Oil and Gas Producing Activity
OGPP	Oil and Gas Production Plant
PAH	Poly-Aromatic Hydrocarbons
PM	Pro Memory (to be filled in later)
PS	Pollutant Substances
PSAS	Persistent Surface Active Substances (same as SSAS)
PTS	Persistent Toxic Substances
PUE	Public Utility Enterprise
RAPS	Rapid Assessment of Pollution Sources
RPAP	Regional Pollution Action Plan
RU	Russia
RWQMP	Regional Water Quality Monitoring Plan
SAP	Strategic Action Program for the Caspian Sea
SP	Sources of Pollution
SSAS	Synthetic Surface Active Substances
TACIS	Technical Assistance Commonwealth of Independent States
TRC	Turkmenbashi Refinery Complex
TM	Turkmenistan
ToR	Terms of Reference
TPH	Total Petroleum Hydrocarbons
TPS	Thermal Power Station
TSS	Total Suspended Solids
WWTP	Waste Water Treatment Plant

EXECUTIVE SUMMARY

OVERALL OBJECTIVE OF THE PROJECT:

The broad overall objective is to justify actions aiming an improvement quality of the marine and coastal environment of the Caspian Sea through the Caspian Environment Program (CEP).

SPECIFIC OBJECTIVES OF THE PROJECT:

1. Develop and implement a regional water quality-monitoring program RWQMP focused on critical contaminants and hotspots; and
2. Undertake a comprehensive land-based source assessment and develop a regional action plan RPAP to remediate areas of pollution concern identified.

General and Specific Objectives of KE4 (Industrial Engineer):

General:

The Industrial Engineer is responsible for feasibility and pre-feasibility studies on pollution amelioration initiatives identified in the project. Due attention must be paid to the environmental monitoring and pollution amelioration problems, faced by economies in transition. The importance of environmental management ownership for calculating the impact of various scenarios must be articulated. A strong contribution must be delivered to the driver/pressure/state/impact and response mechanisms in the DPSIR approach, with emphasis on drivers and response.
The Industrial Engineer is Task Leader for the following output:

- √ **Output c (feasibility studies of selected projects) under Task 5: Production of RPAPs.**

Specific Objectives:

1. Conduct a Baseline Inventory of concerned pollution sources.
2. Liaise with KE3 (Senior Environmental Management Expert) for making water quality assessments based on numerical amalgamation with hydro-physical data.
3. Assess impact on water quality and DPSIR analysis.
4. Prepare selection of priority sources and mitigating scenarios.
5. Work out a ToR for pilot pre-feasibility studies for selected scenario's based on application of BAT techniques.
6. Prepare an Inventory Report and presentation for the First Regional Workshop in Ashgabat.

This report deals with the results of the Baseline Inventory and preliminary priority setting of the concerned land-based pollution sources in the Caspian Coastal Zone.

Main Findings and Results of the baseline inventory

A desk Baseline Inventory of the land-based pollution sources in the Azerbaijan, Kazakh, Russia and Turkmen sectors is conducted based on the recent RAPS Reports (2007). This had left quite some inquiries for Local Sector Experts (LSE) to be answered. The reactions of the LSE's have been received in the course of the first half year of 2008 and are incorporated in this report.
The results of the desk baseline study can be summarized as follows:

Azerbaijan Sector:

- 3 main sources of municipal wastewater discharge (>100 t/yr BOD)
- 6 main sources of industrial wastewater discharges (>10 t/yr BOD and/or 1 t/yr oil)
- 3 "hotspots" of oily waste dump.

Kazakh Sector:
- no significant sources of municipal wastewater (discharge direct or indirect into the Caspian Sea is prohibited)
- no significant sources of industrial wastewater discharges (discharge direct or indirect into the Caspian Sea is prohibited)
- 8 "hotspots" of industrial waste dump of which 6 oily waste and 2 toxic industrial waste.

Russian Sector:
- 7 main sources of municipal wastewater discharge (>100 t/yr BOD)
- no significant sources of industrial wastewater discharges (>10 t/yr BOD and/or 1 t/yr oil)
- 4 significant "hotspots" of industrial waste dump (3 oily waste and 1 phosphorous sludge), 2 large municipal solid waste (MSW) landfills and many scattered small industrial and municipal solid waste dumpsites.

Turkmen Sector:
- no significant sources of municipal wastewater (discharge into desert land)
- 3 possible significant sources of industrial wastewater discharges (no pertinent data, will be further investigated)
- 3 "hotspots" of industrial oily waste dump.

ToR for pilot pre-feasibility studies for selected scenario's
The tentative list of priority scenarios for mitigating measures is as follows:
1. Untreated municipal wastewater discharge (>100 t/yr BOD)
2. Untreated industrial wastewater discharge (>10 t/yr BOD and/or 1 t/yr oil)
3. "Hotspot" with oily waste dump and/or obsolete oil & gas production installations
4. "Hotspot" with industrial toxic waste dumpsite.

For these scenario's a generic format for a pilot ToR of (Pre-)Feasibility Study, and Outlines for such studies were prepared as guideline for further activities in this field.

1 BASELINE INVENTORY OF CONCERNED POLLUTION SOURCES

1.1 Introduction

A review and summary has been made of all available documents: RAPS for all countries; NCAPs for Kazakhstan, Russia (brief), and Turkmenistan; CCPC on Data Collection Scheme, Pollution Load Database and GIS Development; and CEP-SAP on Pollution Load Inventory of the Caspian Sea. Most RAPS (except Tm) include besides pollution loads of individual enterprises also aggregated pollution loads from the following sectors:

31 Food
35 Petrol
37 Metal
39 Other Manufacturing industries
40 Sewage

This data has not yet been extracted as the focus was on inventory of point sources.

This information has been incorporated in the first version of this report. This version has been commented by the National Sectoral Experts and this second version of the report is adjusted accordingly.

The collected information is included in the attached revised inventory lists of priority pollution sources in the coastal zones of the riparian countries (Annexes 1-4). This second collection of baseline data is still not fully complete because some information was not available or could not be made available.

1.2 Inventory Results of the Azerbaijan Sector

1.2.1 General

The available RAPS[1] has been reviewed and relevant data are extracted and summarized in Annex 1.

The RAPS Study of Azerbaijan Sector of the Caspian Sea coast was conducted in order to identify the most acute environmental problems, prioritise negative impacts and provide an assessment of general condition of the environment.

The report is systematically built up and presents per municipality data on river flows, wastewater discharges, air emissions and waste disposal. In total 27 sources of wastewater discharge are listed of which 7 are selected for the priority list based on their BOD load (> 100 t/yr for municipal wastewater and >10 t/yr for industrial sources), 4 of them discharge BOD loads > 100 t/yr.

Further a number of 3 'hotspots' are identified, varying from oily waste dumpsites to oily rocks

The following priority sources of pollution have been identified.

1.2.2 Urban and Industrial water pollution sources

Municipal sewerage systems with more than 100 t/yr BOD discharges to the Caspian Sea:

- Govsan canal (Baku- Surakhani)
- Zykh Treatment Stations (Baku-Hatai)
- Kishly sewerage outlet (Baku-Hatai)

Industrial wastewater discharge sources with more than 10 t/yr BOD:

[1] Rapid Assessment of Point and Dispersed Pollution Sources (Raps) in the Caspian Regione of Azerbaijan Republic; Baku, 2007

- Rubber Synthesis (Sumgait)
- Organic Synthesis Plant (Sumgait)

1.2.3 Sources of pollution by scattered waste disposal

So far the following 3 sites have been identified, but detailed information for prioritization has not yet been provided by the Local Sector Expert fro Azerbaijan.

1. OGPP Bibi-Heybatneft (Baku-Sabail/Absheron): vulnerable to flooding and hazardous areas; reinstatement and rehabilitation of the territory of the suspended OGPP (1st stage). During the 2nd stage treatment facilities will be constructed which will completely eliminate discharges in the marine environment.
2. Oily Rocks at Pirallahi, Jilov and Gum Adasi islands: construction of treatment facilities.
3. Waste dumpsite of Sumgayit: decontamination and secure disposal of mercury containing waste.

These projects, specifically no. 1, may come under Absheron Rehabilitation Program (ARP), for which recently a World Bank loan of USD 164 million has been approved.
The ARP has 3 components:
ARP I: Contaminated Sites Rehabilitation Project (USD 74.5 mln)
ARP II: Integrated Solid Waste Management Project (USD 29.5 mln)
ARP III: Large Scale Oil Polluted Land Cleanup Project (USD 60 mln).

The ARP I Contaminated Sites Rehabilitation Project will support the Environment State Program to curtail environmental degradation in the Absheron Peninsula, by assisting in decontamination of former iodine production sites and the development of a strategy for remediation/containment of Naturally Occurring Radioactive Materials (NORM) contaminated sites. The project will also provide support to develop institutional capacity for the cleanup of former oil production sites.

The ARP II Integrated Solid Waste Management Project will support the State Environment Program to curtail environmental degradation in the Absheron Peninsula. It will support the reform of the Greater Baku solid waste collection and disposal operations into an effective and sustainable system in the fields of:

(i) improving environmental conditions at the existing waste disposal sites
(ii) building-up operational, management and communication capabilities
(iii) rollout of collection services, and
(iv) data collection and planning.

The ARP III Large-Scale Oil Polluted Land Cleanup Project will support the State Environment Program to curtail environmental degradation in the Absheron Peninsula, by improving:

(i) the State Oil Company of Azerbaijan Republic's (SOCAR) capacity and effectiveness in environmental management and in cleaning up of oil-polluted land in the Absheron Peninsula, and
(ii) the quality of soil conditions in oil-polluted lands cleaned up under the project.

These projects are currently (July 2008) under international tendering. For this reason the polluted sites on the Absheron Peninsula have not been evaluated and are not included in the priority list of pollution sources of concern.

1.3 Inventory Results of the Kazakhstan Sector

1.3.1 General

The available RAPS[2] has been reviewed and relevant data are extracted and summarized in Annex 2. The RAPS is not complete and up to standard, and a lot of comments of the CEP still has to be addressed. Nevertheless the following observations could be made.

Besides the contaminations from Volga and Ural rivers, the Caspian Sea has a lot of negative impacts from flooded oil wells.
There are 19 oilfields with 1485 oil wells in the coastal zone of the Caspian Sea, including 148 in the flooded zone. These oil wells belong to the State.
In the context of realization of the Republican program “Liquidation and conservation of self-pour outing oil wells” insulating works were implemented in 2004 on 5, in 2005 on - 7 and in 2006 on - 12 oil wells (In total 24 out of 148).

1.3.2 Point sources of wastewater

- There are no direct discharges of untreated municipal and industrial wastewater to the Caspian Sea because it is completely prohibited by national legislation.
- All untreated wastewaters are discharged to evaporation ponds and filtration fields. Some of these are located close to the Caspian Sea and could thus be a source of diffuse emission by groundwater exchange or flooding. This has to be surveyed in the field and by monitoring of local coastal waters.
- The total volume of discharged wastewater into the Caspian Sea, treated to standard, amounts to 820,138,000 m^3/a. The remaining pollution load of this wastewater is not given in the RAPS and should be assessed or estimated. The results should be put in the Summary Table as presented in Annex 2.
- The situation is not clear of two industrial enterprises ”Atyrau Oil Refinery Plant” and “Maek-KazAtomProm” as listed in the Summary Table 1 of Annex 2. This has to be clarified, completed and concluded by LE4.

1.3.3 Sources of pollution by waste disposal

The flowing sites are identified as sources of waste oil disposal:

- Uzen oil fields
- Zhetybai and Kalamkas oil fields
- Karazhambas oil field
- Zhetybai and Kalamkas
- Karazhanbas

The following sites are sources of other waste contamination:

- Koshkar-Ata tailing site (uranium tailings)
- Tuhlaya Balka sedimentation tank and infiltration field (industrial wastewater and sludge deposit with ammonium salts, heavy metals, oil products and phenol).

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2 The rapid assessment of point and diffuses pollution sources in the Kazakhstan sector of the Caspian Sea; Almaty 2007

1.4 Inventory Results of the Russian Sector

1.4.1 General

The available RAPS[3] has been reviewed and relevant data are extracted and summarized in Annex 3. The RAPS is quite complete and up to standard and contains a comprehensive data file of SP's.
The RAPS report covers the following sections:

- Astrakhan Oblast
- Republic of Dagestan
- Republic of Kalmykia.

The report is systematically built up and is presented with the data for every administrative unit: river flows, wastewater discharges & pollutants, emissions of pollutants by stationary SP's and waste disposal. It appears that no individual wastewater discharges of industries are listed.
The main reason is reprofiling & closing down industrial enterprises, development of the circulating & sequential water supply & discharge of waste water into the swage system. Data on 23 sources of discharge is provided, including contaminated waters, directly into the Caspian Sea & to the surface water bodies, which have a run – off into the Caspian Sea, according to the amount & types of PS's in the contaminated run – offs.

1.4.2 Municipal SPs of polluted water discharge

Municipal sewerage systems with more than 100 t/yr BOD discharges of polluted waste waters to the Volga delta

- Northern facilities for waste water treatment, MUE «VODOKANAL» of Astrakhan town
- Southern facilities for waste water treatment, MUE «VODOKANAL» of Astrakhan town
- MUE «BUYNAKSKY VODOKANAL», Buinaks town
- MUE «DERBENTGORVODOKANAL», Derbent town
- MUE «CITY SEWAGE TREATMENT FACILITIES », Izerbash town
- MUE «DRAINAGE SEWAGE TREATMENT FACILITIES», Hasavyurt town
- MUE «Sewage treatment facilities» of Makhachkala-Caspiysk), Makhachkala town.

1.4.3 Sources of pollution formed by waste accumulation

RAPS did not show in the full volume specific places of landfills of oil waste of operated – off oil & gas wells. One more major source was marked – unofficial landfill of industrial & household waste in the Astrakhan oblast.

In April – May 2008 local experts conducted work on identifying accumulated wastes of operated – off oil & gas wells located on the Caspian coast & inflowing rivers (drilled pits & oil pits contain the following: drilling bit cuttings, drilling fluids, waste of suspensions & oil products mixture, oil containing waters, oil sludge & stratum contaminated with oil products & many others.

Besides that, a number of industrial project sites were specified, on the territory of which various types of industrial activity have been accumulated. For instance, the following waste was accumulated on thermal – electrical heating stations: operated-off mercury containing lamps & lead accu-

[3] Rapid Assessment of Pollution Sources (RAPS), Point and Diffuse in the Near Caspian Region of the Russian Federation; Moscow, 2006

mulators, sand contaminated with oil products (15 % and more petrol), spent engine oil, steam-turbine oil & di-electrical oil (possibly containing PCBs which are still in use), metal junk of ferrous metal & non-ferrous metal & others.
The list of mentioned project sites is provided in Tables 2 & 3 of Annex 3.

The following possible 'hotspots' are identified by the LSE:

Astrakhan Oblast

CJSC "Nature Protection Complex "Eco+"
52,200 ton oily waste, 0,14 ha; Industrial sites of village of Ilyinka, Ikryaninskiy region

RPC "Astrakhanskiy" branch LTD LUKOIL "Nizhnevolzhskoil product"
40,000 ton oily waste; Ikryaninskiy region

Republic of Dagestan

LTD NK Rosneft – Dagneft
Oil products: 1596 ton, 0,15 ha; Karabudahkentskiy region, Mahachkala, OGPD

Administration of Mahachkala city
1 MSW polygon: 2,682,750 ton, 5 ha
(2. MSW polygon: 112,000, 17 ha)

Administration of Derbent city
MSW polygon : 1,236,000 ton, 4 ha

Administration of Kizlyar city
(MSW polygon: 16,500 ton, 4 ha)

OSA "Dagfos", plant of salt of phosphorus
Waste from sludge collector: 80,000 ton, 3.2 ha

1.5 Inventory Results of the Turkmenistan Sector

1.5.1 General

The available RAPS[4] has been reviewed and relevant data are extracted and summarized in Annex 4. The RAPS is quite complete and up to standard,
Besides the RAPS there are 2 major reconstruction projects ongoing:

- Restauration of Soimonov Bay and TRC refinery
- Master Plan for Cheleken

There seems no need to include Soimonov Bay in the TACIS project as the existing project is already started and funded out of oil revenues (managed by Emerol).
The Chelekan plan will have to be further investigated to see if some suitable 'hotspot' projects can be identified. The AE and country LE4 are charged with the follow-up.

4 Report Rapid Assessment of Pollution Sources (RAPS), Point and Diffuse in the Near Caspian Region (Turkmenistan); Ashgabat, 2007

1.5.2 Urban and Industrial water pollution sources

Reportedly there are no discharges to the Caspian Sea of municipal sewerage systems (all urban waste water is directed to inland receptors (infiltration fields).
The only remaining industrial sources are:

- Thermal Power Station (TPS) - City of Turkmenbashi
- “Garabogassulfate” IA (Garabogas)

But The TPS is discharging low polluted cooling water and treated wastewater, thus it seems no priority source of water pollution. The Garabogas Sulfate Plant discharges wastewater with mainly mineral salts (chloride and sulfate), so again no priority source of water pollution.

1.5.3 Sources of pollution by waste disposal

So far the following 3 Oil & Gas Exploration sites have been identified, but detailed information for prioritization is missing and will be collected by the LE:

- Nebitdagnebit OGPA
- Goturdepe OGPA
- Gumdagnebit OGPA.

1.6 Constraints and Recommendations

The RAPS reports were quite different in lay-out and presentation, not always provided with summary tables (especially Kz), and sometimes poorly translated, what made review difficult and quite time-consuming.

2 PRIORITY SETTING OF CONCERNED POLLUTERS

2.1 General

The initial priority macro pollutants[5] form land-based sources for the Caspian Sea are:

- Oil products (TPH)
- Phenols
- Ammonia (NH_4)
- Nutrients: total nitrogen (TN) and total phosphorus (TP)
- Surfactants (PSAS/SSAS/MBAS)
- Heavy metals (Fe, Mn, Zn, Ni, Cu, Pb, *Cd, V, Be, Sr, Cr, Hg*)

(Source: GIWA Regional Assessment 23, Caspian Sea, 2006; and Korshenko 'The Caspian Sea Environment; Springer Verlag 2005)

Specific attention has been paid to the identification and quantification of discharge sources of the above referred pollutants besides the general urban wastewater pollutants of importance such as BOD, COD and TSS.

2.2 DPSIR Methodology

The main 'drivers' for the DPSIR analysis of land-based pollution sources are:

1. Imported pollution from upstream rivers (>100 km); the largest factor by far.
2. Discharge of urban wastewater; the second largest factor.
3. Some industrial waste water discharges, actually only in Az; a quite minor factor.
4. Polluted groundwater migration to the sea (mainly oil layers on the groundwater tables at refineries); unknown extent, a factor of questionable relevance.
5. Flooding of dumpsites of oily wastes, oil-soaked ('masutted') land, and obsolete oil & gas exploration sites; a big risk and a substantial potential factor.

Drivers 1, 2 and 3 can be quantified and prioritized by a weighing method based on pollution load and harmfulness of the pollutants, but drivers 4 and 5 can only be prioritized on extent (area, volume, depth) and exceeding of arbitrary quality standards for groundwater and soil.

2.3 Proposed Priority Setting Methodology for Point Sources

The proposed priority-setting model for urban and industrial pollution sources (by weighing factor for harmfulness of major pollutants) is following:

A certain pollutant, preferably with an ELV of 1 such as phenols, will be set as norm to 'weigh' the pollution loads of all other parameters with an dimensionless weighing factor given by ELV_n/ELV_i, in which is ELV_n is the Emission Limit Value of the 'norm' parameter and ELV_i is the Emission Limit Value of parameter i. Thereafter the 'weighted' emission loads will be summarised. The results will show the pollution sources with their total weighted pollution loads what enables to rank them in order of the ascending total pollution load.
This method is however only applicable for point sources with a regular wastewater discharge such as urban and industrial wastewater discharges of which the pollutant concentrations are known.

[5] Micro pollutants like Persistent Toxic Substances (PTS) such as pesticides, poly-aromatic hydrocarbons (PAH), poly-chlorobifenyls (PCB), and dioxins are under other CEP projects and excluded from this project.

The Emission Limit Values (ELV) per priority pollutant for discharge of wastewater should be derived from the applicable legislation per country and per type of receiving water.
An indicative list of typical wastewater discharge standards is presented in Annex 5.
The following table presents an example of applying this methodology on a few imaginary industrial enterprises.

Table 2.1: Example calculation of priority factors

Calculation of weighted emission loads

Pollutant	ELV (mg/l)	Discharge load (t/yr) per company			Weighted load (t/yr)		
		A	B	C	A	B	C
Lead	0.500	1.0		0.3	100.0		30.0
Mercury	0.005	0.1		0.1	500.0		1,000.0
Copper	2.000	3.0	5.0	1.0	75.0	125.0	25.0
Cadmium	0.200	0.5		0.5	125.0		125.0
Total P	5.000		10.0	3.0	0.0	100.0	30.0
Total N	10.000		30.0	3.0	0.0	150.0	15.0
Nitrate	50.000		60.0	10.0	0.0	60.0	10.0
Phenols	1.000			1.0	0.0		50.0
BOD_5	50.000	60.0	600.0	90.0	60.0	600.0	90.0
Surfactants	15.000			5.0	0.0		16.7
TPH	10.000			100.0	0.0		500.0
Total		**64.6**	**705.0**	**213.9**	**860.0**	**1,035.0**	**1,891.7**

Company A = e.g. Metallurgical plant
Company B = e.g. Food processing mill
Company C = e.g. Metal engineering factory

Priority Setting per point source according this method has been carried out for the Azerbaijan, Russian and Turkmen Sector inventories, as listed in the respective country reports. The results are presented in Annex 7. For Kazakhstan no significant point sources were identified (no direct or indirect discharge into the Caspian Sea).

2.4 Drivers for Priority Setting of Hot Spots

In a plenary workshop with the local sector experts in July 2008 the prioritization method of the inventoried hot spots was discussed. As most important driver besides the pollution potency, it was generally thought by all participants that the attention should be primarily focused on (historical) polluted sites in the coastal zone (maximum 10 km from the sea of river) without current owner, so that the community has to pay for remediation, such as:

√ Abandoned and obsolete Oil & Gas Production Plants (OGPP);
√ Abandoned chemical plants and waste dumpsites from former Soviet era;
√ Malfunctioning, overloaded or absent urban wastewater treatment plants;
√ Unsecured (historic) landfills of municipal solid waste;
√ Scattered dump sites of oily waste and other hazardous industrial waste;
√ 'Masutted' land caused by oil spills, wastewater infiltration ponds and illegal dumping.

For the selection of pilot projects for pre-feasibility studies an additional set of criteria was proposed, such as:

√ Not being included in some other national or international remediation project (to avoid double or unnecessary work).

√ Acting as 'model function' for each of the following pollution sectors:
- urban wastewater discharge;
- industrial wastewater discharge;
- uncontrolled dumpsites of municipal or industrial waste;
- Oil polluted land ('masutted' soil).

√ Considerable but comprehensible in extent and character (not too big or complex to loose view and control).

√ Interested and cooperative 'problem-owners' to get access to information and obtain constructive involvement.

In the actual selection and prioritization of pollution areas of concern these criteria were applied.
For the results of the prioritization and selection of pilot sites is referred to the attached Minutes of the Workshop (refer Annex 8).

2.5 Constraints and Recommendations

Given the limited resources of the MAP project it is recommended to limit the pre-feasibility studies to 4 or 5 pilot sites that can function as 'model' for other similar projects.

3 TOR FOR PILOT PRE-FEASIBILITY STUDIES FOR SELECTED SCENARIO'S

3.1 General

The requested Output of a "ToR for preparation of pilot pre-feasibility studies for selected scenario's" had to be limited to a generic ToR because no concrete mitigating scenarios have been developed yet. However outlines of some most probable general mitigating scenarios could already being prepared.

3.2 Results and Findings

A generic ToR for preparation of pilot pre-feasibility studies and three Feasibility Study Outlines have been prepared for:
1. Point sources of wastewater (municipal)
2. Point sources of wastewater (industrial)
3. Scattered sources of oil pollution (dumpsites, 'masutted' soil and obsolete OGPP's).

The ToR and the outlines for the Feasibility Study Report are presented in Annex 6.

3.3 Required Project Resources

The required disciplines and estimated man power input per study are:
1. International Industrial Engineer (KE4): 5 days
2. International Associate Expert (AE): 15 days
3. Local Environmental Sector Engineer: 15 days
4. Local Costing Specialist (civil engineering and mechanical works): 15 days
5. Local Economist: 5 days.

4 COLOPHON

Client	:	Tacis
Project	:	Caspian Water Quality Monitoring and Action Plan for Areas of Pollution Concern
File	:	A4270.10.010
Length of report	:	14 pages
Author	:	Ary de Koning
Contributions	:	LE4 of AZ, KZ, RU and TM
Project Manager	:	Gijs Kok
Project Director	:	Winfried Pietersen
Date	:	14 August 2008
Name/Initials	:	

Annex 1: Inventory of priority pollution sources in the Azerbaijan Sector

Summary of RAPS Azerbaijan

Source: Rapid Assessment of Point and Dispersed Pollution Sources (Raps) in the Caspian Region of Azerbaijan Republic; Baku, 2007

Inventory of pollution sources of concern

Urban and Industrial wastewater sources

The RAPS contains a rather comprehensive inventory of 27 wastewater discharges to the Caspian Sea of both municipal and industrial sources. The results of an initial selection (municipal sewerage systems with more than 100 t/yr BOD discharge and Industrial sources with more than 10 t/yr BOD discharge) show 9 sources of concern as indicated in the attached Table 1.

Sources of waste disposal and obsolete oil and gas exploration sites

OGPP Bibi-Heybatneft in Baku Sabail district has been operating since 1870; its area is 526.8 hectares; it is an environmental hotspot. According to decree 1697 of the President of Azerbaijan Republic dated 28.09.2006, the Integrated Action Plan to Improve Environmental Situation of Azerbaijan Republic for 2006-2010 includes activities to improve the environmental situation in OGPP Bibi-Heybatneft: rehabilitation of onshore and offshore hydro-technical and engineering facilities, as well as reinstatement and rehabilitation of the territory of OGPP (1st stage). During the 2nd stage treatment facilities will be constructed which will completely eliminate discharges in the marine environment.

Baku bay stretches far inland between spits Sultan, Bailov and Shihov. Many industries are located here; most of them quite close to the coastline. In Baku, at the quaysides of the 20th site communications, pump stations, yards and jetties are flooded. Industrial and agricultural facilities are partially or completely flooded. OGPP Bibi-Heybat in Absheron is considered to be one of the most vulnerable to flooding and hazardous areas.

Sumgayit was a major Soviet industrial center housing more than 40 factories manufacturing industrial and agricultural chemicals. These included synthetic rubber, chlorine, aluminium, detergents, and pesticides.
Partly treated sewage is being discharged into the Baku Bay, and mercury-contaminated sludge (from chlor-alkali industries) has been dumped uncontrolled.
The government of Azerbaijan has obtained international support for the economic and environmental rehabilitation of the city from several United Nations organizations, including the United Nations Development Programme (UNDP) and the World Health Organization (WHO). The UNDP helped to create the Sumgayit Centre for Environmental Rehabilitation (SCER) to research and prioritize the environmental problems and propose programs to address them.
In 2003, the World Bank launched a project for the cleanup of a chlorine producing plant where tons of mercury were spilled, including the construction of a secure landfill. Other international projects funded by UK and Japan have also been implemented.
Reports indicate that only 20% of Soviet Era polluting factories are still operating and there are ongoing debates about closure of the remaining number. However, even if all the polluting industries are dealt with, there remains a significant legacy clean-up challenge.

Recently a World Bank loan of USD 164 million has been approved for the ‘Absheron Rehabilitation Program’ (ARP).
The ARP has 3 components:
ARP I: Contaminated Sites Rehabilitation Project (USD 74.5 mln)
ARP II: Integrated Solid Waste Management Project (USD 29.5 mln)

ARP III: Large Scale Oil Polluted Land Cleanup Project (USD 60 mln).

The ARP I Contaminated Sites Rehabilitation Project will support the Environment State Program to curtail environmental degradation in the Absheron Peninsula, by assisting in decontamination of former iodine production sites and the development of a strategy for remediation/containment of Naturally Occurring Radioactive Materials (NORM) contaminated sites. The project will also provide support to develop institutional capacity for the cleanup of former oil production sites.

The ARP II Integrated Solid Waste Management Project will support the State Environment Program to curtail environmental degradation in the Absheron Peninsula. It will support the reform of the Greater Baku solid waste collection and disposal operations into an effective and sustainable system in the fields of:

(v) improving environmental conditions at the existing waste disposal sites
(vi) building-up operational, management and communication capabilities
(vii) rollout of collection services, and
(viii) data collection and planning.

The ARP III Large-Scale Oil Polluted Land Cleanup Project will support the State Environment Program to curtail environmental degradation in the Absheron Peninsula, by improving:

(iii) the State Oil Company of Azerbaijan Republic's (SOCAR) capacity and effectiveness in environmental management and in cleaning up of oil-polluted land in the Absheron Peninsula, and
(iv) the quality of soil conditions in oil-polluted lands cleaned up under the project.

These projects are currently (July 2008) under international tendering. For this reason the polluted sites on the Absheron Peninsula have not been further evaluated and are not included in the priority list of pollution sources of concern.

A summary of sources of pollution by waste disposal in the Azerbaijan Sector is presented in Table 2.
The pollution concentration in important rivers due to storm water run-off is presented in Table 3.

Environmental Action Plan

Based on NCAP and SAP priorities, the Ministry of Ecology and Natural Resources developed an Action Plan which was submitted to the Government of the Republic; the President of Azerbaijan Republic issued a decree dated 28.09.2006 which approved the “Integrated Action Plan to Improve Environmental Situation of Azerbaijan Republic for 2006-2010”. The Plan contains specific activities which will improve environmental situation both in the coastal areas of the Caspian and the sea itself.

It is necessary to review the NCAP with consideration of priorities of dispersed and spot pollution sources, and take actions to reduce pollution from these sources

According to the decree of the President of Azerbaijan Republic dated 28.09.2006, the Integrated Action Plan to Improve Environmental Situation of Azerbaijan Republic for 2006-2010 includes activities to improve the environmental situation, inter alia, eliminating hot spots. The Integrated Action Plan addresses the following earlier identified hot spots:

1. Prevention of liquid waste discharge in the Baku Bay by separating internal city industrial and domestic sewerage network from the surface water network (2006-2008);

2. Establishment of local treatment facilities in large industrial enterprises located in the coastal zone of the Baku Bay (2006-2009);
3. Cleaning of the Baku Bay from submerged old vessels and other large ferro-concrete wastes (2006-2007);
4. Construction of a centralized system of reception facilities for the disposal of waste water and marine litter from the ships (2007-2008);
5. Construction of a treatment facility and sewerage network in Bibi-Heybat OBPP area; reconstruction of engineering and hydrotechnical facilities; cleaning, reinstatement and rehabilitation of oil contaminated areas (2006-2009);
6. Reconstruction of treatment facilities in the Oily Rocks and Pirallahi, Jilov and Gum Adasi islands (2006-2008);
7. Construction of solid waste disposal facility for Baku, Sumgait and other populated areas in the vicinity of the cities (2006-2009);
8. Construction or rehabilitation of treatment facilities and sewerage networks in Baku and other populated areas of Absheron peninsular (2006-2008);
9. Decontamination and burial of mercury containing wastes of Sumgait (2006-2009);
10. Reduction of traffic emission to the level of European standards (2006-2008).

Table 1: Summary of priority land-based point pollution sources in Azerbaijan Sector

No.	Source	Type of source and GIWA code	Location (city name)	Volume MCM/yr	Pollutants (t/yr)									
					BOD	NH_4	NO_3	SSAS	TSS	Fe	TPH	Zn	Cu	Notes
1.	Oil-and-gas production department "Siyazanneft"	35 Oil industry	Siyazan	1.3	39	1.2	9.75	1.8	16.9	1.56				No discharge in the sea
2.	Joint –Stock Company "Siyazan Broiler"	31 Food	Siyazan	1.8	27	1.8	14.6	0.18	4.5	0.04				Discharge in infiltration fields
3.	Synthetic Rubber Works	35 Rubber	Sumgait	18.7	57.9	0	0	0	377.2	0				Only cooling water?
4.	Sumgait Organic Synthesis Plant	35 Chemical	Sumgait	23.1	401.9	18	6	6	512.1	0.6				WWTP under renovation
5.	Govsan Aeration Station	40 WWTP	Baku-Surakhani	31.2	564	21.8	24.9	3.1	65.5	0.9				
6.	Zykh Treatment Stations	40 WWTP	Baku-Hatai	0.2	108.4	0.8	4.5	0.32	175.8	1.2				
7.	Kishly manifold	40 Sewer outlet	Baku-Hatai	87.3	261.9	130.9	218.2	8.73	261.9	0.87				
8.	Thermal Power Station "Ali Bairamov"	Energy	Baku-Hatai	7.0	28.7	7	3.3	2.7	39.2	2.7				Cooling water
9.	Oil-and-gas production department "Bibi-Heibatneft"	35 Oil & gas production	Baku-Sabail	1,1	10.7	0.3	0	0.4	21	0				No discharge in the sea
	Total			170.6	1499.5	181.8	281.25	23.23	1474.1	7.87				

Notes to Table №1:

1. Oil & gas production plant (НГДУ) "Siyazanneft" is located at the distance of 1.5-2.0 km from the coastal area of the Caspian Sea. But nevertheless, these objects do not have discharges into the sea.
2. Waste waters of the Open Joint-Stock Company (OAO) "Siyazan Broiler" after treatment facilities are channeled to the filtration fields. The filtration zones are located at the distance of 1.5-2.0 km from the coastal area of the Caspian Sea.
3. Wastes of Rubber Synthesis Plant are regulatory clean waters as marine water is used for cooling compressors. Therefore, the information in the RAPS report on the composition of these waters might be wrong.
4. All waste waters of the Sumgait Plant of Organic Synthesis (domestic waste waters, industrial waters, etc.) after treatment at the biological treatment facilities are discharged into the sea. The figures of the degree of pollution discharged into the sea of BOD_5 and TSS at 17 and 22 mg/l do not correspond to reality. For the recent years as a result of overhaul reconditioning, the work of treatment facilities has improved. The treatment facilities of this plant purify some waters of the city of Sumgait. Due to the intensive growth of the city and water consumption, the city management adopted a decision on constructing a new biological treatment facility (BTF) for treatment of waste waters with the capacity of 200 thous. m^3/day. The construction commenced at the beginning of 2007. At present the construction of the BTF is in the completion stage.
5. The first treatment facility which was built in Baku in 1930 with the purpose of the city domestic waste waters treatment, was the Zykh mechanical treatment facility. Despite the fact that this facility was built long ago, the operating parts of this facility still have the capacity for purifying waste waters in the limit of order. The project capacity is 126 thous. m^3/per day

and night, but at this particular moment approximately 20 thous. m^3 of waste waters are channeled into these facilities, as the most part of waste waters is channeled to the Gavhan Aeration Station .

7. Run-offs from the Thermal – Energy Station named after Ali Bairamov are regulatory clean waters, as marine water is used for cooling generators and compressors. Therefore, the information in the RAPS report on the composition of these waters might be wrong.
8. Oil & gas production plant (НГДУ) "Bibiheibatneft" is located in the costal area and currently oil & gas production works in the coastal area are suspended according to the Decree of the President Ilham Aliev "On a Comprehensive Plan of Activities to Improve the environmental state in the Republic of Azerbaijan for 2006-2010".

Table 2: Summary of sources of pollution by waste disposal in Azerbaijan Sector

No.	Name of site	Location	Distance to Caspian Sea	Kind of waste	Area (ha)	Quantity (m3)	Remarks
1.	OGPP Bibi-Heybat	Absheron		Waste oil			vulnerable to flooding and hazardous areas
2.	OGPP Bibi-Heybatneft	Baku-Sabail		Waste oil			reinstatement and rehabilitation of the territory of OGPP
3.	Oily Rocks	Pirallahi, Jilov and Gum Adasi islands		Waste oil			Reconstruction of treatment facilities
4.	Waste dump	Sumgait		Mercury waste			Decontamination and secure disposal of mercury containing waste

Table 3: Pollution concentration in important rivers due to storm water run-off

No.	Source	Pollutants (mg/l)								
		BOD5	NH_4	NO_3	SSAS	TSS	Fe	TPH	Zn	Cu
1	Kura River	2,3	0,12	0,8	0,1	14,0	0,13	0,01	0,.21	0.075
2	Agchay River	1,9	0,5	0,7	0,4	6,0	0,030	0,02	0,19	0.003
3	Devyachinskiy region OJSC “Devyachy Broiler”	5,0	0,6	1,0	0,3	5,0	0,042	-	0,23	0.0040
4	Sumgaitchay River	2,7	0,54	0,9	0,5	6,5	0,012	0,05	0,25	0.004
5	Baku Bay, collector, Yu. Safarov Str.	4,0	0,5	1,7	0,6	7,0	0,045	0,06	0,2	0.006
6	Baku Bay, collector, Azatlyg Pr.	4,2	0,6	1,6	0,5	7,0	0,024	0,05	0,32	0,0045
7	Baku Bay, collector, Niyazy Str.	4,5	0,65	1,4	0,6	5,5	0,040	0,04	0,29	0.012
8	Baku Bay, collector, Yu. Mamedaliev Str.	4,8	0,6	1,9	0,5	5,0	0,05	0,03	0,22	0,0036
9	City Lenkoran, Lenkoranchay River	1,5	0,4	0,8	0	9,0	0,018	0,02	0,19	0.008
10	Astara region, Shahagadjichay River	2,0	0	1,2	0.4	8.0	0.34	0.01	0,26	0.007

Notes to Table № 2: The sources, which are given in the Table, were selected as run-offs presenting interest for us in the Azerbaijan Sector, as storm sewers flow into the Caspian Sea into the sensitive zone of the Baku Bay. The Kura River as a transboundary river has always been in the focus of our attention. Extensive information on these run-offs was submitted to you on February 07, 2008 during the workshop in Ashkhabad.

Annex 2: Inventory of priority pollution sources in the Kazakh Sector

SUMMARY OF RAPS KAZAKHSTAN

Source: CEP-SAP Report "The Rapid Assessment of Point and Diffuses Pollution Sources in the Kazakhstan Sector of the Caspian Sea"; Almaty, 2007

1. SOURCES OF WATER RESOURCES POLLUTION

Water resources of northern part of the Kazakhstan sector of the Caspian Sea are formed mainly due to the water flows of such rivers as Ural, Uil, Emba, Sagis, and also such water streams of Volga delta as Kigach and Sharonovka.

The average annual discharge of suspended sediments of Ural river near the Atyrau city makes up 3.5 million tons. Annually about 5 million tons of sands are carried out to the Sea.

Except the contaminations discharging from Volga and Ural rivers, the Caspian Sea has a lot of negative impacts from the flooded oil wells.
There are 19 oilfields with 1485 oil wells in the coastal zone of the Caspian Sea, including 148 in the flooded zone.
These oil wells belong to the State. Monitoring of them is fulfilled by enterprises where they are located.
It should be noted that the oil wells due to the existing for a long time under the Sea water are exposed to active corrosion and destruction and at present they are very dangerous for the Caspian Sea ecosystem.

In the context of realization of the Republican program "Liquidation and conservation of self-pour outing oil wells" there were held the insulating works in 2004 on 5, in 2005 on - 7 and in 2006 on - 12 oil wells *(In total 24 out of 148)*.

At present all volumes of contaminants releasing with sewage waters discharge to the evaporation and filtration fields and also on the landscape because their emission into the surface waters completely prohibited in according to the national legislation.

The waters released from the enterprise "Maek- KazAtomProm" are discharged through Karakol-Shor to the Caspian Sea. These sewage waters belong to the category of effluents treated to standard quality.

The total quantity of evaporation fields of sewages is 33. They are belongs to the oil and gas enterprises, and also to the local executive bodies and municipal services.

In according to the available information 84% of sewage waters of industrial complex and municipal services towards to the evaporation fields, some parts of which are in very close distances from the Caspian Sea coastal line. The volumes of these sewage waters in 2006 are shown in the table 2.

Table 2: The volume of sewage waters in 2006

Site of discharge	Volume of discharge ($m^3 * 10^3$)
Into surface water bodies (effluents treated to standard quality only)	820,137.7
On the landscape	5,975.0

Into gathering ponds and on filtration fields	13,360.6
Into the Earth's interior	670.4

2. SOURCES OF WASTE DISPOSAL

The problem of oil wastes (masutted areas and oil slimes) is that use, treatment and utilization have been not solved sufficiently for a long time. The total volume of oil wastes in Mangystau oblast is 1,844,651 m^3, from which on Uzen oil field – 1,419,234 m^3, on Zhetybai and Kalamkas oil fields – 343,125 m^3, and on Karazhambas oil field – 82,292 m^3. Partially these oil wastes are used as a construction material to pave the roads and sites on the oil field areas. In 2004 year on Northern Buzachi oil field 468 m^3 of masutted grounds was used and on Karazhanbas oil field in 2005 - 10780 m^3. For 2006 year 8478 m^3 of oil wastes and wastes of drilling were used as a construction material to pave the inside roads and sites on Northern Buzachi, Borankol, Tolkyn oil fields.

The tailings of uranium wastes are the most serious problems for region environment. In this connection the tailing site of Koshkar-Ata should be noted first of all.
In 1960 in Mangystau oblast near Aкtau city in depression “Кoshkar – Ata” on distance 7-8 km from seashore a slot of land was allocated for disposal of radioactive waste of the Caspian Mining and Metallurgical Plant. Since 1965 wastes of Chemical – Metallurgical and Sulphuric Acid factories of this Plant have been disposing in the tailing disposal site “Кoshkar – Ata”.
Since 1965 about 52 million tons of radioactive wastes with total activity 11 thousand Curies have been disposed in the tailing “Кoshkar – Ata”. These radioactive wastes in according to their radionuclide composition are natural series of Uranium - 238. Most toxic of them are Uranium - 238, Radium -226, Thorium – 230. As a result since then 105 million tons of toxic and radioactive wastes are disposed in the tailing.
The last 15 years the negative impact of the tailing on the environment of the Caspian Sea coastal zone has increased significantly. The reason of this is the reduction of the Plant’s productiveness and consequently reduction of sewage. As a consequence the water level in the tailing decreased and a huge bottom area was dried up from which a lot of radioactive elements together with dust spread up to the surrounding area by wind.
Now from 17 up to 32 thousand m^3 of re-treated sewage water from Aktau sewer collectors and up to 7 thousand m^3 non-treated domestic sewage water from Aktau districts are being discharged to the tailing per day. Due to these sewage waters about 5 km^2 of the tailing bottom in its western part is covered by water. Meanwhile, the estimate volume of sewage water should not be less than 6 million m^3 per day in order to retain the necessary water level in the tailing. Because of it about 24 km^2 of the tailing bottom still remains dried up.
From ecological point of view the spray of radio nuclides, heavy metals and other harmful chemical elements from the dried bottom of the tailing by the wind to surrounding area is very serious problem especially for the local people.
Exceeding the concentration of chemical elements and their compounds in air near the tailing above the admissible concentration limit for wastewater discharge in surface water (ACL) is: on fluorine – 1.3 times, on phosphates – 1.8 times. It characterizes the ecological status of the region on available criteria as dangerous.
The discharge of tailing polluted waters to underground is a big threat for the Caspian Sea.
In according to the “Program of Conservation of the Uranium Production Enterprises and Liquidation of Consequences of Uranium Deposits for 2001-2010” it is supposed to re-cultivate the tailing in the period of 2006-2010.

The results of scientific investigations showed, that in the condition of heavy wind the concentration of the lead radioactive isotope Pb-210 in atmosphere air exceeds background values in 15 times. Such elements, as: nickel, zinc, copper, chromium, tungsten also were observed in ambient air near the tailing. Increased concentration of heavy elements in soils of such settlements as Akshukur, Bayandy, Kzyl-Tube and railway station Mangystau which are located on the east and west sites of the tailing were marked too.

3. SOURCES OF LAND RESOURCES POLLUTION

The total area of the land which can not be used due to pollution is 3.3 thousand hectares.

The greatest damages of top soil take place in residential zones of cities and settlements, including camps, and also areas of oil production. Although these kinds of damages are mostly local, they can cover large areas, especially in northern and north-eastern parts of the Caspian coastal zone and also on peninsula Buzachi. In according to some data, the span of residential and industrial areas is 1.3 million hectares, and the span of oil enterprises is 0.5 million hectares.
Production of oil and gas in the region has begun 90 - 100 years ago. In according to that time technology, it was possible to leave the oil and its products on land depressions without any isolation. Therefore the oil products could reach the depth up to 10 meters. Now a lot of financial expenses should be made for treatment of these spoiled areas.

Significant land pollution takes place around of well mouths when they are repaired. For instance, on Uzen oil field from 25,000 up to 40,000 of oil wells restorations are carried out annually. And on Zhetybai and Kalamkas - from 20,000 up to 30,000. Usually after oil wells restoration the spoiled soil takes away just by means of carrying it over to the special areas (polygons). This created additional centers of environmental contamination.

In order to reduce the contamination of the land by oil and its production a lot of oil enterprises have started the replacement of steel oil pipelines on durable plastic ones.
For example, MangystauMunaiGaz in 2006 replaced 198 km of oil pipelines by plastic ones. As a result in 2006 the amount of pipeline damages in comparison with the similar period of 2005 was reduced up to 191. And a volume of oil spills has decreased on 247 tons. Last year on Karazhanbas oil field 6.5 km of plastic pipes was set up. Therefore the amount of pipelines damages were reduced in comparison with the similar period of 2005 up to 105 and volume of oil spills has decreased on 83.8 tons.

In Mangystau oblast of Kazakhstan there are 4 large oil and gas fields: Kalamkas, Uzen, Zhetybai and Karazhanbas. For the period of their operation a lot of land oil storages were created. Near these oil fields large areas of the land are spoiled by oil and oil slimes.

One of the bigger problems in the oblast is the liquidation of land oil storage which belongs to UzenMunaiGaz. To solve the problem the Long-term Program for 2004-2010 has been developed. In spite of the fact that since 2001 till 2006 from this land oil storage 183,190 tons of oil are pumped out, the area of it didn’t decrease and moreover the amount of oil wastes remained at the former level.

In spite of the fact that environment protection actions on clearing the oil fields from historical contaminations has been taking place annually, on these oil fields on 01.01.07 there are 92 land oil storages, the amount of oil in them is - 77118 tons and liquid oil wastes - 398709 tons, the total masuted areas is 1898 hectares. So, in Karazhanbas oil field there are 47 land oil storages in which about 2055 tons of oil has been storing yet, on

Zhetybai oil field there are 42 land oil storages with 28577 tons of oil, on Uzen oil field there are 3 land oil storage with 46485 tons of oil and liquid oil wastes in quantity of 398 709 tons.

In 2003 the Program “On liquidation of the land oil storages and masuted areas on oil fields Zhetybai, Usen, Karazhanbas, Borankol” has been developed.

In 2004 it was pumped out and utilized 68165 tons of oil from land oil storages, in 2005 - 76904 tons and in 2006 – 68339.2 tons. In 2004 it was liquidated - 84 land oil storages and 24.7 hectares of masuted soils, in 2005 - 105 land oil storages and 39.4 hectares of masuted soils, in 2006 - 26 land oil storages and 76.7 hectares of masuted soils.

It should be also noted that there are some places in the region which were polluted by the radioactive emissions as a result of activities of military polygons in 60-70 years of the last century.

Summary of Land-based pollution sources in Kazakh Sector

Table 1: Priority list land-based point water pollution sources discharging to the Caspian Sea (direct or indirect)

No.	Source of pollution[6] (Name of enterprise)	Type of source[7] and GIWA code[8]	Location (city name)	Volume[9] m^3/yr	Pollutants (t/yr)								
					BOD	NH_4	NO_3	SSAS	SS	Fe	TPH	Phenols	Heavy metals[10]
1.	Atyrau Oil Refinery Plant	35 Oil refinery	Atyrau	1,720							1179.8 49.95		
	Total												

Source: *"The Rapid Assessment of Point and Diffuses Pollution Sources in the Kazakhstan Sector of the Caspian Sea"; Almaty, 2007*

6 Refers to "Name of the company"
7 Refers to "Branch of economy"
8 GIWA codes: refer to file <Activity List for Baseline inventory.doc>
9 Refers to "Total volume of sewage discharges (thousand cubic meters)"
10 Indicate the kind(s) of metal(s), e.g. Cu 0.5

Table 2: Inventory of sources of land resources pollution by waste disposal in Kazakh Sector

No.	Name of site	Location	Distance to Caspian Sea	Kind of waste	Area (ha)	Quantity	Remarks
1.	Tuhlaya Balka sedimentation tank and infiltration field	Atyrau	?	Wastewater sludge	?	50-70 mln. m^3	Collected wastewater contaminated with a.o. ammonium salts, heavy metals (copper, zinc, chrome and others), oil products and phenol
2.	Tengiz oil field	Mangystau oblast	?	Oily waste and masuted land	?	?	
3.	Bautino	Mangystau oblast		oil			53 submerged vessels
4.	Zhetybai and Kalamkas oil fields	Aktau/Zhetibay, Mangystau oblast	70 km	Oily waste	14.000	343,125 m^3	Partially used as construction material
5.	Zhetybai and Kalamkas	Mangystau oblast	70 km	Masuted land	14.000	28,577 ton	42 land oil storages
6.	Karazhambas oil field	Mangystau oblast	?	Oily waste	16.000	82,292 m^3	Partially used as construction material
7.	Karazhanbas	Mangystau oblast		Masuted land		2,055 ton	47 land oil storages
8.	Koshkar-Ata tailing site at Zhana-Dzen and New Uzen	Aktau, Mangystau oblast	6-7 km	Uranium tailings	29	105 mln. ton	Radioactive waste of the Caspian Mining and Metallurgical Plant
9.	Karaton and Sarykamys	Mangystau peninsular	?	Oil camps	?	?	
10.	Uzen oil field	Mangystau oblast	>100 km	Oily waste		1,419,234 m^3	Partially used as construction material
11.	Uzen oil field	Aktau, Mangystau oblast	>100 km	Masuted land		445,194 ton	3 land oil storages

Sources:
1 – 7: The rapid assessment of point and diffuses pollution sources in the Kazakhstan sector of the Caspian Sea; Almaty 2007
8: National Action Programme on Enhancement of the Environment of the Caspian Sea 2003-2012.

Annex 3: Inventory of priority pollution sources in the Russian Sector

Summary of RAPS Russia

Source: Rapid Assessment 0f Pollution Sources (Raps), Point and Diffuse in the Near Caspian Region of the Russian Federation; Moscow, 2006

1. Astrakhan Oblast

The oblast area occupies over 44 thousand km2 and locates in two nature zones – semi-desert and desert. Prevailing relief is plain; soils are of various salinity level. Water bodies occupy over 10 % of area, deserts – 10%, wetlands – about 6%, forests cover less than 3% concentrating mainly in floodplain and delta of the Volga river. The oblast length from west to east is 120 km, from north to south – 375 km. As at 1.01.2007, the total number of the population of the oblast is more than 994 thousand people.
There are 6 cities and towns in the oblast, the largest are Astrakhan with population constituting over 50% of the whole oblast population, Ahtubinsk and Znamensk. Urban population constitutes about 70%.
Main mineral resources in the oblast area are hydrocarbons (oil, gas and gas condensate), sodium chloride (Baskunchak deposit is one of the largest in the world with 98% content of sodium chloride of high quality; it provides 80% of total demand in Russia) and construction materials (gypsum, limestone and others).

1.1 Waster water disposal to the Volga delta from the territory of the Astrakhan oblast

Pollution of water bodies and land in the Astrakhan oblast is mainly caused by overloading the design capacities of waste water treatment plants in towns and urban settlements (and in some cases by their absence), pollution of territories with dumps of domestic and industrial waste, harmful substance emissions into atmospheric air from stationary and portable sources of pollution (mainly automobile transport).
Total amount of all pollutants entering the pre-estuarial part of the Volga River from the territory of the Astrakhan oblast does not exceed 10% of basic mass of pollutants transiting with Volga water through the oblast territory.

Major sources of pollution of surface water bodies in the oblast are enterprises of town communal services which apart from their wastes receive also wastes from other enterprises located in these towns. At that, if industrial waste waters from some enterprises are polluted with organic and other toxic substances, they should be treated up to the established norms on local treatment facilities prior to their discharge into the town sewage system. It should be noted that all sewage waters discharged into the Volga delta from enterprises of communal services are currently referred to the category of polluted.
The total volume of sewage water discharge in 2005 constituted some 410 million m3, including polluted waters, constituted about 68 million m3 or 16.6% of total volume of sewage water discharge. At that, the major source of pollution emission of contaminated runoffs in the Volga delta are runoffs of the city of Astrakhan - in 2005, 63.6 million m3 of polluted sewage were discharged into the delta. Pollution of waters with oil products & phenols in 2005 – 2007 remained on the background level.

In 2007 the reconstruction of the aeration system was conducted on the Southern & Northern sewage treatment facilities (STF – OCK), reconstruction of sludge beds, primary & secondary dirt collectors on the Northern STFs, as well as reconstruction of biological ponds on the Right-bank STFs. These measures allowed improving significantly indicators on BOD, ammonium nitrogen, weighted substances & discharge of a number of other PSs.

1.2 Recommended activities on reduction of polluted waste water discharge & PSs.

Considering results of data analysis on point SPs it could be recommended to increase significantly in the nearest future the efficiency of treatment of waste waters discharged into the Volga delta from the territory of the Astrakhan oblast, in the first turn, work of the Southern & Northern & Right-bank waste water treatment facilities. For instance, in the forthcoming years to implement measures on significant improvement of data on BOD & SSAS, to reduce twice the discharge of heavy metals contained in contaminated waste waters, to stop entry of oil products with rain-storm run-offs.

1.3 Sources of pollution formed by waste accumulation

The problem of municipal solid & liquid waste management in the Astrakhan oblast is an acute problem. As at the beginning of 2007 the amount of waste constituted more than 3 mln. tons.

In 2006 the waste formation amounted to 250 thousand tons. MSW generated by the population and economic entities of Astrakhan are scavenged to the MSW polygon; its area is 37 ha. As at 01.01. 2007, with the actual polygon capacity of about 20 mln. cubic meters, its filling has already exceeded 80%. As a result of regime observations in 2003 – 2005, organic and chemical pollution of ground water with high figures of BOD, COD, phenols and Mn was identified in the MSW polygon area.

In 2005 the Government of the Astrakhan oblast approved the program on reforming housing – municipal enterprises on the territory of the Astrakhan oblast. The program envisaged the construction of three refuse disposal works. However, the implementation of the established assignments is delayed, mainly due to the lack of financing.

4 confluent maps of Southern sewage treatment facilities of biological treatment of waste waters with the total area of 3.6 ha are located in the airport area. As at 01.01. 2007, about 50 thousand cubic meters of wastes (sediments) were accumulated with the capacity of 54 thousand cubic meters. Great concentration of Mn, phenols, SSAS was identified in the ground water. The concentration of COD & BOD_5 exceeds MPC for drinking and fishery purposes. The average level of 1^{st} & 2^{nd} hazard class substances is lower than MPC.

In 1970 special oil pits were constructed for storing oil products (fuel-oil residue), which have not been in use since 1980-s as oil storages. As a result of oil pits observation, a high concentration of oil products was revealed in them (30-400 g/kg). The subsoil in oil pits is referred to as heavily polluted, the phenols concentration exceeds MPC. According to the results of monitoring research of water specimen in 2002 – 2003, the oil products concentration in the ground water was higher as compared with the background 1.2 – 1.4 times. As for other identifying data on the quality of ground water, the concentration of pollutants did not exceed the background data.

Collection of liquid and solid oil-containing waste and their processing from side organizations located on the territory of the Astrakhan oblast is vested on CJSC “Nature Protection Complex “Eco+”. Waste placement and processing is carried out on 6 industrial sites. Wastes of suspensions and oil products mixtures (water contaminated with oil products, bilge water), household wastes and discharge from vessels, bore mud and drill fluid, mud from treatment of oil-carrier tanks (bottom sediments), tubs, containers and cisterns, spent oils (engine, industrial, hydraulic oils), surface runoffs from site of unit for combustion of oil polluted materials and their temporary accumulation and others constitute the major group of these wastes.

Table 2 Annex 3 provides the list of major enterprises, which have production & consumption waste & types of this waste.

1.4 Environmental protection activities recommended for implementation for the purpose of increasing efficiency of production & consumption waste management

For the purpose of excluding a further increase of waste negative impact on the environment & the Volga delta it is essential in the forthcoming years to implement a number of activities providing a stable reduction of accumulated waste volumes. Taking into account the available monitoring data on specific SP’s it is expedient to conduct a comprehensive assessment of negative consequences of existing SP’s (impact on human health & environment, including water sources, outflow of land resources & other negative factors), to assess financial costs for implementing required activities.

Following the data from Table 2, the following measures can promote a significant improvement of the situation with wastes:

- reclamation of oil pits with accumulation of great amount of waste from drilling (oil products, oil containing waters, oil sludge, drilling bit cuttings, stratum contaminated with oil products & others. The concentration of oil products in oil pits makes 30 – 400 g/kg;
- to liquidate (reconstruct) confluent maps in the airport area & resoil a plot of land occupied by them;
- to conduct a step – by step liquidation of unauthorized landfills of industrial & household waste, resoil plots of land occupied by them;
- to develop update methods of sorting & disposal of MSW, to construct relevant enterprises (refuse disposal works & incinerators).

2. Republic of Dagestan

The area of the Republic of Dagestan constitutes 50.3 thousand $km^{2.}$ The territory stretches for about 540 km from the south to the north, for 200 km from the west to the east. The territory of the Republic is washed by the Caspian Sea in the east for 400 km. The population of the Republic is 2.6 mln. people; 60% of the population constitute rural community. The majority of inhabitants is concentrated in the sub-mountain and flat parts of Dagestan.

The Republic is rich in mineral resources – oil, gas, peat, brown coal and slate coal, ferrous metal ore, non-ferrous metal ore, nonmetallic mineral feed, etc.

2.1 Waste water disposal from the territory of the Republic of Dagestan

One of the key ecological problems in the Republic still remains the pollution of the Caspian Sea & inflowing rivers with raw waste water & not properly treated wastewater. The major sources of these waters' entry are communal enterprises, entities of industrial & agricultural activities, as well as rain-storm run-offs. The total volume of polluted waste water discharge in 2007 made more than 74 mln. m^3. As compared to 2006 the discharge was reduced for 0.04 mln. m^3.

Waste waters of communal, industrial & agricultural entities located on the territory of the Republic in most cases are discharged into the Caspian Sea or to the inflowing rivers.

Unsatisfactory ecological situation is characteristic of catchment areas. Water of rivers & water bodies is contaminated with salts of heavy metals & organic compounds, as well as with biogenic substances. The major economic load is produced on such river systems as the Terek, the Sulak & the Samur. The concentrations of copper, phenol & oil hydrocarbons in their waters exceed MPC (Maximum Permissible Concentrations) several times. However, it should be noted that recently the tendency to some reduction of these rivers contamination is observed.

A special concern is due to the sanitary condition of surface water bodies of the Dagestan coast of the Caspian Sea. Due to the great overload of city treatment facilities of sewage systems located on the coast or lack of such facilities (in the towns of Izerbash, Derbent, Dagestanskiye Ogny) the efficient waste water treatment is not provided. The biggest volume of polluted waste waters is discharged into the Caspian Sea by MUE "OSK of Mahachkala – Kaspiisk - 52.5 mln. m^3, which makes 70% of total discharge of polluted run – offs of the Republic. Considering the discharge of polluted sewage run – offs of Derbent & Izerbash & OSA "Dagnefteproduct", the discharge volume reaches almost 79%.

Besides that, the amount of pollutants discharged into the sea with contaminated run – offs by 4 above mentioned point SPs made more than 25 thousand tons.

2.2 Recommended activities on significant reduction of polluted waste water discharge & PS's.

Data analysis on main SPs shows that the NCAP shall envisage specific environmental protection activities directed at significant reduction of polluted waste water discharge into the Caspian Sea & inflowing rivers.

These activities shall include the following:

- accomplishing construction of combined facilities for waste water treatment of Mahachkala & Kaspiisk. This will allow to reduce for 70% the discharge of not properly treated run – offs into the Caspian Sea from the territory of the Republic;
- constructing waste water treatment facilities in Derbent where sewage run – offs are discharged directly into the sea;
- detecting all SPs, which discharge the most hazardous PSs into the city sewage systems and whose treatment on the city sewage treatment facilities cannot be provided in the short run. To perform local activities on the detected SPs; this can ensure the significant reduction of some hazardous PSs producing the greatest negative impact on the Caspian Sea marine environment & the Caspian coast. Fr instance, improvement of local treatment facilities and transition to the circulating water supply on the entities OSA "YUGK –TGK – 8" will enable to reduce significantly sulphates discharge, and on OSA "Dagnefteproduct" to reduce the entry of ammonium nitrogen & weighted substances.

2.3 Sources of pollution formed by waste accumulation

More than 4 mln. tons of various types of waste & classes of hazard have been accumulated in storage places, on polygons, landfills, burial sites & other objects of waste placement & storage on the territory of the republic of Dagestan; the amount of solid waste constitutes about 95%. Most objects of solid waste placement represent polygons & landfills, which do not meet sanitary & ecological requirements. The number of disorderly landfills is not diminishing in the vicinity of the Caspian Sea & inflowing rivers.

“Waste sorting station for city household waste processing” in Mahachkala does not solve the problem of the city solid waste disposal. Wastes taken to the authorized landfill located 6 km from Mahachkala are often burnt. As a result, PSs, including dioxins, get into the environment.

Objects of waste placement formed with well drilling represent drilled pits which contain more than 130 thousand tons of such waste, including about 8 thousand tons of oily waste. It should be noted that the significant part of drilled pits is located in the Caspian coastal area. The major part of this waste constitutes non – toxic waste (more than 95%), mainly non-toxic drilling bit cuttings. About 1600 tons of oil products are stored in pits located on the coast (not farther than 2 km from the sea shore). Each such pit occupies not less than 0.15 ha of land area.

Wastes of electroplating industry are placed on the territories of enterprises, as a rule, in metal containers & in storehouses. Operated-off mercury-iferous lamps are also placed in storehouses of some enterprises, however, requirements fort their safe storage do not always meet the established requirements.

27 such objects (drilled pits & sludge collectors containing oil products & sands & soils contaminated with oils) were found in the course of works on identifying the major places of industrial & consumption waste placement located in the vicinity of the Caspian Sea.

As can be seen from Table 3, project sites located in the zone of 300 – 700 m from the coast are as follows: drilled pits (oil sludge burial sites) of wells “Dimitrovskaya” № 21, № 43, № 42, № 248 – Izberbash (LTD NK Rosneft – Dagneft)); oil sludge storages of mechanical treatment of waste waters (RGUP “Dagnefteproduct”); project sites located on the territory of OSA “Sudoremont”, storehouse of industrial waste & other project sites on the territory of the plant “Dazdiezel”; project sites located on construction sites “Dagestanskaya generatsiya”, OSA “YUGK –TGK – 8” (Mahachkala & Kaspiisk thermo – electrical heating station).

At present it is not possible to characterize specifically project sites indicated in Table 3 as SPs of marine environment & the Caspian Sea coast due to the lack of data on regular monitoring observations on these project sites. It should also be noted that Art. 11 of the Federal Law “On Industrial & Consumption Wastes” № 122 – Ф3 stipulates that “individual entrepreneurs & legal persons are obliged…..to conduct monitoring of environment on the territories of project sites of waste disposition when operating and maintaining enterprises, buildings, facilities & other objects related to waste management”.

One can only presuppose direct or indirect impact of project sites. For instance, works on wells № 21, № 43, № 42 located on pasture lands & agricultural lands were completed in 1991 – 2002. Oil

sludge burial site of well № 248 – Izberbash is located on the territory of the Caspian Sea water conservation zone (300m). Works on this well were completed in 2001. Upon the completion of these wells operation a technical reclamation was performed & the cement screen 15 cm thick became the protection system of above mentioned oil sludge burial sites. Biological reclamation was not conducted. More than 600 tons of oil products are contained in these oil sludge burial sites.
Table 3 Annex 3 provides information on major enterprises, which have production & consumption wastes & types of these wastes.

2.4 Environmental protection activities recommended for implementation for the purpose of increasing efficiency of production & consumption waste management

Analysis of SPs of marine environment & the Caspian Sea coast in the Republic shows that the major potential threat is represented by a possible oil pollution, the sources of which are substrata & oil sludges.

It is anticipated that the priority directions on reducing a negative impact of economic activity on marine environment & the Caspian Sea coast (considering planned wide – scale activities in oil & gas production in the forthcoming years on the shelf plate) shall be the following:

First, sequential closing-down of abandoned drilled pits & oil sludge storages containing oil products & other hazardous substances, disorderly landfills of solid wastes, wastes of electroplating industry, operated-off mercuriferous articles, as well as collection & disposal of lead accumulators;

Second, ensuring “zero discharge” with oil & gas production, construction of waste incinerators & enterprises, including those on oil sludge disposal & treatment of substrata contaminated with oil, setting up specialized project sites for collection & disposal of toxic waste, including pesticides, toxic chemicals other persistent organic pollutants (POPs).

3. The Republic of Kalmykia

The territory of the Republic is about 76 thousand km^2. It is washed by the Caspian Sea in the south – west. The region is located in the steppe, semi – desert and desert zones.

The Republic’s population constitutes 289 thousand people including urban population – 128 thousand people, and rural – 161 thousand people (about 103 thousand people live in the city of Elista).
The Republic of Kalmykia has rather diverse mineral resources among which the basic are deposits of oil, natural gas, minerals for production of construction materials (sand, clay, shell rock), mineral underground water, agrochemical resources (potassium and rock salts, dolomite), bischofite resources and others.

The territory of the Republic of Kalmykia is very promising from the point of view of oil & gas exploration & production both on land & on the adjacent aquatic area of the Caspian Sea. The total territory of the shallow-water area & frontier of the Caspian Sea bottom adjacent to the territory of the Republic of Kalmykia constitutes 80 thousand sq. km.

There are 9 gas and oil producing fields in the zone under study. They are located 15 – 30 km from the Caspian Sea. Waste waters of oil and gas producing enterprises and the town of Lagan are discharged to the filtration fields for treatment.

Impact on ecological condition of the Caspian Sea resulted from the Republic of Kalmykia may be considered as insignificant in comparison with impact produced by the Astrakhan oblast and the Republic of Dagestan.

Table 1: Priority wastewater point sources of pollution in Russian Sector

№	Name of the sources of pollution (SP)	Code based on GIWA method	Sources location			Pollutants discharges from pollution sources with sewage, t/a										
			Name of the nearest city/town	Name of the water body	Distance to the Caspian shore (km)	Waste water volume mcm	BOD	TPH	Phenols	Sulphates	NH_4-N	Nitrates NO3	SSAS	SS	Fe	Heavy metals
1.	MUE Northern sewage disposal plant, «VODOKANAL»	40	Astrakhan city	r. Volga.	50	26.8	140	-	0.03	3540	83,5	52,1	3,2	480	11,2	Cu: 0.12 Zn: 0.13 Mn: 1.36 Pb: 0.13
2.	MUE Southern sewage disposal plant, «VODOKANAL»	40	Astrakhan city	r. Volga	50	30.18	240	-	0.03	4230	14,6	154	2,3	800	10,3	Cu: 0.10 Zn: 0.16 Cr: 0.10 Pb: 0.12
3.	MUE “VODOKANALHOZ	40	Buynaksk city	r. Shura-ozen'	42	3.75	520	-	-	727	53,4	1,96	5,7	2556	0,56	Cu: 0.003 Zn: 0.03 Cr: 0.06
4.	MUE«DERBENTGORVODO KANAL»	40	Derbent city	Caspian	0,5 - 1	4.5	292	-	-	972	10,3	23,21	2,1	660	1,17	Cu: 0.01 Zn: 0.03 Cr: 0.02
5.	MUE «CITY SEWAGE TREATMENT FACILITIES”	40	Izerbash city	Caspian	1	1.80	186	0,23	-	1814	32,2	9,0	0,29	160	0,23	-
6.	MUE « SEWAGE TREATMENT FACILITIES”	40	Khasaviurt city limits	r. Yaryk-Su	74	5.34	440	-	-	1070	45,8	1,76	2,24	260	0,8	Zn: 0.03
7.	MUE «Combined facilities for waste waters treatment of Mahachkala, Caspiysk”	40	5 km from Makhachkala city	Caspian	1,5	52.51	610	-	-	6143	162, 77	52,1	1,47	735	6,3	Cu: 0.07 Zn: 0.4 Cr: 0.25

Table 2: List of SP caused by waste storage on the territory of the Astrakhan oblast

Name of organizations and places of waste formation and emplacement	***Type of waste***	***Units of measurement***	***Amount of waste***	***Location and occupied area***	***Distance in km***	
					To the sea shore	**To Volga & its delta channels**
1. **CJSC "Nature Protection Complex "Eco+"** Enterprises: - reservoir park, oil treatment stations; - polygon of oil fleet treatment; - sites of accepting spent oils and solid oil containing waste - units for combustion of oil polluted materials and acceptance	Wastes of suspensions and oil products mixtures (water contaminated with oil products, bilge water), household wastes and discharge from vessels, bore mud and drill fluid, mud from treatment of oil-carrier tanks (bottom sediments), tubs, containers and cisterns, spent oils (engine, industrial, hydraulic oils), surface runoffs from site of unit for combustion of oil polluted materials and their temporary accumulation and others	Thous. tons	52,2	Industrial sites of village of Ilyinka, Ikryaninskiy region. 0,14 ha	50	0,1-0,2
RPC "Astrakhanskiy" branch LTD "LUKOIL"Nizhnevolzhskoil product"	Membraneous oil-product, oil containing water, oil sludges, bore muds & substratum contaminated with oil products are accumulated in four oil pits.	Thous. cubic meters	40	Ikryaninskiy region 1.9 km from village Ilyinka &1.2 km from village Krasnye Barricady	50	Erik "Kazachiy" 0,05- 0,1 km

Table 3: List of SPs caused by storing production & consumption wastes in the coastal zone of the territory of the Republic of Dagestan

Name of organizations & places of waste formation & placement	Types of wastes	Amount of wastes, tons	Location of placement & occupied area	Distance to the Caspian Sea or inflowing river
LTD NK Rosneft – Dagneft	Total amount of waste with oil & gas production including: - non – toxic waste (drilling bit cuttings & other); - oil products.	32521 29552 1596		
1. Drilled pit of well № 38 - Dimitrovskaya	Total including: - non – toxic waste (drilling bit cuttings & other); - oil products.	2870 2667 192	Karabudahkentskiy region, Mahachkala OGPD. 0,15 ha	1 km to r. Talginka
2. Drilled pit of well № 43ch - Dimitrovskaya	Total including: - non – toxic waste (drilling bit cuttings & other); - oil products.	3640 3448 190	Mahachkala city, Mahachkala OGPD. 0,15 ha	0.3 km to r. Talginka
3. Drilled pit of well № 18 - Dimitrovskaya	Total including: - non – toxic waste (drilling bit cuttings & other); - oil products.	710 374 330	Karabudahkentskiy region, Mahachkala OGPD. 0,15 ha	2.0 km to the sea shore
4. Drilled pit of well № 21 - Dimitrovskaya	Total including: - non – toxic waste (drilling bit cuttings & other) - oil products.	5160 5073 76	Karabudahkentskiy region, Mahachkala OGPD. 0,15 ha	0.7 km to the sea shore

Name of organizations & places of waste formation & placement	Types of wastes	Amount of wastes, tons	Location of placement & occupied area	Distance to the Caspian Sea or inflowing river
5. Drilled pit of well № 24 - Dimitrovskaya	Total including: - non – toxic waste (drilling bit cuttings & other); - oil products.	3790 3579 204	Karabudahkentskiy region, Mahachkala OGPD. 0,15 ha	1.5 km from Kaspiisk town
6. Drilled pit of well № 39 - Dimitrovskaya	Total including: - non – toxic waste (drilling bit cuttings & other); - oil products.	2890 2798 84	Karabudahkentskiy region, Mahachkala OGPD. 0,15 ha	2 km from Mahachkala city
7. Drilled pit of well № 31 - Dimitrovskaya	Total including: - non – toxic waste (drilling bit cuttings & other); - oil products.	6870 6690 179	Karabudahkentskiy region, Mahachkala OGPD. 0,15 ha	1.6 km to the sea shore
8. Drilled pit of well № 42 - Dimitrovskaya	Total including: - non – toxic waste (drilling bit cuttings & other); - oil products.	2418 2189 227	Mahachkala city, Mahachkala OGPD. 0,15 ha	0.2 km to r. Talginka
9. Drilled pit of well № 248-Izberbash	Total including: - non – toxic waste (drilling bit cuttings & other); - oil products.	2521 2399 114	Karabudahkentskiy region, Mahachkala OGPD. 0,15 ha	0.3 km to the sea shore
OSA Geotermneftegaz	Wastes with oil & gas production	4,0		
1. Drilled pit of well № 1	Loamy suspended matters, including bentonite, lignin-alkaline reagent, sodium dichromate	1,4	Town Izberbash, vil.Burnnaya	1.0 km to the sea shore

Name of organizations & places of waste formation & placement	**Types of wastes**	**Amount of wastes, tons**	**Location of placement & occupied area**	**Distance to the Caspian Sea or inflowing river**
2. Drilled pit of well № 41	Loamy suspended matters, including bentonite, lignin-alkaline reagent, sodium dichromate	1,1	Vil. Reduktorny, base MGKH	
3. Drilled pit of well №1	Loamy suspended matters, including bentonite, lignin-alkaline reagent, sodium dichromate	1,5	Town Kizlyar, trust Kizlyarrisvodstroy	2.5 km from r. Terek tributary
LTD Caspiygazprom Drilled pit of well № 1	Sulphanole, oil products, lignin-alkaline reagent, sodium dichromate	100	Town Derbent 0.01 ha	2.0
OSA "Dagfos", plant of salt of phosphorus	Sludge collector	80000	3.2 ha	2.0 km to r. Sulak
RGUP "Dagnefteproduct"	Sludge collector (oil sludge storages of mechanical treatment of waste waters)	155,8	Territory of the enterprise 0.52 ha	0.5 km to the sea shore
OSA "Sudoremont"	Industrial operated-off oils, sand contaminated with oils, (oil content less than15 %), scrap iron, other wastes	267	City Mahachkala, tanker basin	On the sea shore
OSA Plant "Dagdiezel"	Operated-off mercury-iferous lamps & mercury containing tubes, brimstone acid, synthetic & mineral oils, galvanic bit cuttings, copper, zinc & titanium waste, metal cutting, scrap steel, other waste	638	Town Kaspiisk	0.5 km to the sea shore
Storage of industrial waste on the territory of the plant	Metals hydroxide (copper, nickel, ferrum, zink & others)	141	Territory of the plant 0.05 ha	-.-
OSA "Kaspiiskiy plant of Fine	Operated-off mercury-iferous lamps & mercury containing tubes, cupric chloride	43	Kaspiisk	1.4 km to the sea shore

Name of organizations & places of waste formation & placement	Types of wastes	Amount of wastes, tons	Location of placement & occupied area	Distance to the Caspian Sea or inflowing river
mechanics" Dirt collectors of neutralizing station	Chrome, copper, nickel & ferrum hydroxide	42	0.016 ha	
Administration of Mahachkala city 1 MSW polygon 2. MSW polygon	 MSW MSW	 2682750 112000	5 ha, 6 km from City Mahachkala 17 ha, 4 km from City Mahachkala	Соответственно 3,5 и 2 км от канала им. Октябрьской революции
Administration of Derbent city MSW polygon	MSW	1236000	Town Derbent, 4 ha	1.5 km to the sea shore
Administration of Kizlyar city MSW polygon	MSW	16500	Kizlyarskiy region, sand pit, 4 ha	1.5 rm from r. Terek
"Dagestan generatsiya" **OSA "YUGK –TGK – 8"** Mahachkala thermo – electrical heating station 1. Site B1 with non - permeable coating (asphalt), open reservoir 2. Closed site B2 with non - permeable coating (asphalt), impermeable reservoir 3. SiteB3 – storehouse (enclosed space)	Mercuryferous lamps & mercury containing tubes, operated-off lead accumulators with non-drained off electrolyte, sand contaminated with petrol (15 % & more petrol) MSW, greased wipe-off rag, waste of coating composition, waste of asbestos & others Oil sludge from reservoir cleaning, stratum contaminated with oil products, spent engine oil, steam-turbine oil & dielectrical oil. Operated-off mercury-iferous lamps, & thermometers, metal junk of lead accumulator storage batteries, sulfuric acid	1,6 21 185 0,9	Mahachkala port	0.01 km to the sea shore

Name of organizations & places of waste formation & placement	Types of wastes	Amount of wastes, tons	Location of placement & occupied area	Distance to the Caspian Sea or inflowing river
4. Site B4 – open site with non - permeable coating (asphalt)	Metal junk of ferrous metal & non-ferrous metal, roasted product of welding electrode, chippings of non – ferrous metal	12		
Kaspiiskaya thermo –electrical heating station, branch of OSA "YUGK–TGK–8"			Town Kaspiisk 9 ha	0.01 km to the sea shore
1. Site B1 with non - permeable coating (asphalt), open reservoir	MSW, waste of offloaded insulator, construction debris, recrement & hearth cinder, waste of coating composition, waste of asbestos	168		
2. Closed site B2 with non - permeable coating (asphalt),	Stratum contaminated with oil products, Oil sludge from reservoir cleaning, operated – off engine oil, steam-turbine oil & dielectrical oil.	14		
3. Site B4 – open site with non - permeable coating (asphalt), in bulk	Metal junk of ferrous metal & non-ferrous metal, chippings of non – ferrous metal	51		
4. Site B5 – Open site with non - permeable coating (asphalt), in bulk	Oil sludge of water treatment systems, scrap brick	33		
OSA "Dagenergo Derbentskiye electrical circuits"			Town Derbent	1.0 km to the sea shore
Metal containers with Operated-off oils (guard rail is available, no permission for allotment of land)	Operated-off oils: dielectrical oil & engine oil	1,4		

Annex 4: Inventory of priority pollution sources in the Turkmen Sector

Etrap Turkmenbashi, territory (of khykimlyk) Hazar/Esenguly etrap, as well as the towns of Turkmenbashi, Hazar, Garabogazgol adjoin to the coastal area of the Caspian Sea from the Turkmenistan side. All of them are located in the Balkan velayat. The Balkan velayat is located in the western part of the country & covers the eastern part of the Caspian Sea coast, the Atrek river basin, the Kurendag Mountains, the western part of the Kopet – Dag Mountains and the Kara – Kum desert.

The oil and gas production, oil refinery, power generation, food and light industry, fishery and cattle-breed are the major activities in the velayat. But, presently, oil and gas production, oil refinery, chemical and power industry branches are the most significant ones. 90% of Turkmenistan total oil expected reserves are concentrated in the Caspian Sea Turkmen shelf.

Agriculture is very limited due to lack of fresh water and salinity of soils.
In general, 2,46 mln sheep and 122 thous. cows and camels in Balkan velayat.

According to the available data there are no sources of pollution of the regional significance on the territory of Turkmenistan and its marine sector. The coast and the Turkmenistan coastal waters are relatively clean due to the low density of the population, lack of river run – offs, limited agriculture.

The major sources of pollution of the Caspian Sea aquatic area are enterprises of oil and gas producing, petrochemical, chemical and energy industries. The major industrial enterprises in the Caspian zone are the Turkmenbashi Oil Refineries Complex (the town of Turkmenbashi), thermoelectric power-and-heating station (the town of Turkmenbashi), the Hazar Chemical Plant (the town of Hazar), Industrial Enterprise “Garabogazsulphat” (the town of Garabogaz), the Turkmenbashi sea port (Department “Turkmendenizyollary”, the town of Turkmenbashi), industrial complex “Guvlyduz”.

The following industrial enterprises and public utilities are located in the coastal area of the Caspian Sea, but they are not direct sources of pollution, as there is no direct discharge from their activities into the Caspian Sea.

- The company “Dragon Oil” and the company “Petronas Chirigaly” conduct O&G extraction and marine prospecting in compliance with the principles of “Zero discharge” or “Without impact on the quality of marine environment”.
- The Turkmenbashi sea port (Department “Turkmendnizderyayellary”) after 1988 was connected to the city sewage system which discharges waste waters into the closed evaporative cavity in the desert zone located 20 km from the coastal line (Attachment 1).
- The Turkmenbashi city sewage system together with treatment facilities and pump stations (enterprise “Turkmenbashyagsuv” – “Vodokanal”) does not have a fixed discharge of the city waste waters into the Caspian Sea, but there are emergency discharges into the Soimonov Bay.
- The rise of the Caspian Sea level in the 1990-s flooded public owned treatment facilities of the town of Hazar. Immediately the industrial complex of public utilities in the town of Hazar laid the pipeline for the discharge of domestic waste water into the desert.
- Domestic waste water of the town of “Garabogazgol” (Bekdash) is discharged to evaporative fields located in the desert zone through the sewage collector (10.799 thousand m^3/year).
- Petroleum-storage depot “Kenar” (Ufrinskaya petroleum-storage depot) is administratively subordinate to the Turkmenbashi Oil Refineries Complex. Industrial waste waters flow to the treatment facilities of the petroleum-storage depot. After the mechanical treatment waste waters are discharged through the collector (26 km long) inward the territory to the natural cavity – the lake “Djamart”.
- Oil - production enterprises “Nebitdagnebit”, “Goturdepe”, “Gumdagnebit” are located in the coastal zone. The main waste is oil containing waste waters generated from associated - bedded water extracted from the bowels of the earth together with gas & oil. Associated - bedded water is discharged into the natural limited hollows, which are not connected with surface water.

- Enterprises involved in oil transportation are the following oil terminals: Ekerem, Aladja and Ufra.

Information on these land–based sources of pollution is provided in the Tables 1 to 3.

The main sources of municipal pollution are the towns of Turkmenbashi & Cheleken as the most populated settlements with more or less stable water supply. Though in Turkmenbashi the major direction of feces water discharge is at some distance from the shore & very often in emergency cases the water is discharged into the isolated Soimonov Bay, the poor technical capacity (equipment) on four pump stations located on the Turkmenbashi Bay shore lead to emergency discharge into this bay. The town of Hazar also has a practically non – operating waste water processing station half of which is in the water (due to the coastal zone degradation).

There are radioactive wastes at the Hazar Chemical Industrial Complex located to the north of the town of Hazar. Their storage site is a bit farther than 100 meters from the water-front & every year it is coming closer & closer due to the offshore coastal strip.

All the organized discharges in the town of Turkmenbashi are made into the Soimonov Bay. At present the ecological situation of the Bay has become worse and its pollution degree has increased. It should be noted that a special dam was built up to prevent the water of the Soimonov Bay from entry into the Caspian Sea. The Company “Emerol” (Ireland) is conducting a complex of scientific, research & monitoring works on the project of restoration of the Soimonov Bay natural resources. The information on the Bay pollution is provided in Attachment 2 and Table 4.

Information on oil- production enterprises (Table 3) of the administrative use is not provided in this report.

Oil & gas sector sources of pollution

Oil terminals are one of the significant potential sources of pollution. For the recent years oil & oil products transportation from terminals in Turkmenistan has drastically increased. The main terminals of oil & oil products transportation on the Turkmen shore are terminals in Ekerem (the south), Aladja (the Cheleken peninsula), Ufra (the Turkmenbashi Bay) and the port of the company “Dragon Oil”. Though officially there have not yet been big oil spills, potential oil spills can have a great impact on pollution & add up to the existing threats from ballast & bilge waters from vessels. The construction of gas terminal in Gyaynly is planned but it is envisaged it will be quite safe.

Oil & oil products storage spots are potential sources of pollution; some of them are located near oil terminals (Ufra, Ekerem), others are located at some distance. A specific attention should also be given to “Dragon Oil” oil storage stations to the south – west of the town of Hazar & “Turkmenneft”.

Residual spot located to the south of town of Hazar. Due to the offshore coastal strip degradation (destruction) fuel-oil residue together with soil is washed off into the sea.

Associated waters generated from oil and gas extraction. Though part of associated waters is pumped back into wells, there appeared lakes of associated waters near big deposits. Sometimes in the process of drilling (prospecting & oil production) there occur oil fountains or just water discharges which also generate such lakes. With the increase of the sea level or increase in the number of such lakes, they may contact the sea. The main “hot spots” are deposits (from the south to the north) Akpatlavuk, Keimir, Kamishlydja & Koturdepe.

Restoration Plan for Soimonov Bay[11]

There is a special programme to remediate the Soimonov Bay. This is mainly in hands of Emerol.
The plan contains following sections:

- Brief information on Soimonov bay
- The history of pollution of the bay
- Brief description of the current state of the bay
- Hydrocarbon and chemical pollution
- Bacteriological study
- Monitoring of biological diversity
- Projects to cleanup Soimonov bay
- Environmental Impact Assessment (EIA) Project
- Project on Maximum Allowable Discharges (MAD)
- Project on treatment facilities
- Project on ground water cleaning
- Project of solid waste disposal.

The substantial investments for environmental protection have been made for reconstruction of treatment facilities of the Turkmenbashi Oil Refinery and recovery of biodiversity of the Soimonov bay. The project was secured by the Decree of the President from March 2002 “About signing the contract on realization of the first phase of environmental projects in Turkmenbashi Oil Refinery”.
The first phase of environmental projects includes:

- Construction of new treatment facilities in the Refinery
- Conduction of scientific research and monitoring works in Soimonov bay
- Elaboration of projects on EIA and MAD (maximum allowable discharge), on the reconstruction of the refinery’s sewerage system, on the introduction of recycling water supply system, on the utilization of oil sludge, and on the catch of hydrocarbons from discharge into the air.

The total amount of investment in the first phase equals 27,315,000 US Dollars. Presently, Emerol Company utilized 34% of total investment, or 9,338,534 US Dollars[12].

The second phase includes:

- Soil recultivation, cleaning and recovery of the biological potential of Soimonov bay
- Reconstruction of the recycling water supply
- Utilization of oil sludge and oil-containing soils
- Equipping reservoir system with the system of air pollution prevention
- Implementation of the project to prevent discharge of polluted ground waters into the Caspian Sea.

Emerol Company is the main implementer of the project. Emerol invests in the project with the following disbursement from Turkmenistan by oil products from the refinery. From Turkmen side the contractor is Turkmenbashi Oil Refinery, the controlling body in the government – the Cabinet of Ministers of Turkmenistan.

Master Plan for Cheleken[13]

It is recommended to prepare an environmental master plan for remediation and mitigation of environmental impact for the whole Cheleken area. The environmental master plan should include all major environmental issues covering the mentioned and additional environmental impact, which may be identified in the future. The

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[11] Source: CEP-SAP REPORT ON SOYMONOV BAY, Ashgabat 2006
[12] Source: SAP/NCAP Implementation Review; Ashgabat, 2006
[13] Source: CEP Report: Summary Findings of the Caspian Centre for Pollution Control; May 2000

implementation of the environmental master plan for Cheleken is expected to identify feasible Priority Investment Projects. The master plan should as a minimum include the following

- remediation of areas with radioactive pollution
- improvement of pollution control of the iodine factory and assessment of the economic viability of the plant
- improvement of pollution control of the technical carbon factory, and assessment of the economic viability of the plant
- establishment of municipal sewerage collection system and treatment from Cheleken area
- establishment of reception facilities for ballast water
- improvement of pollution control in the oil fields located in the city.

Table 1: Inventory of point pollution sources (Turkmen sector)

#	Name of the source of pollution (SP)	Source of pollution category based on GIWA	SP location			Pollutants discharged with waste waters (tons per year)									
			Distance to the nearest town, km	River or name a water body	Distance to the Caspian Sea, km	Volume (m^3/year*10^3)	BOD	Phenols	NO_3-N	Oil products	NH_4-N	Solid residuals	SSAS	TSS	Fe
1	Turkmenbashi Oil Refineries Complex	353005	On the territory of the town of Turkmenbashi	The Soimonov Bay	The Caspian coast	12.264	829	10,608	1,193	90,0	13,35	17.100	8,62	132,0	-
2	Thermoelectric power and heating station Turkmenbashi	39	On the territory of the town of Turkmenbashi	The Turk-menbashi Bay, the Caspian Sea	The Caspian coast	605.835 720 CTIW		-	0,022	-	0,003	-	-	-	0,013
3	“Garabogaz-sulphat” Industrial Association	35	On the territory of the town of Garabogaz	The Caspian Sea	The Caspian coast	1195		-	-	0,02	-	-	-	-	-
4	Chemical Plant “Hazar”		On the territory of Hazar/ Cheleken	Infiltration in desert	The Caspian coast	5682				0,003					0.026
5	“Dragon Oil”		the town of Hazar/ Cheleken	The Caspian Sea	The Caspian coast	1,6 1	120	0,004		0,03	69,3		2,08		19,8
6	“Petronas Chari-gali”			The Caspian Sea	The Caspian coast	3,6	0,5			0,051					

#	Name of the source of pollution (SP)	Source of pollution category based on GIWA	SP location			Pollutants discharged with waste waters (tons per year)									
			Distance to the nearest town, km	River or name a water body	Distance to the Caspian Sea, km	Volume (m^3/year*10^3)	BOD	Phenols	NO_3-N	Oil products	NH_4-N	Solid residuals	SSAS	TSS	Fe
7	Public utility		the town of Hazar	The Caspian Sea	The Caspian coast	110	50					0,005			
8	Public utility		the town of Garabogaz	The Caspian Sea	The Caspian coast	11	53								
9	Petroleum-storage depot Kenar vil.		the town of Turkmenbashi	The natural cavity pond "Djamart"	26	628				0,003					
10	Industrial Association "Turkmen-bashiagyzsuv"		the town of Turkmenbashi	The Soimonov Bay	The Caspian coast	8000	0,42								
11	Turkmenbashi port		the town of Turkmenbashi	Kenar treatment											
	Total					**622186**	**1.053**	**10,612**	**1,215**	**90,107**	**82,65**	**17.100**	**10,7**	**132**	**19,84**

Source: Report Rapid Assessment of Pollution Sources (RAPS), Point and Diffuse in the Near Caspian Region (Turkmenistan); Ashgabat, 2007

Tabel 2: Inventory of sources of pollution by waste disposal in the Turkmen Sector

No.	**Name of the place**	**Location**	**Distance to the Caspian Sea (km)**	**Waste type**	**Area (ha)**	**Volume (m3)**	Comments
1.	**Soimonov Bay**		**0 km**	**Oily waste dumpsites and "masut-ted" land**			Partly under the Soimonov bay remediation plan
2.	Hazar/Cheleken			"Masutted" land			
3.	Oil production "Nebitdagnebit"		>100 km	Oil drilling sludge & "oily" soil			Oil waste from formation water from drilling site in coastal zone
4	Oil production "Goturdepe"		<100 km	Oil drilling sludge & "oily" soil			Oil waste from formation water from scattered oil wells
5	Oil production "Gumdagnebit"		<100 km	Oil drilling sludge & "oily" soil			Oil waste from formation water

Source: Report Rapid Assessment of Pollution Sources (RAPS), Point and Diffuse in the Near Caspian Region (Turkmenistan); Ashgabat, 2007

Remarks:

1. "Masutted" land is oil-saturated land which can reach 10 m deep.

Table 3: Concentration in mg/l of oil products and phenols in the Caspian Sea aquatic area of the Turkmen sector

The Caspian Sea area	2002		2003		2004		2005		2006	
	Oil products	Phenols	Oil products	Phenols	Oil products	Phenols	Oil products	Phenols	Oil products	Phenols
Turkmenbashi Bay	0,07	0,002	0,07	0,001	0,07	0,001	0,07	0,001	0,07	0,001
Garabogaz area	0,05	0,001	0,05	0,001	0,05	0,001	0,05	0,001	0,05	0,001
Hazar, the area of marine drilling	0,08	0,002	0,08	0,002	0,08	0,002	0,07	0,002	0,08	0,002
Turkmen Bay	0,08	0,002	0,08	0,002	0,09	0,0025	0,08	0,002	0,07	0,002
Ekerem area	0,06	0,002	0,06	0,001	0,06	0,002	0,06	0,002	0,06	0,002

MAC – Maximum Admissible Concentration for marine water used for fishery purposes:

Oil products (OP) – 0, 05 mg/l

Phenol – 0,001 mg/l

Table 4: Quality characteristics of the Soimonov Bay

(Area: outlet of the Soimonov Bay into the Turkmenbashi Bay)

Quality indicators	MAC	2002, mg/l	2003, mg/l	2004, mg/l	2005, mg/l	2006, mg/l
Oil products	0,05	1,88	2,65	0,76	2,43	2,88
Phenol	0,001	0,017	0,009	0,017	0,038	0,037
SSS	0,1	0,18	0,15	2,95	2,09	2,31
Weighted substances	+0,25 water of the water body	28,0	32,0	51,0	21,77	30,4

Source: NCAP 2007

Attachment № 1

Pollution in the area of the Soimonov Bay & activities on improving its ecological situation

Up-to-date computer technology was used for processing & interpreting the results of research of the Soimonov Bay pollution. The following data were obtained as a consequence of computer calculations & modeling:

- the volume of water in the bay depending on the level varies from **9** to **21 mln. cubic meters**;
- the volume of polluted bottom & coastal sediments is **9 mln. cubic meters**.

The results of work allowed identifying the main factors of technogenic impact on the Bay.

1. Salination as a result of lack of natural water rotation with the sea. As a result of intensive evaporation, water salt content in the bay is approaching the Garabogazgol parameters;

2. The run-off of ground waters polluted with oil waste (up to 6 thousand tons of oil waste per year);

3. Emergency discharge of city sewage run – offs & discharge of hotels' desalting units, the volume of public utility discharge can be compared to the volumes of plants' discharge; however, public utility run – offs enter the Bay without treatment &, therefore, are more hazardous;

4. Waste water discharge of Turkmenbashi Oil Refineries Complex. Up to the year of 1966, technological & emergency discharges were made without treatment (up to 20 thousand tons/year); they are the reason for the scope of current oil pollution of bottom sediments & coastal substratum. As from 1966 (waste treatment facilities commissioning), & especially from 1995 after the works on the plant's waste water treatment started, the discharge of oil waste with waste waters of the plant to the bay does not exceed 70 tons per year.

5. Entry of various pollutants from **unauthorized landfills** in the coastal, periodically flooded zone.

Pollution of substrata & eruptive rocks in the area of Turkmenbashi Oil Refineries Complex & the Soimonov Bay happens in two various ways. Oil pollutants either get on the surface & are filtrated into its depth or move under the ground on the surface of ground water table.

Thus, taking into account the ways of oil pollutants entry into the substratum, two zones of pollution of substrata & eruptive rocks in the area of Turkmenbashi Oil Refineries Complex & the Soimonov Bay are distinguished. In the first (western) zone covering the Soimonov Bay pollution is related to the entry of oil waste with the plant's waste waters (mainly in the 50-s - 60-s) on the surface of the bay water & their subsequent sorbing by coastal & bottom substrata. In the second, (Eastern) zone covering the territory of Turkmenbashi Oil Refineries Complex, pollution of substrata & eruptive rocks is due to the presence of lens of oil pollution collection CH3.on the ground water table.

In the **first Western zone** substrata polluted with oil waste are superposed on the soil surface & the bottom of the bay; their capacity changes from 0 m on the coastal line of the maximum water standing in the bay (-26,5 m at the beginning of the 40-ies) up to 20 – 30 cm.

The degree of bottom sediments pollution is concentrically increasing from the center of the bay to its shores. The multiple excess of the degree of shores pollution over the central part of the bay has a quite real physical justification. The surface oil slick or the layer of oil wastes is driven by the wind to this or that shore, thus increasing its pollution degree.

The content of oil waste in the surface layer of the bottom sediment (0.0-0.3 м) fluctuates from 1 – 5 mg/g of dry stratum in the central part of the bay up to 250 – 330 mg/g of dry stratum on some parts of the coastal line.

The capacity of polluted bottom sediments & stratum does not exceed 0.1 – 0.2 m on a large area of the central part of the bay.

The total high concentration of oil wastes in the bottom sediments is confined to the eastern part of the bay adjacent to the plant & places of emergency unloading of the city sewage run – offs. High concentrations are also registered in places of the former location of crude storage containers.

A significant amount of eruptive rocks contaminated with oil wastes is in the **Eastern zone** under the territory of Turkmenbashi Oil Refineries Complex. Their contamination is due to the availability of oil waste lens on the level of ground water & their run – offs into the bay.

However, one should mention that polluted eruptive rocks lie on significant depths under the zone of aeration (from 3 to12 m). The volumes of clean substrata covering them on the top exceed 10 mln. m^3. Therefore polluted eruptive rocks in the eastern zone under the territory of Turkmenbashi Oil Refineries Complex are not accessible for standard means of treatment. In the world practice eruptive rocks under these conditions are not cleaned with direct actions. The main objective is elimination of the source of pollution – lens of oil pollution collection CH3. After the lens elimination a long process of substrata & eruptive rocks autopurification occurs in-situ, which can be intensified with the biotreatment means (bacteriological means)

The average statistical capacity of the polluted layer calculated with the use of special computer programs made 0.3 m. These computer programs (Arc Info, Arc View) allowed calculating to a high precision the area of sites in the Western part of the bay subject to treatment in the first turn.

Under 30 – cm layer of polluted bottom sediments lies practically clean (low contaminated) layer; the concentration of oil waste in it does not exceed 1-6 mg/g of dry substratum. Small polluted plots with the concentration of oil waste 30-336 mg/g of dry substratum are confined to the above described plots of intensive pollution.

Plots subject to treatment

Plot №	Plot area ha	Capacity of a polluted layer, cm	Capacity of a layer subject to elimination, cm	Volume of strata & bottom sediments subject to elimination, thous. m^3
1	109	30	20	218
2	131			262
3	225			450
4	105			210
5	101			202
Total:	**671**			**1 442**

As a result of weathering processes, high-gravity bituminous oil fractions (asphaltogenic acids, lactones, polyester resins, carboides, carbenes) constituting the main part of pollution, are enriched with polyaromatic substances which are strong cancerogenes. Practically high concentrations of naphthalene, methylnaphthalene, naphthalene ethylene, fluorine, phenanthrene, anthracene, benzopyrene & other hazardous substances have been discovered in substrata & bottom sediments practically on the whole territory of the bay.

In the cleaned bay after the bottom & coastal zone treatment the following measures can be taken: restoration of a natural substratum cover & landscape, vegetation complex (in two variants – either natural or cultural for providing the city municipal needs), creating conditions for immigration of local species of terrestrial & aquatic flora & fauna.

№	Activities on treatment, redevelopment & restoration of the Bay area	Commencement of operations	Completion of works
1.	Conceptual project of the Bay treatment	08.2007	05.2008
2.	Project of ground water treatment from oil pollution	Preferably to start in 2007	On a permanent basis
3.	Construction of a new sewage system of Turkmen-bashi Oil Refineries Complex (with treatment facilities) & transition of the plant to circulating water supply	02.2007	12.2008
4.	Reconstruction of a sewage system of the town of Turkmenbashi, construction of treatment facilities & a desalting unit	Preferably to start in 2008	Preferably to finish in 2009
5.	Reconstruction of discharge facilities of Turkmen-bashi thermoelectric power-and-heating station	Preferably to start in 2008	Preferably to finish in 2009
6.	Construction of a new dividing dam	2007	2008
7.	Treatment of a western part of the Bay	2008	2009
8.	Disposal of polluted bottom sediment, substrata polluted with oil waste & solid waste disposed from the Bay	2009	
9.	Construction of a polygon of solid waste & waste processing plant	2009	
10.	Restoration of a natural water exchange between the bay & the sea		
11.	Restoration of a natural environmental potential of the Bay		
12.	Monitoring observations for ecological state of the environment	2008	On a permanent basis
13.	Compiling environmental protection documentation stipulated by the Turkmenistan legislature (MPE-Maximum Permissible Emission, MPD-Discharge, EIA- Environmental Impact Assessment	2008	On a permanent basis
14.	Redevelopment of the Bay in line with selected variant of this territory development within the tourist zone “Avaza”		

The necessity & expedience of a comprehensive regional & sectoral access approach is obvious for the solution of ecological problems in the whole Caspian region. Such approach should take into consideration all mentioned factors of anthropogenic impact, as well as envisaged increase of load on ecology due to the further social – economic development of the region.

Annex 5: Proposed Wastewater Discharge Standards for discharging into water bodies

No	Parameter	Unit (max.)	Emission limit values (ELV)		
			Discharged into Inland Waters		Discharged into Coastal Waters
			Sensitive Waters	General Waters	
1.	pH at ambient temperature	-	6.0 – 8.5	6.0 – 9.0	5.5 – 9.0
2.	Temperature	^oC	N+4	N+7	N+8
3.	Total suspended solids (TSS)	mg/l	30	50	100
4.	Biochemical oxygen demand (BOD_5 at 20^oC)	mg/l	30	50	100
5.	Chemical oxygen demand (COD)	mg/l	50	100	250
6.	Total phosphorus (as P)	mg/l	1	5	-
7.	Total nitrogen	mg/l	50	100	150
8.	Ammonia (NH_4 as N)	mg/l	0.5	1.0	5.0
9.	Cyanide (as CN)	mg/l	0.1	0.2	0.2
10.	Total residual chlorine	mg/l	0.2	1.0	1.0
11.	Chlorides (as Cl)	mg/l	500	1000	-
12.	Fluorides (as F)	mg/l	2.0	5	10
13.	Sulfide (as H_2S)	mg/l	1.0	2.0	5.0
14.	Arsenic (as As)	mg/l	0.1	0.2	0.2
15.	Cadmium (as Cd)	mg/l	0.1	0.2	0.5
16.	Chromium, total (as Cr)	mg/l	0.5	2.0	2.0
17.	Chromium, Hexavalent (as Cr^{6+})	mg/l	0.1	0.1	1.0
18.	Copper (as Cu)	mg/l	0.5	2.0	3.0
19.	Iron (as Fe)	mg/l	3.0	5.0	-
20.	Lead (as Pb)	mg/l	0.1	0.5	1.0
21.	Mercury (as Hg)	mg/l	0.0005	0.005	0.01
22.	Nickel (as Ni)	mg/l	0.5	2.0	5.0
23.	Selenium (as Se)	mg/l	0.05	0.1	0.1
24.	Zinc (as Zn)	mg/l	2.0	3.0	5.0
25.	Pesticides	mg/l	0.005	0.05	5
26.	Detergents/surfactants	mg/l	0.5	1.0	-
27.	Phenolic compounds (as C_6H_5OH)	mg/l	0.01	0.1	1.0
28.	Oil and grease (organic)	mg/l	5	10	20
29.	Mineral oil	mg/l	0.5	1.0	1.0

No	Parameter	Unit (max.)	Emission limit values (ELV)		
			Discharged into Inland Waters		Discharged into Coastal Waters
			Sensitive Waters	General Waters	
30.	Total coliforms	MPN/100 ml	1000	5000	5000
31.	Faecal coliforms	MPN/100 ml	40	100	100

Source: DHV internal documentation, 2000 (compilation of EU and USEPA standards)

Annex 6: Generic ToR for pilot pre-feasibility studies for selected mitigating scenario's

6.1 Generic ToR (format): *insert file <ToR for preparation of pilot pre-feasibility study (format).doc>*

6.2 Outline Feasibility Study for municipal wastewater: *insert file <Outline for Feasibility Study Municipal.doc>*

6.3 Outline Feasibility Study for industrial wastewater: *insert file: <Outline for Feasibility Study Industrial.doc>*

6.4 Outline Feasibility Study for waste disposal/polluted soil: *insert file <Outline for Feasibility Study Waste.doc>*

6.1 ToR for preparation of pilot pre-feasibility studies for selected scenario's (Format)

Caspian Environment Programme

Caspian Water Quality Monitoring and Action Plan for areas of Pollution Concern

TACIS/2005/109244

Title	
Country	
Sector	
Type	Pilot Pre-Feasibility Study
Objectives	
Activities	1. Field inspection 2. Geo-technical investigations necessary for the planning of the foundations and revetments 3. Soil and water analyses 4. Analyses and projecting 5. Initial cost and feasibility estimation 6. Reporting
Estimated Input	Staff: 1. International Industrial Engineer (KE4) 2. International Associate Expert (AE) 3. Local Environmental Engineer 4. Local Economist 5. Local Costing Specialist (civil engineering and mechanical works) Resources: 1. International experts: KE4: x days, AE: y days 2. Local expert: z working days 3. Interpretation 4. Travelling 5. Other expenses: PM
Expected Output	Pre-Feasibility Report (refer to attached outlines)
Remarks	
References	PM

6.2 Outline for (Pre-) Feasibility Study for Municipal Wastewater

1. BASELINE INFORMATION
   - 1.1. General
   - 1.2. Location of the WWTP and/or outlet
   - 1.3. Process Description WWTP
   - 1.4. Problem Identification
   - 1.5. Description of existing wastewater situation
2. PROJECT OBJECTIVES
   - 2.1. General Objectives
   - 2.2. Applicable Standards
   - 2.3. Required Reduction Efficiencies
3. PROPOSED PROJECT
   - 3.1. Project Identification
   - 3.2. Number of connected inhabitants (i.e. inhabitant equivalent)
   - 3.3. Wastewater Volumes and Composition
   - 3.4. Achievable Pollution Reduction
   - 3.5. System selection for (improvement of) treatment of wastewater
4. BASIC DESIGN WASTEWATER TREATMENT SYSTEM
   - 4.1. Process description
   - 4.2. Design criteria
   - 4.3. Technical Specifications
   - 4.4. Operation & Maintenance
5. COST ESTIMATE
   - 5.1. Unit Costs
   - 5.2. Manpower Input
   - 5.3. Capital Investment Cost
     - 5.3.1. Investment for sewerage to connect to the WWTP
     - 5.3.2. Investment for (improvement of) the wastewater treatment plant
   - 5.4. Treatment cost per inhabitant and per m^3 of sewerage
   - 5.5. Summary of Investment Cost
   - 5.6. Operational Cost
6. FEASIBILITY ASSESSMENT
   - 6.1. Financial Information of the public utility enterprise (PUE)
   - 6.2. Benefits
     - 6.2.1. Collected discharge levies
     - 6.2.2. Savings on non-compliance fees
   - 6.3. Cost Estimate
     - 6.3.1. Capitalized investment depreciation costs
     - 6.3.2. Annual operational costs
     - 6.3.3. Internal rate of return (IRR)
   - 6.4. Feasibility Analysis
     - 6.4.1. Assumptions
     - 6.4.2. Financial Feasibility
   - 6.5. Financial Appraisal
     - 6.5.1. Impact on the operation of the PUE
     - 6.5.2. Impact on cost of living for connected inhabitants
   - 6.6. Possibilities of Funding
     - 6.6.1. Funding from internal sources (wastewater levies)
     - 6.6.2. Funding from government (municipality)

APPENDICES:

6.3 Outline for (Pre-) Feasibility Study for Industrial Enterprises

1. BASELINE INFORMATION
   1.1. General
   1.2. Location of the Plant
   1.3. Process Description
   1.4. Problem Identification
   1.5. Description of existing wastewater situation
2. PROJECT OBJECTIVES
   2.1. General Objectives
   2.2. Applicable Standards
   2.3. Required Reduction Efficiencies
3. PROPOSED PROJECT
   3.1. Project Identification
   3.2. Wastewater Volumes and Composition
   3.3. Achievable Pollution Reduction
   3.4. System selection for treatment of wastewater
4. BASIC DESIGN WASTEWATER TREATMENT SYSTEM
   4.1. Process description
   4.2. Design criteria
   4.3. Technical Specifications
   4.4. Operation & Maintenance
5. COST ESTIMATE
   5.1. Unit Costs
   5.2. Manpower Input
   5.3. Capital Investment Cost
      5.3.1. Investment for in-plant measures
      5.3.2. Investment for water conservation and recycling
      5.3.3. Investment for wastewater treatment
   5.4. Summary of Investment Cost
   5.5. Operational Cost
6. FEASIBILITY ASSESSMENT
   6.1. Financial Company Information
   6.2. Benefits
      6.2.1. Savings on direct costs
      6.2.2. Savings on indirect costs
      6.2.3. Savings on discharge levies and non-compliance fees payable
   6.3. Cost Estimate
      6.3.1. Investment costs
      6.3.2. Operational costs
   6.4. Feasibility Analysis
      6.4.1. Assumptions
      6.4.2. Financial Feasibility
   6.5. Financial Appraisal
      6.5.1. Impact on operational cost of the plant/site
      6.5.2. Impact on product price and competitiveness
   6.6. Possibilities of Funding
      6.6.1. Funding from internal sources
      6.6.2. Funding from government
      6.6.3. International funding

APPENDICES:

6.4 Outline for (Pre-) Feasibility Study for Waste Dumpsites

1. BASELINE INFORMATION
   1.1. General
   1.2. Location of the Site
   1.3. Situation Description
   1.4. Problem Identification
   1.5. Description of pollution situation
2. PROJECT OBJECTIVES
   2.1. General Objectives
   2.2. Applicable Standards
   2.3. Required Remediation Facilities
3. PROPOSED PROJECT
   3.1. Project Identification
   3.2. Waste Volumes and Composition
   3.3. System selection for remediation
4. BASIC DESIGN REMEDIATION SYSTEM
   4.1. Process description
   4.2. Design criteria
   4.3. Technical Specifications
   4.4. Operation & Maintenance
5. COST ESTIMATE
   5.1. Unit Costs
   5.2. Manpower Input
   5.3. Capital Investment Cost
      5.3.1. Investment for in-situ measures
      5.3.2. Investment for removal and disposal
   5.4. Summary of Investment Cost
   5.5. Operational Cost
6. FEASIBILITY ASSESSMENT
   6.1. Financial Site Information
   6.2. Benefits
   6.3. Cost Estimate
      6.3.1. Investment costs
      6.3.2. Operational costs
   6.4. Feasibility Analysis
      6.4.1. Assumptions
      6.4.2. Financial Feasibility
   6.5. Possibilities of Funding
      6.6.1. Funding from internal sources
      6.6.2. Funding from government
      6.6.3. International funding
      6.6.4. Funding from commercial sources
7. Financing Plan

APPENDICES:

APPENDIX 1 LOCATION (Situation map and site lay-out and demarcation)
APPENDIX 2 MAP OF IN-SITU WORKS
APPENDIX 3 MAP OF SITUATION AFTER REMEDIATION
APPENDIX 4 COST SPECIFICATIONS

Annex 7: Priority calculation of land-based pollution sources

Insert file: < Point source priorities rev1.xls>

Annex 8: Minutes of Workshop for National Sector Experts July 2008

Insert files:
<Minutes of country meetings July 2008.doc>
<National Priority SP sites.doc>
<Ranked Regional Priority Sources of Pollution.doc>

Appendix 3. Pre-Feasibility studies

Thermal Soil Treatment Process

1 Thermal Treatment Process

The Thermal treatment unit developed by Soil Recovery A/S (Thermal Desorption Unit Model 500) is built into a standard 40 ft container, therefore it is mobile and can be erected and operated without substantial advance ground preparation. This allows for the equipment to be relocated to other treatment locations should it be deemed necessary.

The technical specifications for the Soil Recovery Thermal Treatment Unit Model 500 are listed below.

- **Plant Description** — **Thermal oil-electric combi unit**
- **Electric Capacity** — **300 kW**
- **Thermal power (Boiler Capacity)** — **800 kW**
- **Nitrogen demand** — **approx 0.2 m^3/h**
- **Burner Fuel type** — **diesel oil/waste oil**
- **Expected fuel consumption** — **80kg/hr**
- **Electric installation** — **400V 50Hz**
- **Process temperature** — **max 540 ^oC**
- **Product temperature** — **240-530 ^oC**
- **Treatment Capacity** — **upto 2500 kg/hr**
- **Container Dimension** — **standard 40-ft container**
- **Total Weight** — **40 tonnes**

Figure 1 outlines the main processing components of the TDU. A flow diagram of the ITD process is provided in Figure 2. The main processing components listed as below are further described in this section:

1. Pre-treatment
2. Feed Hopper (Product inlet)
3. Main Processor & High Temperature Section
4. Outlet and collection container for solid residuals
5. Condenser & Cooling Unit (Convector)
6. Separator
7. Oil/water discharge
8. Boiler for thermal oil (heat transfer oil)

1.1 Pre-treatment

The cuttings composition will vary considerably depending upon well conditions experienced during different stages of drilling and the different drilling locations. To maximise the efficiency of cuttings treatment an optimal composition of cuttings is desirable in terms of viscosity, water and oil content. Homogenisation of the cuttings will facilitate regular and efficient throughput of cuttings. An excavator will be used to mix cuttings within the storage pit to achieve this composition prior to feeding into the treatment unit.

1.2 Feed Hopper

Once pre-treatment has been completed, the cuttings will be transferred, using an excavator, to a feed hopper. The feed hopper will be located outside of the main TDU containment unit. It will be sited over a cuttings storage pit to ensure that any spills do not contaminate the site.

The cuttings will be screened to allow for the removal of contaminating objects. The feed hopper provides controlled volumes of cuttings at the required rate through a self-cleaning, double-screw auger to a conveyor belt. This will deliver the cuttings to the main processor. Once in the TDU, the cuttings delivery process is fully contained to ensure that there are no atmospheric emissions and that safety risks are minimised.

1.3 Main Processor & High Temperature Section

The central processing unit is a specially designed rotary heat exchanger. The processor is a horizontal vessel divided into two sections of 10 heated discs each;

1. Closed loop circulation of thermal oil to heat the cuttings up to 340 °C. The heat exchanger is a hollow shaft with veins through which the heated oil is passed. An oil fired boiler system is used to heat the oil (10 discs are heated by this method).
2. Steel section incorporating electrical elements to further heat the cuttings up to 550 °C if necessary (10 discs are heated by this method).

The expected temperature required to volatilise Synthetic Based Muds containing LAO as the base fluid is 260 °C. This temperature will be closely controlled to avoid “cracking” the base oil and rendering it unsuitable for re-use. Cracking refers to the process by which hydrocarbon molecules are broken down into smaller or shorter chains. The hydrocarbons and water within the cuttings are transferred to a gaseous phase during the heating process and leave the processing unit by means of a low overpressure.

Should BP move to using low toxicity oil based mud the expected processing temperature requirements are likely to increase.

1.4 Condenser & Convector

The gaseous hydrocarbons and steam leave the processor through a dust trap which leads to a scrubber condensing unit where the vapours undergo controlled cooling and subsequent liquefaction. Liquefaction of the heated vapours is achieved using a cooled condensate sprayed into the unit. A separate closed loop cooling system is used to produce the cooled condensate, which is then pumped into the scrubber condensing unit.

Cooling of condensate is achieved via a heat exchanger situated within a cooling tower located next to the central processing unit. The condensate is in a closed loop, which exchanges its heat with a closed loop of re-circulated water. This closed loop of water is cooled in turn by a convector (air/water heat exchanger) and the cooling tower (an open-circuit system, using evaporation of water to cool the water in the closed loop).

The convector will be used to maintain the re-circulated water temperature at 40 °C, reducing the loss of water by evaporation from the cooling tower. The maximum expected water requirements for the cooling tower are approximately $12m^3$ per day during hot weather, when the convector is less effective since it uses air to cool the water in the closed loop. This water will be tankered daily to the Serenja Waste Management Facility from the SPS Yard using a vacuum tanker with a storage capacity of 16 m^3. There will be a continued re-circulation of water.

1.5 Separator

The liquid phase hydrocarbons and water are collected in a separation tank. Gravity separation occurs between the hydrocarbons and water. Two pumps are used to remove the separated liquids (base oil and water) from the tank to containers for recovery and further treatment, or re-circulation into the cooling process.

1.6 Outlet and Collection Container for Solid Residuals

Processed solids are discharged via an encased auger from the central processing unit to a skip container outside, allowing for ease of transfer to the interim storage location.

1.7 Boiler for Thermal Oil (HTO)

A boiler system is required to heat the oil (HTO) used in the heat-transfer process for the cuttings treatment in the central processing unit. The boiler itself is heated using an oil-fired burner and distributes the HTO through a circulation pump.

2 Utilities Consumption

Table Error! **No text of specified style in document.**.1 below provides an overview of the main sources of utility consumption expected during the operation of the TDU. Figures are derived from measurements conducted on a Soil Recovery Thermal Treatment Model 500 unit identical to the unit to be operated in Azerbaijan.

Table Error! No text of specified style in document.**.1 Utilities and Consumables Summary – Model 500 Thermal Treatment Unit**

Consumables & Utilities required	Design capacity Max.	Expected during operation
Oil to burner	80 kg/h	40 kg/h
Fresh water to unit	1.5m^3/h	0 m^3/h
Fresh water to cooling tower	2m^3/h	1 m^3/h
Electrical power	306.5kW	240 kW

Expected fuel consumption is estimated at 35 litres per metric tonne of treated waste, depending on the initial water content of the material. Fuel consumption will vary according to the consistency of cuttings. The fuel storage requirements for the site will be increased accordingly; the bunding around tanks will comply with the existing 110% capacity requirement.

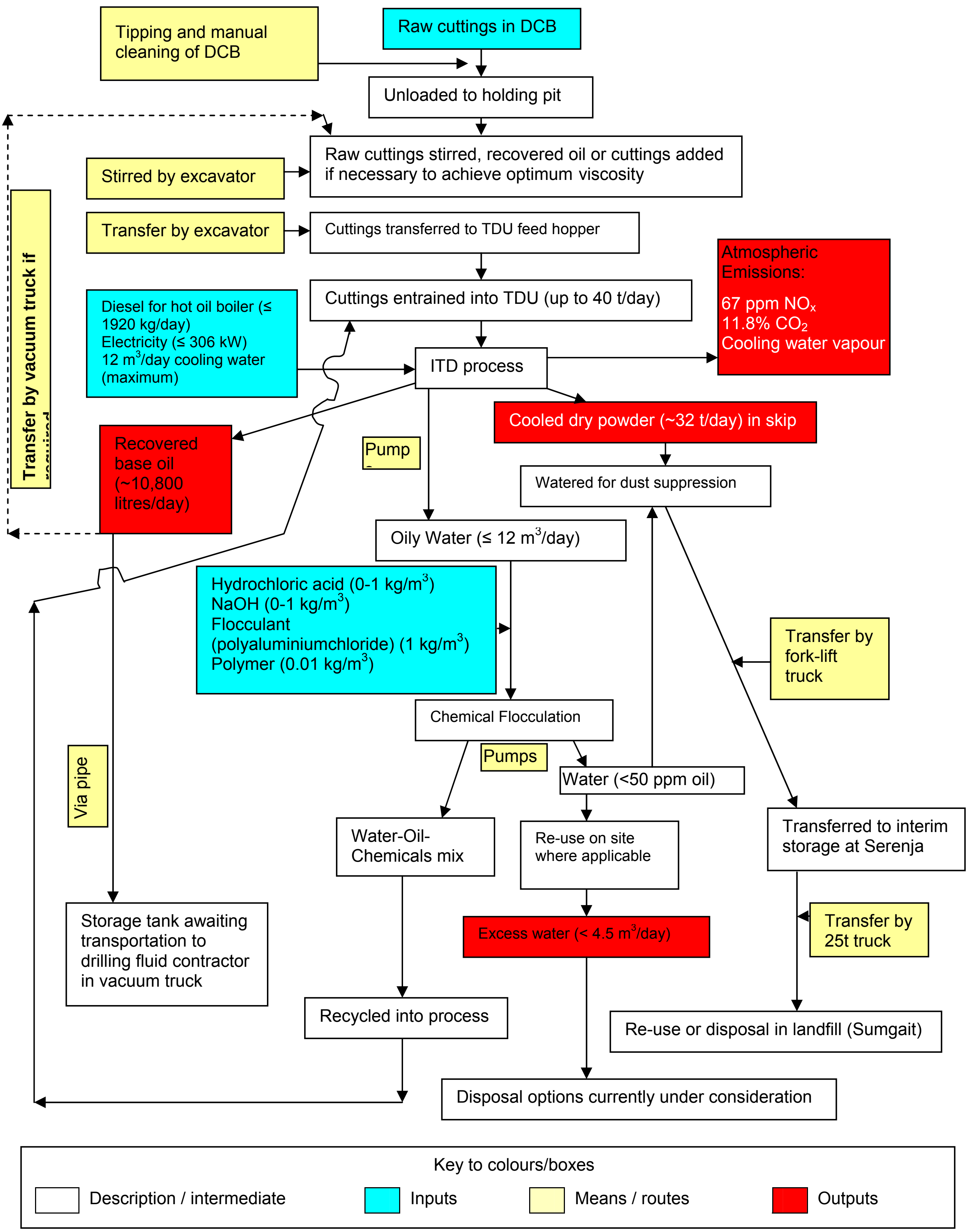
3 ITD Process Residuals

The outputs from the Indirect Thermal Desorption process are three end products:

- Recovered base oil
- Water
- Dried solid residuals

Table Error! **No text of specified style in document.**.3 lists some of the possible re-use and disposal options under consideration for these products.

Figure Error! No text of specified style in document.**.1 Flow diagram of the ITD Process at the Serenja Waste Management Facility**



3.1 Recovered Base Oil

The quantities of recovered base oil will vary according to the levels incorporated into the drill cuttings received at Serenja. It is estimated that cuttings containing approximately 15% drilling mud will result in the recovery of approximately 180 litres of base oil per tonne of materials treated. The recovered base oil will be collected in a separate storage tank outside the main TDU container. Once the tank is full the recovered base oil will be removed using a vacuum truck and transported to BP's drilling fluid contractors for re-use. Recovered base oil can also be assessed for possible use as a fuel source for the oil fired burners used to heat the TDU boiler system.

3.2 Water

On average, the ITD process will recover 50 to 100 litres of water per tonne of treated cuttings, depending on the initial water content of the cuttings. This wastewater will be contaminated with emulsified oil from the drilling mud recovered from the cuttings. The recovered water will be collected in a storage tank following gravity separation from the recovered base oil. It will be treated using chemical flocculation (as described below) to further remove the remaining hydrocarbons to a level below 50 ppm.

The treated waste-water will initially be collected in a recovered water holding tank before being re-circulated back into the treated cleaned cuttings. This is carried out to dampen down the fine solid residuals for the purposes of dust reduction and ease of handling. Excess water not required for re-circulation will either be re-used on site or uplifted and delivered to an appropriate location for further treatment and disposal. Excess water is expected to amount to 4.5 m^3 per day.

Chemical Flocculation Treatment

Following receipt of sufficient quantities of water, flocculant will be added to the storage tank. The pH of the water will be adjusted (pH 7-8) to ensure appropriate flocculation reactions once the polymer is added. The water will be left for 8 to 24 hours depending on the initial oil content to allow for separation of the 2 liquids. The water will be pumped to a separate storage tank whilst oily sediment and sludge will be removed to the cuttings storage pits for treatment in the TDU.

Table Error! No text of specified style in document.**.2 Estimated consumption of flocculant chemicals**

Chemical	Per m^3 recovered water	Per Year
Hydrochloric acid	0-1 kg	1100 kg
Lye (NaOH)	0-1 kg	1100 kg
Flocculant (poly-aluminium chloride)	1 kg	2000 kg
Polymer	0.01 kg	25 kg

The chemicals listed in Table Error! **No text of specified style in document.**.2 above will be stored in the existing hazardous chemicals storage area of the site in accordance with the existing approved procedures at Serenja.

3.3 Solid Residuals

The solid residuals will retain a residual hydrocarbon content from between 0.1-0.5%, after the addition of the re-circulated wastewater described in section 3.2. The metals content (**Error! Reference source not found.**,**Error! Reference source not found.**) will not change as a result of the thermal treatment process. The treated cuttings, which will be a friable dry powder, will leave the TDU via a conveyor belt and will be collected in jumbo skips. The solid residuals will be temporarily held within a designated area at the

Serenja site prior to disposal to landfill or re-use. Re-use is subject to leachability and geotechnical evaluation of the treated cuttings, which will take place on the first available batch of treated materials.

The temporary storage area will be designed to effectively minimise visual impact and dust generation, associated with handling, during its short lifetime. The storage area will also be designed to avoid the production of leachate by protecting the solid residuals from surface run-off.

4 Personnel Requirements

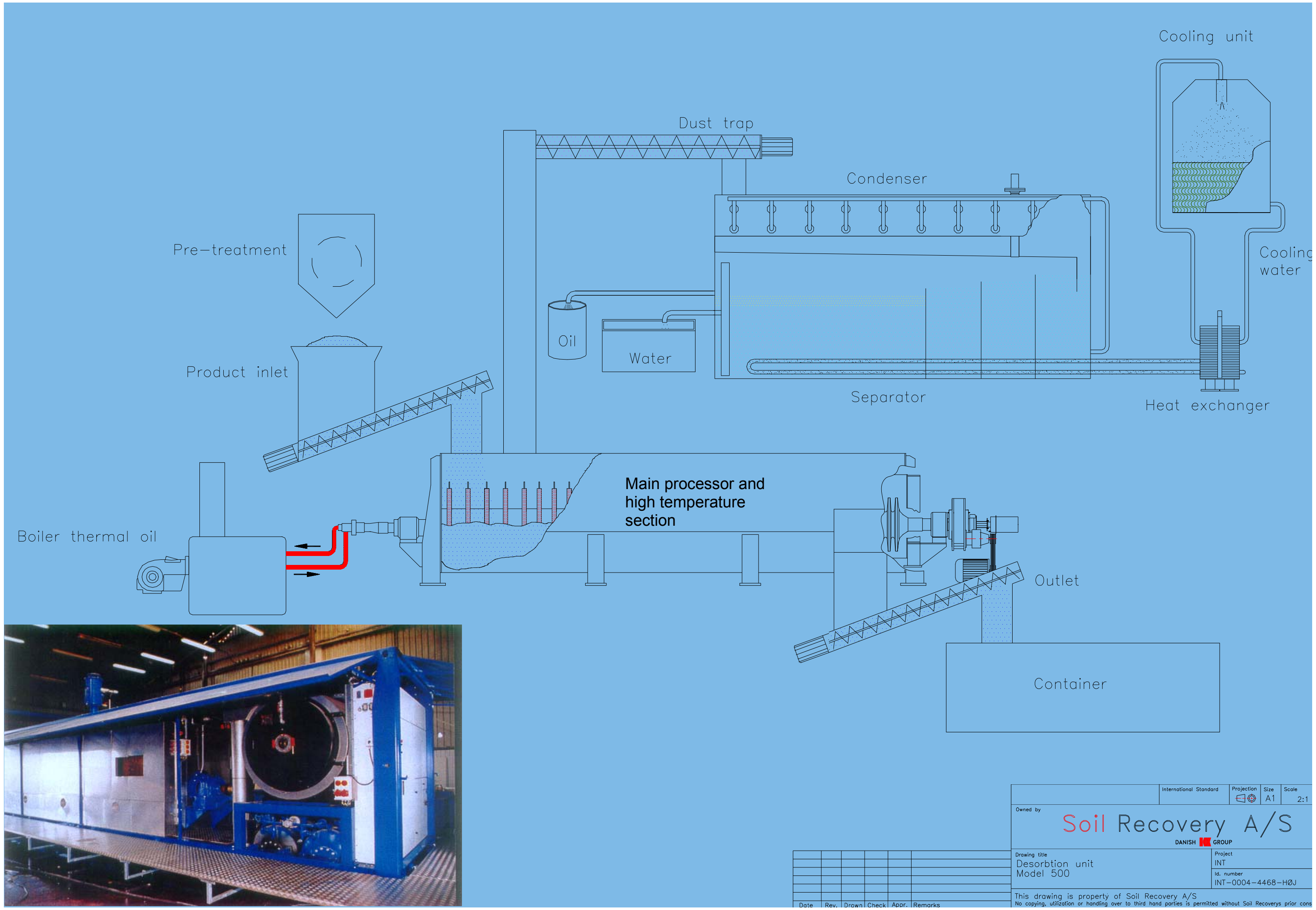
AA Services currently employ a total of 13 national staff during normal operations at the Serenja waste management facility. An additional 6 personnel will be employed as a result of the installation and operation of the TDU. Two expatriates will work on a rotational basis to oversee the operation of the unit during a 24 hour working day. It is intended that the expatriates will train Azeri personnel to assume one of these operational roles in the future.

AA Services will advertise locally on notice boards in the settlements of Shongar and Gizildach followed by interviews with potential candidates. Should no suitable applicants be found locally candidates will be sought from a wider area.

Table Error! No text of specified style in document.**.3** **Assessment for the Disposal of ITD Residuals**

End Product	Proposed Destination/Disposal route	Comment
Solid Residuals	Interim storage at Serenja in purpose built facility	▪ Will minimise HSE risk via wetting, cover & containment
	Final disposal to landfill (Base Case)	▪ Potential for use as cover material (mixed) or for engineering within the cell. Cover material is used to reduce dust and odour generation ▪ Sumgait National Hazardous waste landfill scheduled for delivery end 1st Q 2004 (interim short term storage is required)
	Reuse (Preferred option)	Potential re-use options include**;** ▪ Road building material for local road network or fill ▪ Landscaping projects ▪ Trench lining ▪ Construction of bricks and tiles ▪ Cover material for landfill cell ▪ Path construction ▪ Provision of fill for used Quarries Requires geotechnical and leachability evaluation prior to a trial. Options will be assessed on a risk based approach on a case by case basis
Recovered Base Oil	Dispatch to drilling fluid contractor for reuse in building OBMs and WBMs.	▪ Return to contractor who will manage its reuse in accordance with industry practice (QA/QC measures)
	Reuse as fuel	▪ Less likely as economically not as attractive and depends on quality restrictions for usage
Recovered Water	Re-use on site	▪ Evaluation for use in other site activities eg bioremediation trial, pending suitability and requirements
	Wetting cuttings to reduce dust	▪ Small quantities likely to be required - will vary according to throughput rates
	Sangachal Terminal Expansion Programme	▪ Introduction into STEP waste water treatment plant. – under assessment pending information on water quality
	Dispatch to drilling fluid contractor for re-use in building OBMs, WBMs and brines	▪ Under assessment pending information on water quality

Figure Error! No text of specified style in document.**.2 Main processing sections of the Soil Recovery AS Model 500 Thermal Treatment unit (inset photo of main processing unit)**



CASPIANMAP RPAP Prioritised Investment Programme

Pre-feasibility study for the pilot project for Municipal Sewage Treatment System of Atyrau and Restoration of the Tuhlaya Balka Sedimentation Tank

1. BASELINE INFORMATION		
1.1	General Information	The sedimentation/evaporation tank "Tuhlaya Balka" in Atyrau is one of the potential pollution sources for the Caspian Sea. By present time, the fields of this tank have accumulated around 50-70 million m^3 of highly contaminated liquid waste. This wastewater contains high concentrations of chlorides, ammonium salts, sulfates and heavy metals (copper, zinc, chromium, etc.). The concentration of oil products in wastewater reaches up to 200 MPC[1], phenol - from 20 to 80 MPC. As the Caspian Sea water level rises, it closely approaches the tank. During the surge the distance between the tank and the sea reduces to 3-4 km. In case of release of the tank water into the Caspian Sea, serious adverse environmental consequences are possible.
1.2	Location of the Site	The sedimentation tank «Tuhlaya Balka» is situated on the left-bank of Atyrau, and belongs to the evaporation fields of LTD «Atyrau Petroleum Refinery» (APR). Referred is to the attached location map (Annex 1). The tank is situated at about 1 km distance from the residential area of Atyrau. The river Ural is situated on 3,5 km from the tank, the shore of the Caspian Sea is more than 8 km.
1.3	Situation Description	The sedimentation tank annex evaporation fields were built in 1945. 20 industrial enterprises of the city discharge about 60,000 m^3 per day of sewage waters into the tank. At present time a huge quantity of contaminated liquid wastes is collected in the tank. All the domestic and industrial drainage of the left bank of Atyrau are also discharged to the evaporation fields without any treatment and neutralization. The evaporation fields are limited with earth embankment, which is destroyed in many places and does not protect from overflow of sewage in the lower places, and causes pollution of the ground water and the adjacent territories.
1.4	Problem Identification	The ecological danger for the Caspian sea is connected with the change (elevation) of the sea level and frequently repeated rundown-runup phenomena, which can lead to flooding of «Tuhlaya Balka» sedimentation tank followed by intense pollution of the off-shore part of the Caspian sea. The processes of flood of the Ural river delta are coarctated with the level regime. In the seafront, in connection with unidirectional rise of sea level, there is layer wise flood of delta, river valley and delta lowering. This process is activated during strong high flood. Flat slopes of seaside plain do not prevent the salt water intrusion to the sea coast. In the delta below Atyrau, during the high flood levels, the parts of the beach and coastal areas of dykes, dams, embankments of the road bed are flooded in the first place. The area of these sections from both arms at the mark in the riverbed - 26,25 m is not big (about 10 km2). At the mark in the riverbed - 25,00 m Yaik can be flooded for about 21 km2, and in the Golden – about 70 km2.
1.5	Description of Pollution Situation	Average daily rated sewage from the population and industry (except the APR) of the left bank of Atyrau will compose up to 70 thousand m^3/day (25,5 mln m^3 per year). The pollution concentrations and loads that are now-a-days discharged to the Tuhlaya Balka tank are displayed in the following table.

[1] MPC = Maximum Permissible Concentration (standard for pollutants in water)

Pollutant	Concentration mg/l	Load t/yr
BOD	250	6,375
Oil products	1	26
phenols	1.28	33
suspended matters	212	5,406
nitrogen ammonium	22	561
detergent	0.54	14
heavy metals (Cu, Cr and Zn)	0.6	15
arsenic	9	230

2. PROJECT OBJECTIVES

2.1	General Objectives	The general objective of the project is to eliminate the risk of serious contamination of the Caspian Sea by accidental release of Tuhlaya Balka natural sedimentation/evaporation tank of untreated urban waste water. The specific objective is improvement of sanitary epidemiological condition of the left bank of Atyrau and improve the social environment.
2.2	Applicable standards	Regulations of Republic of Kazakhstan for waste water reception in sewage systems of settlements, from 1.04.11.2002; Code of practice 2.04.03-1985 on Maximum industrial wastewater flows; Code of practice 4.01-02-2001 on Water use rate for the dwellings.
2.3	Required Remediation Facilities	To stop discharge of untreated wastewater to the Tuhlaya Balka tank by construction of a new sewage treatment facility (STF), including storage ponds and evaporation fields, at least 2 km outside of the Atyrau urban area. The natural Tuhlaya Balka tank will be restored and recultivated for other use. Part of the tank may be used as evaporation pond for treated effluent of the STF.
2.4	Local and Regional Environmental Benefits of the Project	Restoring of the tank and full treatment of the urban wastewater of the left bank of Atyrau would promote: - Elimination of risk of accidental release of heavily contaminated wastewater into the Caspian Sea; - improvement of the ecological situation in the coastal zone; - improvement of the social environment and public health of the Atyrau population.

3. PROPOSED PROJECT

3.1	Project Identification	Construction of a modern biological wastewater treatment plant including disinfection, effluent stabilization ponds and storage for reuse, and evaporation fields for the total urban sewage of the West bank of Atyrau with a capacity of 70.000 m^3/d an efficiency of at least 95%..
3.2	Waste Volumes and Composition	The wastewater volumes for year 2005 and projected for year 2015 to be treated are presented in the table below. For the pollution concentrations and achievable reductions is referred to the attached description of the treatment system (refer Annex 1)

Wastewater source	Wastewater volume (10^3.m^3/day)	
	2005	2015
Population	31.24	51.0
Industry (except APR)	18.54	18.54
Total for STF left bank	49.8	±70.0
Sewage system of APR	27.4	27.4
Total for the left bank with APR	77.2	97.0

		Total for city, reuse and evaporation ponds — 104.1 — 127.0
4. CONCEPTUAL DESIGN REMEDIATION SYSTEM		
4.1	System Selection for Remediation	The Sewage Treatment Facility (STF) for secondary biological purification will consist of the following main elements: - primary radial settling tank - aeration tank (aerotank); 2 sections of the aeration tank are fitted with «synthetic algae» - secondary radial settling tank - evaporator fields with separation of part of the area for the facilities of stabilization ponds. - disinfection is provided by chlorination. Excess sludge together with sediment from primary settler is directed for fermentation to aerobic stabilizers. After stabilization the sediment is pumped over to the sludge bank by the pump station. Sludge water from the sludge banks is pumped over to the STF. Dry sediment undergoes composting on the areas.
4.2	Process scheme of remediation measures	Not available yet
5. COST ESTIMATE		
5.1	Energy cost (fuel, electricity, etc.)	Not applicable yet
5.2	Manpower Input	Not applicable yet
5.3	*Capital Investment Cost*	
5.3.1	Investment for permanent on-site installations	Construction cost of the sewage treatment facilities is 2.457.776,87 thousand tenge (16,358,179 US dollars). Construction cost of the head sewage pump station is 713.890,88 thousand tenge (4,759,272 US dollars) Construction cost of the pond-evaporators is 1.717.587,24 thousand tenge (11,450,581 US dollars)
5.3.2	Investment for removal and treatment of polluted soil	Not applicable
5.4	Summary of Investment Cost	The total capital investment cost are estimated at USD 32,568,032
5.5	*Operational Cost*	
5.5.1	Operation & Maintenance	Not applicable yet
5.5.2	Waste Disposal/Treatment	Not applicable yet
5.5.3	Environmental Monitoring	Not applicable yet
6. FEASIBILITY ASSESSMENT		
6.1	Financial Site Information	Not available yet
6.2	Anticipated financial benefits	Not available yet
6.3	*Feasibility Analysis*	
6.3.1	Assumptions	
6.3.2	Financial Feasibility: Cost-Benefit Analysis (CBA)	Not possible yet, to be carried out after basic design and detailed cost estimate
6.3.3	Least cost analysis	Not provided
6.4	*Possibilities of Funding*	
6.4.1	Funding from internal sources	
6.4.2	Funding from government	- Local government (municipality) - National government
6.4.3	International funding	- World Bank loan - Asian Development Bank loan - European Bank for Reconstruction and Development loan
6.4.4	Funding from commercial	Both population and industries will be charged a service fee.

	sources	If the service fee per m^3 of wastewater for the consumers on an average is 30 tenge (0,2 US dollars), then revenues from dues and fees will be approximately 5 mln US dollars per year. The pay-back time will than be 7 to 8 years
6.5	Financing Plan	Not available yet

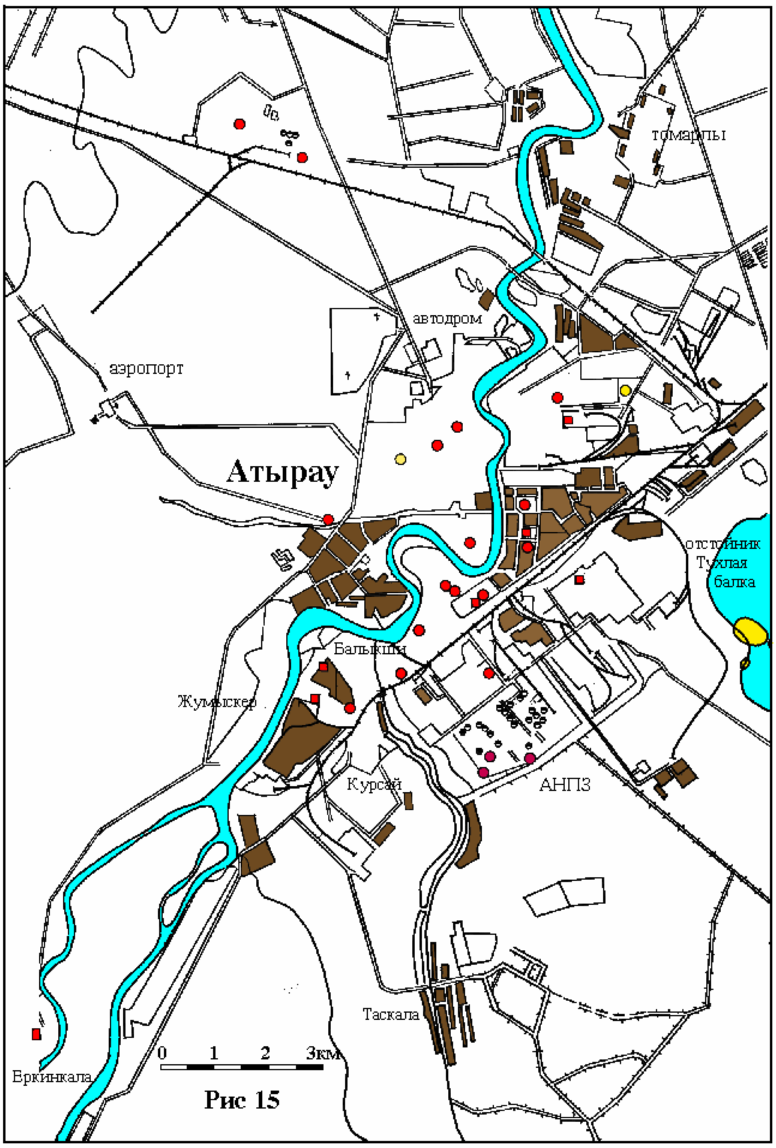
ANNEXES:

ANNEX 1 Location Map

ANNEX 2 Description of Wastewater Treatment System; insert file <Draft Pre-Feasibility Scheme Municipal WWTP Atyrau_Eng.doc>

CASPIANMAP RPAP Prioritised Investment Programme

Annex 1: Situation Map of Atyrau and Tuhlaya Balka



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ANNEX 2 Description of Wastewater Treatment System

Insert file <Draft Pre-Feasibility Scheme Municipal WWTP Atyrau_Eng.doc>

Pre-feasibility study for the pilot project "Controlled Discharge of Municipal Stormwater Drainage in City of Astrakhan"

1. BASELINE INFORMATION		
1.1	General Information	Annually 540,000 m^3 of polluted run-offs on average is passing through the stormwater-drainage collection system from the territory of Astrakhan and is discharged by pump stations to the Volga River Delta. A significant part of the above run-offs is also reaching the Volga Delta via self-flowing.
1.2	Location of the Site	Throughout the City of Astrakhan
1.3	Situation Description	There are no specially allocated land parts for local treatment facilities at the present time. From 14 organized storm-drainage waters collectors the discharges to the municipal canalization system are performed at two. Though it should be noted that these canalization treatment facilities of the city do not provide the clean-up of run-offs entered there up to the established norms.
1.4	Problem Identification	The summary amount of pollutants discharges is significant, but their discharge is distributed across 14 releases, for each of which it is not efficient to construct the treatment facilities.
1.5	Description of Pollution Situation	It is following from the studies that the following contaminants could be found in the category specified: heavy metals (iron, copper, zinc, lead), SS, oil-products, chlorides, sulphates and others.
2. PROJECT OBJECTIVES		
2.1	General Objectives	To reduce the discharge of contaminated stormwater into the Volga Delta and to organize the smooth drainage of stormwater from the paved surfaced in Astrakhan city.
2.2	Applicable standards	pm
2.3	Required Remediation Facilities	Considering the periodical character of stormwater run-offs during the year, their amount and pollution, alternate proposals could be assessed, related to the clean-up of the run-offs specified from pollutants per each of organized discharges. For instance, where possible merge the acting storm-drainage systems and establish a treatment system for them, or equip the pump stations with local treatment facilities that provide for clean-up of run-offs from the most hazardous contaminants.
2.4	Local and Regional Environmental Benefits of the Project	- Improved water quality in the Volga delta - Less toxic sedimentation in the Volga Delta - Less flooding in the streets of Astrakhan city
3. PROPOSED PROJECT		
3.1	Project Identification	Considering the periodical character of stormwater run-offs during the year, their amount and pollution, alternate proposals could be assessed, related to the clean-up of the run-offs specified from pollutants per each of organized discharges. For instance, where possible merge the acting storm-drainage systems and establish a treatment system for them, or equip the pump stations with local treatment facilities that provide for clean-up of run-offs from the most hazardous contaminants.
3.2	Waste Volumes and Composition	The total volume is 540,000 m^3/yr divided over 14 outlet locations. The discharge volumes of stormwater from the territory of Astrakhan by the storm-drainage pump stations is given in the following table.

Sites of discharges into the Volga delta	Stormwater amount, th. m^3/year
Discharge №1 into the Channel after May 1	32
Discharge №2 into the Kutum river	22

		Discharge №3 into the Kutum river — 11 Discharge №4 into the Kutum river — 38 Discharge №5 into the Volga river — 70 Discharge №6 into the Erik Kazachiy river — 20 Discharge №7 into the Erik Kazachiy river — 15 Discharge №8 into the Kutum river — 80 Discharge №9 into the Tzarev river — 70 Total — 358 2 pumping stations discharge to the exiting STP's and the remaining outfalls are free flowing into the Volga Delta. The pollutant concentrations and loads of 9 discharges are presented in Annex 1
4. CONCEPTUAL DESIGN REMEDIATION SYSTEM		
4.1	System Selection for Remediation	It is not efficient to direct the stormwater run-off to existing Sewage Treatment Plants (STP) because it will increase the hydraulic load, decrease the biological degradation process and can lead to hydraulic overloading and unwanted bypassing. Moreover the cost of sewage treatment will unnecessarily increase. The relevant decisions should be proposed for the Astrakhan executive bodies.
4.2	Process scheme of remediation measures	It is proposed to intercept the stormwater drainage releases before the pumping stations by so called 'equalization-sedimentation tanks', in which the stormwater is buffered to prevent overloading of the pumps causing possible flooding. The suspended solids can settle and are periodically removed to be processed at the existing Sewage Treatment Plants. The underground tanks should have no bigger footprint than 10 to 20 m^2 and must be designed on basis of the drained paved surface and the statistical hourly rainfall data. The retention time of the stormwater should be at least 1 hour under high rainfall conditions. To facilitate the easy removal of sludge, the tanks should be equipped with an automatic bottom scraper, sludge pump and sludge transport container.
5. COST ESTIMATE		
5.1	Energy cost (fuel, electricity, etc.)	Not available yet
5.2	Manpower Input	Not available yet
5.3	*Capital Investment Cost*	
5.3.1	Investment for permanent on-site installations	The capital investment cost of such systems are roughly estimated at about USD 100,000 each, including connecting pipe works and sludge removal facilities but excluding land acquisition. The total investment for 12 outfalls is than USD 1,200,000
5.3.2	Investment for temporary treatment, removal and disposal facilities	Not applicable
5.4	Summary of Investment Cost	The total investment for 12 outfalls is USD 1,200,000
5.5	*Operational Cost*	
5.5.1	Operation & Maintenance	Not available yet but generally low (electricity for control panel, scraper and pump)
5.5.2	Waste Disposal/Treatment	Not applicable unless STP is charging for sludge disposal
5.5.3	Environmental Monitoring	Not available yet
6. FEASIBILITY ASSESSMENT		
6.1	Financial Site Information	Not available
6.2	Anticipated financial benefits	Not applicable
6.3	*Feasibility Analysis*	

6.3.1	Assumptions	Assumed is that the necessary land (10 to 20 m^2 per installation) will be made available by the government for free. If not, the land acquisition cost should be included in the capital investment cost.
6.3.2	Financial Feasibility: Cost-Benefit Analysis (CBA),	Not applicable
6.3.3	Least cost analysis	Not available
6.4	*Possibilities of Funding*	
6.4.1	Funding from internal sources	Not applicable
6.4.2	Funding from government	- Local government (municipality) - National government (Republican and Federal)
6.4.3	International funding	- World Bank loan - Asian Development Bank loan - European Bank for Reconstruction and Development loan
6.4.4	Funding from commercial sources	Not anticipated
6.5	Financing Plan	Not available

Annex:

1. Pollution loads from stormwater drainage in Astrakhan; file <Pollution loads from stormwater drainage in Astrakhan.xls>

CASPIANMAP RPAP Prioritised Investment Programme

ToR for preparation of pre-feasibility study for reclamation of a sludge disposal site of Astrakhan Canalization Facilities

1. BASELINE INFORMATION		
1.1	General Information	The sludge produced at the southern wastewater treatment plants (WWTP) of the town's sewerage system, operated by MUE «VODOKANAL», are disposed off at a sludge disposal site. The indicated facility embraces an area of 3.6 hectares. On four beds 49 thousand m^3 of sludge of the WWTP's, cesspits and household drainage is accumulated.
1.2	Location of the site	Russian Federation, Astrakhan Oblast, City of Astrakhan, in 0.9 km northeast from airport.
1.3	Situation Description	The sludge bed grounds №'s 1-4 have filtration-proof concrete walls, in which deformation is reported, thereof, possibly, infiltration of polluted sewage waters into the ground waters is taking place.
1.4	Problem Identification	The sludge disposal site inventory report says that this object does not meet the state sanitary-epidemiological rules and norms.
1.5	Description of Pollution Situation	According to the observations (2002-2008) for sludge grounds the average values exceed the MPC of drinking significance as follows: - COD – in 19.8 times, - BOD_5 – in 9.9 times, - manganese – in 5.8 times, - SS – in 28.8 times, - phenols – in 162 times, - mineralization (solid residue) – in 6.6 times. As result of the sludge fermentation process the sludge beds are sources of atmospheric air pollution. According to calculations of maximum-single and gross pollutants discharges of the above beds as per separate contaminants are as follows (kg/year): - nitrogen dioxide (NO_2) 88, 2 - ammonia (NH_4) 348,6 - hydrogen sulfide (H_2S) 49,6 - carbon oxide (CO) 10281,0 - methane (CH_4) 418000, 0 - hydrocarbons mixture of saturated C_1 – C_5 938,4 - mixture of natural mercaptans 0,5
2. PROJECT OBJECTIVES		
2.1	General Objectives	Assess the technical abilities for cleaning-up the sludge lagoons and reclamations of grounds cleaned-up from wastes.
2.2	Applicable Standards	- "The List of maximum allowable concentrations (MOC) and tentative additional quantities (TAQ) of chemicals in soil" approved by main Sanitary Inspector of RF of 19.11.1991 #6229-91 with modifications of 27.12.1994 - The resolution of Main Sanitary Inspector of RF # 1 of 23/01/2006 "Introduction into operation of hygienic regulations GN2.1.7.2041-06", including MOC of chemicals in soil - The resolution of Main Sanitary Inspector of RF # 2 of 23/01/2006 "Introduction into operation of hygienic regulations GN2.1.7.2042-06", including TAQ of chemicals and chemical norms in soil
2.3	Required Remediation Facilities	Mechanical excavation of grounds and delivery elsewhere, as well as use of mineral fertilizers for biological reclamation
2.4	Local and Regional Environmental Benefits of the Project	Removal of a ground water and adjacent soil pollution source, as well as pollutants discharges into atmospheric air. Moreover, land area after reclamation will be available for economic needs.
3. PROPOSED PROJECT		
3.1	Project Identification	The Committee of Housing and Communal Services of the Astrakhan City Administration proposed to close and reclaim the

		WWTP sludge disposal site. The project will consist of removal of part of the existing sludge disposal beds and rehabilitation of the land for urban development purposes.
3.2	Waste Volumes and Composition	Sludge beds composition: - Solid residue contained a range of contaminants (lead, copper, zinc, mercury, oil-products and phenols); - Amount of solid residue in bed №1 - 2300 m^3, and in bed №2 - 6750 m^3. Totally 9050 m^3 (14480 t).
4. CONCEPTUAL DESIGN REMEDIATION SYSTEM		
4.1	System Selection for Remediation	Local specialists give a preference to technical and biological reclamation of the beds.
4.2	Process scheme of remediation measures	Not available
5. BASIC DESIGN REMEDIATION SYSTEM		
5.1	Design Criteria	Not available
5.2	Basic Design Text, Calculations and Drawings	Not available
5.3	Technical Specifications	Not available
5.4	Operation & Maintenance	Not available
6. COST ESTIMATE		
6.1	Unit Costs (man power, fuel, electricity, etc.)	Not available
6.2	Manpower Input	Not available
6.3	*Capital Investment Cost*	
6.3.1	Investment for permanent on-site installations	Not applicable (no permanent constructions)
6.3.2	Investment for temporary treatment, removal and disposal facilities	Baseline costs for reclamation will be connected with ground excavation and delivery, as well as with mineral fertilizers use for biological reclamation in-situ during 4 years. Estimated that 50% of the sludge has to be removed, the transport and disposal cost can be estimated at USD 25 -75 (ave. 50) per ton. Total cost can than be calculated as 0.5 * 49,000 * 50 = USD 1,225,000
6.4	Summary of Investment Cost	According to preliminary assessment total costs for reclamation will make 7 mln. rubles (about USD 230,000)
6.5	*Operational Cost*	
6.5.3	Operation & Maintenance	Not available
6.5.4	Waste Disposal/Treatment	Not available
6.5.5	Environmental Monitoring	Not available
7. FEASIBILITY ASSESSMENT		
7.1	Financial Site Information	
7.2	Anticipated financial benefits	At the present time the organization-owner pays for atmospheric air pollution some 2.5 mln. Rubles annually.
7.3	*Feasibility Analysis*	
7.3.1	Assumptions	That excavated soils for leveling can be disposed off at sanitary landfills at reasonable cost or can be used as fertilizer in agriculture (depending on the content of hazardous substances).
7.3.2	Cost-Benefit Analysis (CBA), Internal Rate of Return (IRR) or Net Present Value (NPV)	Not possible in this stage
7.3.3	Least cost analysis	The proposed method (partly excavation and in-situ biological reclamation) is generally acknowledged as a lengthy (4 years) but very cost-effective method because no thermal energy is required and transportation and disposal cost are limited because of the on-site reclamation.

7.4	*Possibilities of Funding*	
7.4.1	Funding from internal sources	In principle the investment cost should be generated by the ‘problem owner’, which is the Local Vodokanal.
7.4.2	Funding from government	Local government could be interested to develop the reclaimed area for community purposes
7.4.3	International funding	An EBRD loan seems the most likely opportunity.
7.4.4	Funding from commercial sources	Project developers could be interested to use the reclaimed land for urban development projects.
7.5	Financing Plan	Not possible in this stage

CASPIANMAP RPAP Prioritised Investment Programme

Pre-feasibility study for the pilot project "Establishment of specialized processing site for industrial waste products formed during well-drilling for oil extraction» at Dagestan"

1. BASELINE INFORMATION		
1.1	General Information	Considering the significant expansion of activities related to the oil and gas extraction at the Caspian Sea and its coast the priority actions to reduce the adverse impact of economic activity on the marine environment should be activities for collection and integrated treatment of drilling wastes of Oil and Gas Producing Plants (OGPP's) in an environmentally safe and economic feasible way. The Department on Technological and Ecological Supervision of Rostechnadzor of the Republic of Dagestan has proposed as a pilot project for CASMAP to consider and prepare a pre-feasibility study for establishment of a special general processing site for the whole Republic of Dagestan for collection, cleaning and neutralization of the above mentioned wastes for the purpose of reutilization, recovery and disposal.
1.2	Location of the Site	Russian Federation, Republic of Dagestan, City of Makhachkala area (no specific site location designated yet)
1.3	Situation Description	There are over 4 mln. tons of wastes of different types and hazard classes generated at the territory of the Republic of Dagestan at warehouses, drilling sites, dumps, disposal sites, and other objects for wastes storage. Provision of facilities of the majority of these objects does not meet the sanitary and environmental requirements.
1.4	Problem Identification	During the Dagestan shelf exploration of the Caspian Sea during 20 years, in the absence of treatment and utilization of wastes, the cost for the ecological damage will amount more than $2 mlrds. Calculation is made according to the current rates in the Russian Federation for evaluation of the negative impact on the environment.
1.5	Description of Pollution Situation	Objects for wastes generated during well drilling are representing the drilling sites where 130 th. tons of such wastes are concentrated, including around 8 th. tons of oil-containing wastes. The main part of these wastes is non-toxic (over 95%), mainly mineral cuttings. A significant part of oil drilling sites is located in the Caspian Sea coastal area. Each of these sites occupies not less than 0.15 ha of land and represents hazard of possible oil pollution of groundwater, surface water and the sea.
2. PROJECT OBJECTIVES		
2.1	General Objectives	1. Prevention of oil pollution of groundwater, surface water and the marine environment of the Caspian Sea and its coast. 2. Obtaining of drilling wastes treatment products for re-use aimed at economic needs.
2.2	Applicable standards	N.A.
2.3	Required Remediation Facilities	To address the above pollution concern it is proposed to establish a specialized site for collection and treatment of the mentioned waste group.
2.4	Local and Regional Environmental Benefits of the Project	Establishment of the site would promote: - improvement of the ecological situation at the places of oil & gas well drilling on the platforms, as well as in the coastal area; - decrease of risk and loss to the fish industry during the

		drilling and extraction at the sea platforms; - avoidance of ecological charges and penalties for the waste disposal; - rendering of service for the O&G drilling sector by reclamation of the oil contaminated waters, mazutted lands, bottom sediments of the seaports, treatment of ballast waters of marine and inland waterways, etc.; - usage of processed wastes for road building and other needs, and also reuse of the treated wastewaters; - land release, what is currently occupied with the drilling wastes and their transfer for domestic needs; - obtaining of additional long-term social-economic effects (public health, conservation of sea biodiversity and off-shore areas, growth of the ecological stability of the Caspian sea ecosystem).
3. PROPOSED PROJECT		
3.1	Project Identification	The proposed project will consist of the establishment of a special collection and processing site for oil & gas drilling waste for the whole coastal zone of Dagestan to be located in area of the City of Makhachkala. Refer for further details to the attached Process Description.
3.2	Waste Volumes and Composition	(see table below)
4. CONCEPTUAL DESIGN REMEDIATION SYSTEM		
4.1	System Selection for Remediation	Site construction and provision of equipment for integrated treatment of drilling wastes as developed by the company LTD «SINTECO-N» of Makhachkala. Other designs and suppliers are also possible, such as: - Thermal evaporation process of the firm "Alfa Laval" - Mechanical treatment technology of the firm "Certified Remediation Systems" (CRS Inc) - Steam thermol method (?).
4.2	Process scheme of remediation measures	Schemes for the processing of the different types of drilling wastes are provided in figures 1 and 2 of the attached Process Description.
5. COST ESTIMATE		
5.1	Energy cost (fuel, electricity, etc.)	Not available
5.2	Manpower Input	Not available
5.3	*Capital Investment Cost*	
5.3.1	Investment for permanent on-site installations	Land acquisition and construction of facilities: around US$ 2.5 mln. Technical installations: around US$ 1.5 mln.
5.3.2	Investment for temporary treatment, removal and disposal facilities	Not applicable (permanent installations)
5.4	Summary of Investment Cost	Estimated cost of the establishment of the treatment site can amount US$ 4 mln.

Table for 3.2 Waste Volumes and Composition:

Waste type	Total volume of wastes	
	th. t	th. m^3
Drilling sewage waters	893,7	893,7
Processed drilling mud, drilling slimes	696,6	348,3
Construction waste	413,3	275,5
Incidentally-reservoir water	62000	62000
Solid Wastes	1110,0	623,9

5.5	*Operational Cost*	
5.5.1	Operation & Maintenance	Not available yet
5.5.2	Waste Disposal/Treatment	The only waste is wastewater that will be transported to the municipal Wastewater Treatment Station.
5.5.3	Environmental Monitoring	No need for environmental monitoring as no air emissions and wastewater discharges will take place.
6. FEASIBILITY ASSESSMENT		
6.1	Financial Site Information	Not available yet
6.2	Anticipated financial benefits	In line with the norms for assessment of adverse impact on the environment of drilling wastes without treatment and their disposal in force in the Russian Federation according to the evaluation of authors of proposed pilot project (OOO “SINTECO-N”) the cost of environmental damage in 20 years will amount over US$ 2 billion.
6.3	*Feasibility Analysis*	
6.3.1	Assumptions	That the OGPP’s are willing to collect and transport their drilling waste to the general site and to remove the old waste from dumpsites and pits on their territory also to be processed in the new plant against the required service charges.
6.3.2	Financial Feasibility: Cost-Benefit Analysis (CBA), Internal Rate of Return (IRR) or Net Present Value (NPV)	To be calculated
6.3.3	Least cost analysis	Not available
6.4	*Possibilities of Funding*	
6.4.1	Funding from internal sources	Mobilization of resources of oil- and gas companies. Potential companies to participate and invest in the project are: 1. LTD NK “Rosneft – Dagneft”; Oil products: 1596 ton, 0,15 ha; Karabudahkentskiy region, Mahachkala, OGPD 2. OSA Plant “Dagdiezel” at Kaspiisk: Storage of industrial waste on the territory of the plant (638 + 141 on territory of the plant 0.05 ha) 3. RGUP “Dagnefteproduct”: 156 ton of oil sludge storages, 0.52 ha 4. LTD “Caspiygazprom”: 100 ton of drilling waste, 0.01 ha 5. OSA “Geotermneftegaz”: 8 ton of drilling waste,
6.4.2	Funding from government	- Local government (municipality) - National government (Republican and Federal)
6.4.3	International funding	- World Bank loan (not likely) - Asian Development Bank loan (not likely) - European Bank for Reconstruction and Development loan (most likely)
6.4.4	Funding from commercial sources	It seems possible to setup and exploit the site self-supporting on commercial basis with income from oil & gas companies for rendered services (removal of waste) and revenues from recovered oil and mineral aggregate.
6.5	Financing Plan	In a the first stage funds would be required for the acquisition and preparation of the land part and building of a fence and utility buildings; required investment around US$ 2.5 mln. The next stage after completion of stage 1 is purchase and construction of the installations at around US$ 1.5 mln.

Annex:

1. Process Description of Pilot Project for Industrial Waste Products
2. Cost Calculation (to be added by Leyla)

Annex 1: Process description of a special processing site for industrial waste products formed during well-drilling for oil extraction

Russian company LTD «Sinteco - N», which has work experience in reclamation of industrial and domestic waste handling, proposes the establishment of special processing site, where the cleaning and neutralization for the purpose of reutilization, recovery and disposal, will be accomplished, for:

a. drilling wastewater;
b. drilling sludge;
c. waste mud;
d. oil slurries and masutted soil
e. oily waters

The establishment of such processing site is quite up-to-date in connection with irrupting volumes of production, transportation and hydrocarbon processing. Besides that, the development of treatment techniques, reutilization and recycling of drilling wastes will allow to use the proposed method on the territory of other littoral states.

The processing of the above-mentioned group of wastes is proposed to carry out with the manufacturing equipment, which is grouped and located on the special processing site.

The biggest volume of the drilling wastes is composed of drilling wastewater. For their purification it is proposed to use an effective and technological method of treatment of these waters with coagulant and flocculant solutions for the purpose of quick deposition of the pollutants, with further division by the method of sedimentation on settling and refined part, which is off-the-shelf for the repeated application and utilization at the municipal treatment facilities.

Semi fluid waste products represent basically cuttings, contaminated with chemical reagents and materials. For the purpose of immobilization and burial improvements of the semi fluid waste products a baking method is used which turns the mentioned wastes into inert, nontoxic, consolidating mass, which can be used in road building (in the base course and road pitching) and during reclamation of the broken lay of land (open cast).

The main direction of utilization of the waste mud (accumulated during the process of drilling) must be its conditioning with the purpose of their repeated usage during the drilling of the following bores or division on centrifuge on the technical water and slurry.

With the help of the techniques the division of the oil-slurries on solid and liquid phases is implemented. The solid phase represents a ground with the oil products content, less than 7%. This ground is loaded in special containers and transported into the storehouse with the drilling sludge for the further solidification. The liquid phase is directed to the separation filter installation, where, the water is separated from the oil products, then, the oil-water emulsion is developed on the separator till the condition of the qualified usage as fuel oil. The water goes to the installation of purification of the drilling waste water and further to the storage capacitor with the industrial water.

Oil-slurry and mazutted grounds are usually formed in the oil-slurry deposits, oil outflow points, in surge tanks at the pump stations, etc. All these wastes will also be processed at the processing site.

During the processing of the oil wastes with the thermo-chemical methods with the following sedimentation the phase division occurs, after centrifugation of which the additional water extraction takes place, and slurry goes to the neutralization and consolidation and, further on, can also be used in the road engineering and reclamation.

Obtained oil products can be used for intended application (e.g. for satisfaction of processing site's needs in thermal energy).

It is proposed to carry out the treatment of oil-containing waters in two stages:

- removal of the suspended matters by the centrifugation;
- oil-water separation on the separator up to the normative level (1-2 mg/l).

The centrifugate is collected in the store-house of fuel oil and further can be used as fuel for processing site's boiler, and the separated water goes to the treatment installation of the drilling wastewaters, where it is collected in the tank with industrial water.

It is rational to locate the special processing site overland at the place of maximum concentration of the drilling wells and wastes delivered from the platform (for example, near the seaport Makhachkala).

On the well sites all the drilling wastes should be collected in special hermetical containers, with a volume of 4-6 m^3 and, after filling, they should be delivered to the processing site, where they are discharged and sorted out, according to the waste type, to the correspondent suction pit.

The planned technology productivity for the reclamation:

- bore mud - 6 $м^3$/hr
- drilling wastewater - 10 $м^3$/hr
- waste mud - 5 $м^3$/hr
- oil-slurry and mazzutted grounds - 4 $м^3$/hr
- oily water - 8 $м^3$/hr

Estimated cost of the processing site's establishment can amount $4 mlns.

Evaluation of the waste volumes, forming during the development and exploitation of the Dagestan shelf of the Caspian Sea to the hydrocarbons is given in the following table:

№	Waste type	Total volume of wastes		Type of waste danger
		thsnd. ton	**thsnd. m^3**	
1	Drilling sewage waters	893,7	893,7	IV
2	Processed drilling mud, drilling slurry	696,6	348,3	IV
3	Construction waste	413,3	275,5	IV
4	Incidentally-reservoir water	62000,0	62000,0	IV
Total				
	Solid Wastes	1110,0	623,9	IV
	Liquid Wastes	62893,6	62893,6	IV
	TOTAL	**64003,6**	**63517,5**	**IV**

The figures 1 and 2 present the schemes of the entire processing of drilling wastes, oil contaminated waters, oil slurry and mazutted lands.

CONTACT INFORMATION :
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Mungiev Ahmed Abdulovich – general manager

Figure 1 Scheme of waste processing, formed during well drilling on the special processing site

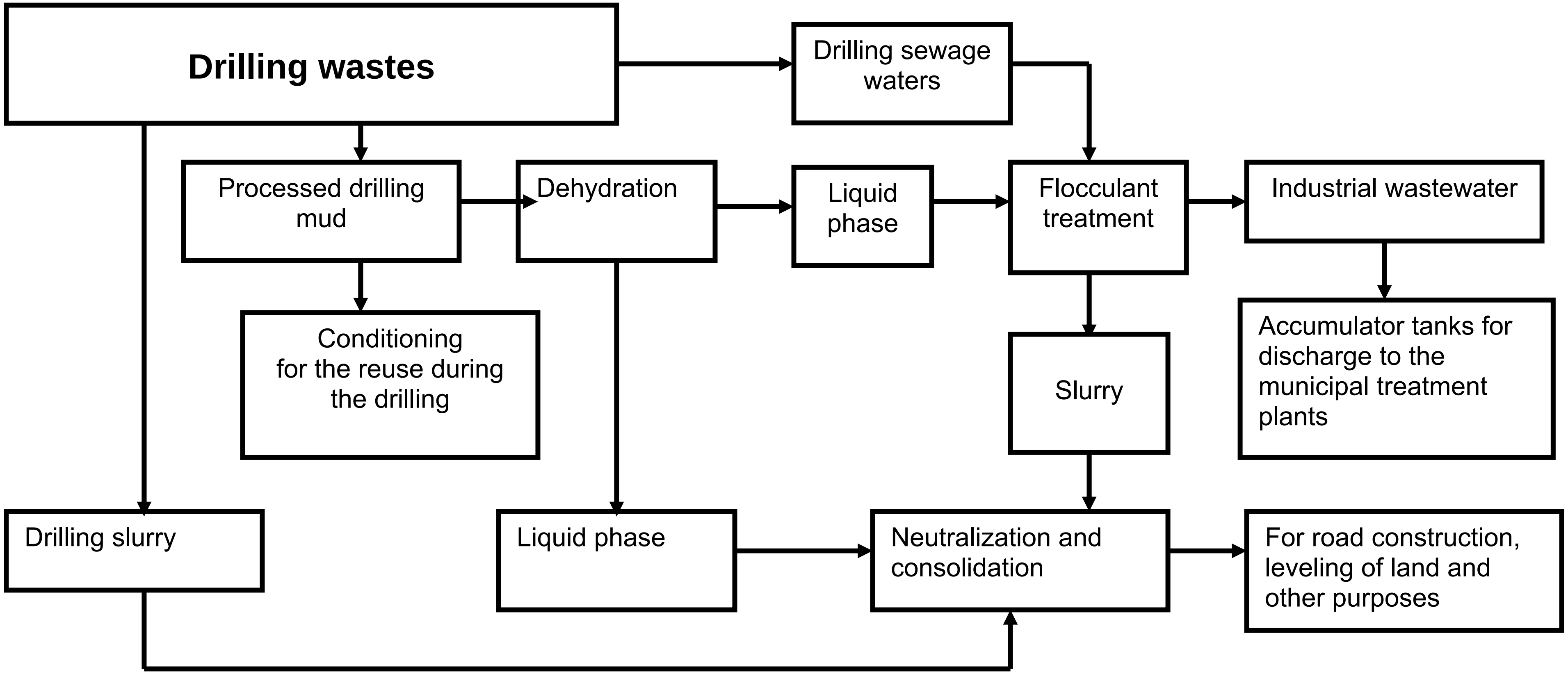
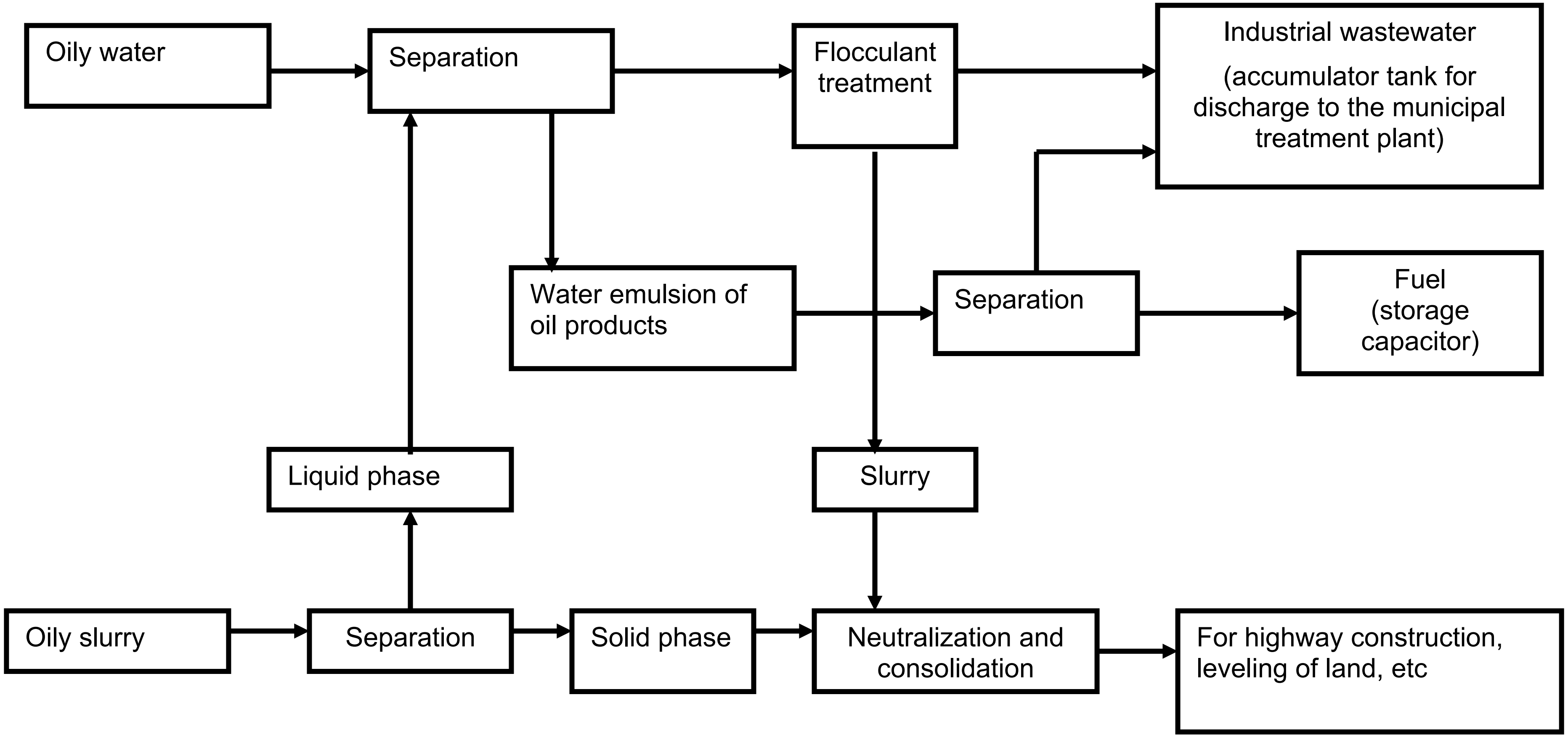


Figure 2 Scheme of the entire process of oil waters and oil slurry



CASPIANMAP RPAP Prioritised Investment Programme

Pre-feasibility study for the pilot project for the cleaning of mazutted land at Khazar – Cheleken in Turkmenistan

1. BASELINE INFORMATION		
1.1	General Information	On the territory of Khazar/Cheleken region there are several areas polluted with crude oil (mazut). The presence of mazutted lands is proved by the space surveys (see aerial pictures in the attachment), and visual observations. A full evaluation of the pollution degree of the land areas has not been conducted. In the present project it is proposed to develop the cleaning of the mazutted lake, to the south of Khazar, on the Turkmen sector of the Caspian Sea.
1.2	Location of the Site	Khazar is situated in the coastal zone of the Caspian Sea from the Turkmen side on the territory of Balkan region – the western part of the country. The lake is bordering directly to the sea side (see annex 1)
1.3	Situation Description	Oil-and-gas exploitation and chemical industry are basic for this region of Turkmenistan. On the area adjoining to Khazar/Cheleken there are lands, polluted with oil. The sites' pollution with oil leads to the deterioration of ground structure, its acidity rises, the pathogenic germs are accumulated in the soil, the degradation and drawdown of micro-biologic life takes places. Oil and oil products cause practically a complete drawdown of the functional activity of flora and fauna.
1.4	Problem Identification	The development of oil extraction and oil refining is accompanied by the rise of the oil pollution volumes and wastes, which cause increase of the ecological threatening, the reduction of the household land areas, the decrease of soil fertility, and worsening of the populations health. The basic sources of pollution with oil and oil products are oil exploring enterprises, the elements of the transfer and transportation system of oil and oil products, the oil terminals and storage depots, and the dumping of drilling waste and waste oils. Oil is an ecologically hazardous substance, which in case of environment contact (soil, water body) depress the important vital processes, depressing or making them run in other modes. The environmental pollution during the oil extraction, oil transportation and oil processing leads to economical and ecological damage. It takes a lot of years for the natural reclamation of the fertile lands, polluted with the oil products. Modern environmental protection strategies require the implementation of up-to-date, highly effective technologies for the cleaning of areas contaminated with the oil products. The recommended cleaning technologies must lead to the remediation process of the oil pollution, provided that the cost of work are acceptable and the operation is safe and environmental friendly.
1.5	Description of Pollution Situation	During the extraction, storage and transportation of oil a huge amount of oil products has been brought into the soil and the lake, which spreads to considerable distances, polluting the soil and ground waters, and eventually the Caspian Sea. A typical ecological problem for all the littoral countries of the Caspian sea is the pollution of the soil with oil products. Recently samples have been taken of the pollution of the mazutted lake. The evaluation of the sampling results showed that the pollution with oil is located in two, and sometimes tree layers, and form from 10% till 25% of the whole depth. Besides, the level of oil absorption also varies and can reach 50%. For the evaluation of the complete degree of pollution it is necessary to make thorough chemical analyses of the soil. The evaluation of the pollution area can also be only approximate.

		According to the specialists, the pollution of soil was discovered far beyond the visible spot, for example, it was discovered on the sand drifting, northwards of the lake. - The minimum area of pollution, with a glance of the adjoining mazutted lakes, is estimated at 83.9 ha or 839,000 m^2. - The maximum area of pollution is estimated in 124.4 ha or 1,244,000 m^2.
2. PROJECT OBJECTIVES		
2.1	General Objectives	The general objective of the project is an improvement of the ecological situation in the region, restoration of the operation of the ecological systems by means of the area cleaning, polluted with the oil. The specific object – is an evaluation of pollution degree of the mazutted lands, selection and development of treatment technologies for the lands, polluted with oil, production of the recovered oil products and reclamation of polluted territory.
2.2	Applicable standards	- «Nature Protection. Soil Protection. Classification of the chemical elements for pollution control» TDS - 17.4.1.02-83 - «Nature Protection. Soil Protection. Index nomenclature of sanitary condition» TDS - 17.4.2.01-81. Changes (1-VIII-85) - «Nature Protection. Soil Protection. General requirements for the soil classification for the identification of the chemical contaminated elements impact to it» TDS - 17.4.3.06-86 - «Nature protection. Soil reclamation. Terms and definitions». – Exchange for State Standard 17.5.1.01-78. TDS - 17.5.1.01-83 - «Nature Protection. Soil Protection. Classification of the disturbed lands for reclamation». - Exchange for State Standard 17.5.1.02-78. TDS - 17.5.1.02-85 - «Evaluation of impact on the environment from the aimed economic and other activity in Turkmenistan. Fundamentals». TDS 579-2001 - MPC of the chemical elements in the soil, № 3210-85; Sanitary codes of maximum permissible concentration (MPC) of chemical elements in the soil, № 4433-87.
2.3	Required Remediation Facilities	The realization of the project's objectives is connected with the execution of the following researches: - Evaluation of area condition and pollution degree of the soil, contaminated with the oil products - Execution of geotechnical researches for the planning of treatment works for the mazutted lands. Definition of the polluted area and depth. - Chemical analyses of the soil - Research of the technological methods of treatment of the mazutted lands, evaluation of their ecological-economic efficiency - Development of the project's documentation of the technological process of treatment of the polluted lands - Evaluation of the cost of inputs for the treatment technology: equipment, delivering, transport, chemicals, reagents and other expenses.
2.4	Local and Regional Environmental Benefits of the Project	Cleaning of the site would promote: - improvement of the ecological situation in the coastal area; - decrease of risk and loss to the fish industry during flooding and washing out into the sea; - land release, what is currently useless by pollution and its transfer for domestic needs; - Recovery and sale of crude oil.
3. PROPOSED PROJECT		
3.1	Project Identification	The developing pilot project can be a model and used in the other littoral countries for the cleaning of the mazutted lands. The

		recommended technological installation can be used for collection, soil regeneration, polluted by oil, oil sludge, collection of oil spills, processing of mazutted soils, ground store houses, waste burial places for the restoration of soil fertility till the residual of oil components in the limits of 1% of weight of the cleaned soil. Besides, the recommended technological method of cleaning is based on the extraction process of oil products and allows its reuse. The technical installations, after the cleaning process, could be transferred to the other polluted areas for their further exploitation.
3.2	Waste Volumes and Composition	The minimum area of pollution with the adjoined mazut lakes is estimated as 83.9 hectares or 839,000 square meters. The maximum area of pollution is estimated as 124.4 hectares or 1,244,000 sq. m. The volume of the mazutted soil is dependent on the thickness of the oil containing layer and the level of saturation, estimated between 83,900 and 311,000 m^3 (50,000 – 150,000 ton)
4. CONCEPTUAL DESIGN REMEDIATION SYSTEM		
4.1	System Selection for Remediation	For the rehabilitation of the ecological situation on the areas, polluted with oil and oil products, it is recommended to use a modular process flow sheet for cleaning of the mazutted lands. There are different methods of cleaning of the mazutted lands: physicochemical, high-temperature, electrochemical, biochemical, etc. After analyzing the methods of cleaning and taking in consideration the peculiarities of the mazutted locations, it is recommended to use steam thermol method of cleaning.
4.2	Process scheme of remediation measures	Not available yet
5. COST ESTIMATE		
5.1	Energy cost (fuel, electricity, etc.)	Refer to Annex 4
5.2	Manpower Input	Refer to Annex 4
5.3	*Capital Investment Cost*	
5.3.1	Investment for semi-permanent on-site installations	Estimated cost of a unit with a capacity of 1 t/hr is between the limits of 6-10 mln. rbls. (€ 134,000 - 225,000) depending on the packaging arrangement. For more capacity, more units will have to be employed.
5.3.2	Investment for removal and treatment of polluted soil	Included in Annex 4
5.4	Summary of Investment Cost	€ 182,000 - 303,000 (on average € 295,000) For a reasonable processing time of 2 years about 5 units will be required at an investment of € 890,000
5.5	*Operational Cost*	
5.5.1	Operation & Maintenance	Refer to Annex 4
5.5.2	Waste Disposal/Treatment	Not applicable
5.5.3	Environmental Monitoring	Not available yet
6. FEASIBILITY ASSESSMENT		
6.1	Financial Site Information	
6.2	Anticipated financial benefits	Revenues of recovered oil will amount about € 10,000 per month at a treatment capacity of 1 t/h (528 t/month)
6.3	*Feasibility Analysis*	To be calculated (refer annex 4)
6.3.1	Assumptions	none
6.3.2	Financial Feasibility: Cost-Benefit Analysis (CBA), Internal Rate of Return (IRR) or Net Present Value (NPV)	The feasibility study (refer Annex 4) shows an investment payback time of 13 years by a capacity of 1 t/h and an oil price of € 75. Sensitivity analyses have been made at higher capacity and oil prices (refer Annex 4).
6.3.3	Least cost analysis	Required information not provided.

6.4	*Possibilities of Funding*	
6.4.1	Funding from internal sources	Not applicable (the perpetrator does not exist anymore)
6.4.2	Funding from government	- Local government (municipality) - National government (Republican and Federal)
6.4.3	International funding	- World Bank loan - Asian Development Bank loan - European Bank for Reconstruction and Development loan
6.4.4	Funding from commercial sources	It seems possible to setup and exploit the site in a self-supporting way on commercial basis with revenues from sales of recovered oil and rehabilitated land.
6.5	Financing Plan	Not available yet

ANNEXES:

ANNEX 1 Location and evaluation of pollution degree of the mazutted lake
ANNEX 2 Process Description (of steam thermol treatment process)
ANNEX 3 Flow Sheet (diagram of steam thermol treatment process) NOT AVAILABLE YET
ANNEX 4 Cost Evaluation; file <Annex 4 TM PFS Calculation pollution mazut lake.xls> (to be revised and edited by Leyla and Yuriy)

Annex 1: Location and evaluation of pollution degree of the mazutted lake

The full evaluation of pollution of lands, polluted by the dump oil (oily polluted or mazuted), was not executed. Presently, the company Chemics evaluates the pollution of mazuted soils. During the evaluation 1-meter bore pits were dug out, which showed that the pollution by the dump oil is located in two, and somewhere even in tree strata, and forms 10% - 25% of the whole depth. Besides, the level of the soil pollution differs as well, and is able to reach 50%. Thorough chemical analysis of soil is necessary.

The evaluation of the polluted area also may be only approximate. According to the specialists, the soil pollution was discovered well over the boundaries of the visible spot, e. g. it was discovered on the drifting, northwards from the mazutted lake. That is why two evaluations of the polluted area were selected, which are given below. For the evaluation of the area the space pictures of 2000 year were used.

I The minimum area of pollution with the adjoined mazut lakes is estimated as 83,9 hectares or 839,000 square meters.

II. The maximum area of pollution is estimated as 124,4 hectares or 1,244,000 sq. m.

Annex 2: Process Description of the cleaning of the mazutted land at Khazar – Cheleken in Turkmenistan

1. Basic Design

After evaluation of the pollution degree of the area and identification of the main spreading parameters of oil and oil products, it is possible to use the technological steam thermol process for treatment of the mazutted soil. After the erection of processing equipment, which consists of modular blocks, its exploitation is possible. The steam thermol process of treatment runs according to the following scheme:

1. The polluted soil-grounds, with the help of excavation, intake system and conveyor, are directed to the rotating drum-type furnace of isothermal desorption of oil products. There are two zones in the furnace:
   - heating and fume zone, where the heating of raw materials and pumped water takes place, water evaporation and major portion of oil products;
   - desorption zone, where at the preset temperature 400-500^{o}C (versus type of raw material) total removal of the oil product occurs.
2. Heating of the furnace is accomplished by the flue gas, which is supplied to the jacket of the furnace form the burning facility. The temperature of the flue gas is 700-800oC. After the furnace the flue gas is discharged into the atmosphere through the smokestack.
3. The water and gas-vapor mixture, which is circulating along the contour «furnace - fridge - furnace», are delivered to the interior hermetic furnace cave, along with the raw material. The soil-grounds, purified from the oil products, are carried out of the furnace.
4. The gas-vapor mixture, which contains water vapor and stripped soil/ground oil products, goes to the air capacitor - fridge. The cooling temperature is 110-150oC. In the capacitor the condensation of the hydrocarbon phase and other organic elements of the gas vapor mixture takes place without water vapor condensation.
5. The water vapor, non-condensed part of the organic and inorganic compounds and condensate of oil products go to the block of the steam and fluid phase separator. From the phase separator block the oil condensate goes to the sedimentation tank, and vapor mixture with the indicated cooling temperature is directed to the circulation loop.
6. Surplus amount of water vapor and non-condensed in the fridge gas, which are uninterruptedly forming in the process of the steam thermal desorption, are discharged from the closed flow circuit into the burning facility, where afterburning of the organic matter takes place.
7. The sedimentation tank is used for the separation of the oil and fraction and water, the steam oil emulsion after centrifugation and oil condensate from the capacitor-fridge are supplied to it. The oil and water from the sedimentation tank in small amount are supplied to the burning facility and furnace, and an excess of oil and water is supplied to the storage capacity.

2. Technological integration of the installation

- Block of soil supplying for regeneration: intake bunker and conveyor (screw);
- Block of soil regeneration: drum-type furnace, heat-exchanger-capacitor, sedimentation tank, steam and oil-water mixture separator, system of supplying of heating gas;
- Dispatch block of purified soil: bunker and conveyor (screw);
- Block of temporary storage of the collected oil and water;
- Automatic control system;
- Autonomous power service (diesel power station).

a. Characteristics of the technological process:

- purification efficiency of the soils, polluted with oil products, is 1% of residual oil;
- purification process is conducted at the lower power inputs, which is reached by a closed loop technology, where the expenditure of energy is compensated by the recovered oil products, extracted during the treatment process;
- the technological treatment process is realized at the comparatively low temperatures (300-450 ^{o}C), which enables an additional lowering of the power inputs;
- processing plant capacity = 1 ton/hour;
- the installations are mobile, economically effective with the opportunity of movement to the zones of local pollution.

b. Operating characteristics of installation

The operating characteristics of the mobile technological complex for regeneration of the oily polluted soil and oil sludges:

- MTBF – not less than 8000 hours;
- total specified service life – not less than 8 years
- MTTF - not more than 10 hours;
- life cycle – not less than 5 years;
- medium retention term before implementation – not more than 2 years;
- treatment process of feed stock is fully-automatic.

Estimated cost of the complex is between the limits of 6-10 mln. rbls. (US$ 182,000 - , 303,000) depending on the packaging arrangement.

CASPIANMAP RPAP Prioritised Investment Programme

Annex 3:

Appendix 4. Water Box Model

Appendix 5. Received documents for RPAP

(Excl. those for Baseline Inventory)

Azerbaijan

- Rekultivatsiya.doc
- ______________.doc

From Imanov in Russian 04/30/2009

- caspian-zagrazneniye.doc

From Imanov in Russian 05/04/2009

- Page1.jpg & Page2.jpg

From Imanov in Russian 05/05/2009

- Комментарии.doc [Response on RPAP]

From Imanov in Russian 07/14/2009

Kazakhstan

-

Russian Federation

-
- *Reporting*, [Email response on RPAP, working paper addressed to Mr. Pietersen]

From T. Butylina in Russian and English 07/03/09

Turkmenistan

-
- RPAP compiled_ru-DD.doc corrected (Turkm)

From Orazdurdyeva in Russian 07/01/09

- Berkelieva notes
- Саймоново_2.doc

From Leyla Berkelieva in Russian 18/07/09

Data received for modelling exercise

Azerbaijan

-

Kazakhstan

- Данные по водному балансу.xls
- Дополнительные данные.xls

From Akmetov in Russian, 04/29/2009

- Sev._Kaspij-1987,1990,1991,_2004-2007.doc
- Karta-Kaspij08.doc
- Sr.Kaspij-04-07.doc
- spisok.doc

From Akmetov in Russian, 06/25/2008

- Ural01.doc –Ural07
- Ural-_1996.doc
- Ural-_1997.doc
- Ural-_1998.doc
- Ural-_2000.doc

From Akhmetov in Russian, 08/26/2008

Russian Federation

- Contribution to Data management tables Ru.xls (appendix_D1a)

From Korshenko in Russian, 03/27/2008

- ….

From Bolgov ….. , 06/14/09

Turkmenistan

- Contribution to Data management tables TU.xls
- swedeniya_A.doc

From Berkelieva and Aronsky in Russian, 04/29/2009

Appendix 6. Review of and additional data to the Caspian map modeling exercise as delivered by the Institute of water problems (Moscow, Russian Federation)

СОДЕРЖАНИЕ

1. Антропогенное воздействие на качество вод Волжского бассейна.

Р. Волга, площадь водосбора которой оценивается в 1360 тыс. км^2 (почти 13 % территории Европы), является крупнейшим поставщиком загрязняющих веществ (ЗВ) в Каспийское море. Главной причиной неудовлетворительного качества поверхностных вод в Волжском бассейне является чрезмерная антропогенная нагрузка, которая в несколько раз больше, чем на других крупных реках России. Площадь Волжского бассейна составляет только 8 % территории России, в то же время в Поволжье проживает 40 % населения, производится 45 % промышленной и около 50 % сельскохозяйственной продукции всей страны.

Антропогенная нагрузка характеризуется значительной пространственной неоднородностью. Техногенная составляющая нагрузки складывается из точечных источников промышленных, коммунальных и ливневых сточных вод и сосредоточена в районах больших городов. Сельскохозяйственная (диффузная) составляющая нагрузки в основном формируется на водосборах малых и средних рек и приурочена к участкам впадения притоков в водохранилища.

В бассейне р. Волги насчитывается около 6 тыс. контролируемых водовыпусков, или точечных источников загрязнения, через которые ежегодно сбрасывается 2,3 км^3 загрязненных вод (20 % всех загрязненных вод России). В маловодные годы вклад сточных вод может достигать 14 %. По приблизительным расчетам (существующая система учета и контроля качества сточных вод не обеспечивает получения полной и объективной информации о массе ЗВ) в водные объекты Волжского бассейна ежегодно поступает со сточными водами: органических веществ – 302 тыс. т; взвешенных веществ – 400 тыс. т; азота аммонийного – 1015 тыс. т; нефтяных углеводородов (НУ) – 140 тыс. т; меди – 3740 т; хрома – 3690 т; фенолов – 910 т.

Еще менее надежным является определение количества ЗВ, поступающих в водотоки и водоемы от сельского хозяйства. Площадь сельскохозяйственных угодий на территории Волжского бассейна составляет 65 млн. га. Из них около 43 млн. га занимает пашня, на которую ежегодно вносится около 1,5 млн. т минеральных и более 66 млн.т. органических удобрений. Исследования по количественной оценке поступления азота и фосфора в водоемы показали, что в условиях длительного применения высоких доз минеральных удобрений в поверхностные и грунтовые воды поступает до 20 % внесенного азота и до 1,5 – 2,0 % фосфора.

1.1. Характеристика загрязнения водотоков Волго-Ахтубинской поймы и дельты Волги.

Качество вод Нижней Волги в значительной степени определяется уровнем загрязнения воды, поступающей из Волгоградского водохранилища. Это водохранилище, как последняя ступень в каскаде волжских искусственных водоемов, собирает все ЗВ, приносимые транзитным потоком сверху. Помимо этого, влияние на качество воды в нем оказывает также хозяйственная деятельность на собственном водосборе (Волгоградская область) и поступление химических веществ с поверхностным стоком из атмосферы.

Основными источниками загрязнения атмосферного воздуха в Волгоградской области являются ОАО «Лукойл-Волгограднефтепереработка» и ОАО «Волгоградский алюминий», которые в 2005 г. Выбрасывали в атмосферу, соответственно, 22,2 и 24,0 тыс. т различных веществ (Государственный доклад…, 2006). Объемы выбросов ЗВ стационарных источников в крупных городах составили: г. Волгоград – 75,46 тыс. т; г. Волжский – 42,75 тыс. т. При этом на долю оксида углерода приходилось 29 %, оксидов азота – 12 %, метана – 28 %, диоксида серы – 5 %, твердых веществ – 10 %, других веществ – 16 %. В целом по области количество выбросов от стационарных источников снизилось от 363,0 тыс. т в 2000 г. до 221,4 тыс. т в 2005 г. (доля автотранспорта оценивается в 262,3 тыс. т).

Основными источниками загрязнения водных объектов являются ОАО «Волгоградские коммунальные системы», ЖКХ г. Камышин, ТЭЦ-2 (г. Волгоград), Волгоградская ГРЭС, АО «Металлургический завод «Красный октябрь». Доля загрязняющих сточных вод, сбрасываемых в области со сточными водами в водные объекты, в 2005 г. составила 97 %. Динамика сброса загрязняющих сточных вод в водные объекты выглядит следующим образом:

Год	2000	2001	2002	2003	2004	2005
Объем, млн. $м^3$	216,6	211,6	206,5	201,5	208,2	204,4

Основная часть руслового участка Нижней Волги и дельты реки находятся в пределах Астраханской области. Здесь, как и в Волгоградской области, имеются достаточно крупные источники загрязнения атмосферы и водной среды. В 2005 г. выбросы ЗВ в атмосферу от стационарных источников составили 131,3 тыс. т (Государственный доклад…, 2006). Это существенно выше, чем в 2000-2001 гг., когда выбросы составляли, соответственно, 110,8 и 106,9 тыс. т. Состав загрязняющих веществ: диоксид серы – 39 %, оксид углерода – 41 %, метан – 10 %, оксиды азота – 5 %, твердые вещества – 2 %, прочие вещества – 3 %.

Главные стационарные источники загрязнения атмосферы и объемы выбросов (тыс. т): ОАО «Астраханьгазпром» в пос. Аксарайский (105,4) и ООО «Астраханьэнерго» (4,5) . На долю автотранспорта приходится 142,1 тыс. т.

Основными источниками загрязнения водной среды являются ЖКХ г. Астрахани и водный транспорт. В 2005 г. сброс загрязненных сточных вод составил 67,9 млн. $м^3$, из них 1,1 % без очистки. Основными ЗВ, сбрасываемыми в водотоки Нижней Волги, являются фенолы, нефтепродукты, тяжелые металлы (медь, цинк), СПАВ, органические вещества. Данные по сбросу ЗВ со сточными водами приведены в таблице 1.

Таблица 1. Поступление загрязняющих веществ со сточными водами в Астраханской области (Устьевая область…, 1998).

Вещество, т/год	Год							
	1985	1986	1987	1988	1989	1990	1991	1992
Органические в-ва (по $БПК_{полн}$)	1000	1012	1009	1080	1000	1500	1999	1617
Взвешенные в-ва	1000	866	1470	1290	1550	2200	-	-
Фенолы	-	-	-	0,15	0,11	0,035	-	-
Азот аммонийный	-	150,5	-	352	452	518	890	612
Азот нитратный	-	-	-	390	169	158	-	-
Нефтепродукты	20	18	18,1	-	-	-	25	14,3
Медь	-	-	-	1,8	0,81	1,59	3,1	1,25
СПАВ	-	-	-	65,4	35,3	22,5	-	24,9

В настоящее время в Астраханской области имеются следующие выпуски сточных вод:

- загрязненных без очистки – 14 выпусков общим объемом 7,2 млн.$м^3$/год;
- нормативно очищенных – 12 выпусков объемом 2,9 млн.$м^3$/год;
- недостаточно очищенных – 21 выпуск общим объемом 93,2 млн.$м^3$/год;
- нормативно чистых без очистки – 341 выпуск общим объемом 1059 млн.$м^3$/год (в том числе сбросы с сельхозугодий).

Кроме того, в Астрахани и 439 других населенных пунктах области выявлено более 440 свалок отходов, из которых около 300 – несанкционированных, 7 полигонов отходов (из них 6 полигонов ТБО и 1 полигон промышленных отходов). Общая площадь земель, занятых свалками, составляет 634 га, полигонами – 65 га, несанкционированными свалками – 182 га (в том числе в г. Астрахани- 63 га с количеством накопленных отходов 30,8 тыс.т). В правобережной части города создалась напряженная экологическая обстановка, связанная с отсутствием площадей под размещение твердых промышленных и бытовых отходов.

При оценке потоков ЗВ, поступающих из р. Волги в Северный Каспий, необходимо знать их динамику в системе рукавов дельты в соответствии с перераспределением стока реки. Русловая сеть дельты необычайно густа, причем количество водотоков постоянно изменяется. Так, за период 1960-1980 гг. число водотоков увеличилось от 800 до 1000 (Михайлов и др., 1977). В настоящее время можно выделить 5 крупных систем, через которые волжская вода поступает в Северный Каспий (Устьевая область…, 1998).

Система Бузана - наиболее крупная из частных русловых систем дельты. На ее долю приходится почти половина площади дельты и половина всех ее водотоков. Система Бузана питается водой через начинающийся в вершине дельты рукав Бузан, а также через Ахтубу и временные водотоки Волго-Ахтубинской поймы.

Система Болды по площади занимает второе место в дельте, но ее гидрографическая сеть в связи с отмиранием многих водотоков менее сложна.

Система Камызяка занимает узкую полосу в западной части дельты. Основные направления стока: Камызяк – Рытый банк и Камызяк – Никитинский банк.

Система Старой Волги включает основные водотоки: Старая Волга – Гандуринский банк и Старая Волга – Гандурино.

Система Бахтемира занимает относительно небольшую площадь, но весьма водоносна. Рукав Бахтемир начинается ниже ответвления от основного русла Волги рукава Старая Волга. Русловая часть системы Бахтемира довольно редка в связи с сосредоточением стока по основному направлению, продолжением которого на устьевом взморье служит Волго-Каспийский канал (ВКК) – главный судоходный выход из Волги в Каспийское море.

Дальнейший анализ потоков ЗВ в дельте будет строиться на данной классификации. При этом в качестве контрольного створа, по которому рассчитывается поступление ЗВ в рукава дельты, принят пункт в вершине дельты (с. Верхнее Лебяжье).

Динамика суммарного стока растворенных ЗВ в вершине дельты за период 1977-1993 гг. представлены в таблицах 2, 2а.

Таблица 2а. Суммарный сток ТМ в вершине дельты за 1995-2004 и 2001-2007 гг. (по данным Росгидромета и ИВП РАН).

Год	W,	Металлы, т								
	км³	Fe	Mn	Cr	Pb	Mo	Co	Ni	Cd	Hg
1995-2004 ср	251	46600	232	220	238		198	1160	68,6	7,3
2001	281	48146	702,5	786,8	843		843	3821,6	309,1	23,9
2002	261	75690	548,1	208,8	339		652,5	914	156,6	2,6
2003	250	30000	275	250	200		50	850	25	3,5
2004	261	46980	234,9	52,2	209		78,3	653	26,1	4,4

2005	254	65940	117,5	117,5	203	228,2	25,4	583	126,8	6,8
2006	208	49920	228,8	104	104	228,8	20,8	3328		4,8
2007	282	37580	704,3	112,7	338	253,5	56,3	845		6,7
2001-2007 ср	257	48146	401,6	233,1	319	236,8	246,6	1571	128,7	7,5

Как видно из табл. 2, поступление ЗВ в дельту изменяется в широком диапазоне:

НУ – от 21,25 до 157,6 тыс. т/год;

Фенолы – от 272 до 1821 т/год;

СПАВ – от 2,25 до 12,16 тыс. т/год;

Органические вещества – от 609 до 3432 тыс. т/год;

Cu – от 0,86 до 5,46 тыс. т/год;

Zn – от 0,225 до 15,05 тыс. т/год;

ХОП - от 0,5 до 17,0 т/год.

Кроме растворенной формы ЗВ необходимо учитывать их перенос на взвеси. Результаты расчетов, выполненных с учетом оценки коэффициентов сорбции ЗВ взвесью в волжской воде, представлены в таблице 3.

Таблица 3. Суммарный сток загрязняющих веществ со взвесью в вершине дельты за 1977-1992 гг. (Устьевая область…, 1998).

Год	Поступление ЗВ со взвесью							
	т				кг			
	НУ	СПАВ	Cu	Zn	ДДТ	ДДЭ	А-ГХЦГ	Г-ГХЦГ
1977	2913	24,0	85	48	-	-	-	-
1978	3584	1,0	139	398	-	-	-	-
1979	722	3,0	103	-	-	-	-	-
1980	1145	5,0	149	298	-	-	-	-
1981	1414	2,3	118	248	-	-	-	-
1982	1430	1,3	41	102	-	-	-	-
1983	3002	0,6	71	153	1060	88	59	71
1984	1675	1,4	140	14	978	0	56	84
1985	2868	0,9	72	27	1299	314	54	108
1986	4168	1,3	117	677	912	260	78	104
1987	5537	1,2	49	504	185	62	0	0
1988	12333	2,1	88	599	599	-	-	-
1989	4526	2,1	65	647	647	-	1778	1261
1990	8113	1,9	86	397	-	-	-	-
1991	876	1,9	-	-	-	-	-	-
1992	979	2,4	49	153	-	-	-	-

Сравнивая данные таблиц 2 и 3, можно сделать вывод, что ориентировочный сток ЗВ, сорбированных на взвеси, в среднем может составить относительно массы ЗВ, поступающих в дельту в растворенном виде, для НУ – 4,8 %, для СПАВ – 0,06 %, для меди – 4,3 %, для цинка – 5,2 %, для ДДТ – 19,2 %, для ДДЭ – 18,8 %, для А-ГХЦГ –8,3 %, для Г-ГХЦГ – 8,7 %.

Поступивший в вершину дельты поток ЗВ далее распределяется по пяти основным системам рукавов, перечисленным выше, а затем по секторам отмелой зоны устьевого взморья. Распределение среднемноголетнего стока растворенных ЗВ от с. Верхнее Лебяжье по частным потокам представлено в таблице 4.

Таблица 4. Распределение потоков загрязняющих веществ по системам рукавов в дельте (Устьевая область…, 1998).

Вещество	Частные потоки					
	Бахтемир № 1	Стар.Волга № 2	Камызяк № 3	Болда+Рачан № 4	Бузан № 5	Всего
НУ, тыс.т	22,90	17,61	5,21	17,90	7,60	71,22
Фенолы, т	251,60	194,70	57,50	197,00	83,80	784,60
СПАВ,тыс. т	1,43	1,11	0,33	1,13	0,48	4,47
ВВ, тыс. т	3759,00	2906,00	858,50	2948,00	1251,10	11722,60
Cu, т	721,90	551,20	162,80	558,30	237,40	2222,60
Zn, т	1789,90	1383,60	408,60	1402,80	595,50	5580,40
А-ГХЦГ, кг	1308,00	1005,80	297,30	1019,80	433,30	4057,00
Г-ГХЦГ, кг	993,50	767,50	226,90	779,40	330,40	3097,70
ДДЭ, кг	247,10	191,20	56,30	193,50	81,80	769,90
ДДТ, кг	1172,60	906,70	267,50	978,40	390,50	3655,70

Как видно из табл. 4, максимальный поток ЗВ наблюдается в рукаве Бахтемир (поток № 1), куда в основном попадают промышленно-бытовые сточные воды г. Астрахани и сброс с судов. Практически во всех водотоках (за исключением Бахтемира), наблюдается уменьшение количества взвешенных веществ. Это позволяет судить о накоплении ЗВ в водотоках и возможном повышении уровня загрязнения Северного Каспия при экстремальных ситуациях, которые могут вызвать промыв дельты.

В целом 42-50 % водного стока приходится на период половодья, 25-31 % - на летнюю межень и 24-28 % на зимнюю межень. Здесь зимняя межень охватывает период декабрь-март, половодье – апрель-июнь, летнее-осенняя межень – июль-ноябрь. В соответствии с этим в течение года заметно меняются и потоки ЗВ (табл. 5).

Здесь необходимо отметить следующее важное обстоятельство, а именно влияние водности на сток ЗВ. Это можно видеть из таблицы 6, где представлены данные для маловодных, многоводных и среднеклиматических лет, полученные суммированием потоков ЗВ в дельте.

Таблица 5. Внутригодовое распределение поступления загрязняющих веществ по частным потокам в дельте Волги с осредненным гидрографом стока за 1961-1993 гг.
(Устьевая область …, 1998).

Вещество	Гидрологич. сезон	Частные потоки						
		№ 1	№ 2	№ 3	№ 4	№ 5	Всего	Год
НУ, тыс.т	Зимняя межень Половодье Летне-осенняя м.	6,08 9,55 7,27	4,68 7,30 5,59	1,38 2,17 1,66	4,75 7,46 5,69	2,02 3,17 2,41	18,92 29,70 22,60	- 71,22 -
Фенолы, т	Зимняя межень Половодье Летне-осенняя м.	66,82 104,92 79,86	51,71 81,19 61,80	15,27 23,98 18,25	52,32 82,15 62,53	22,26 34,94 26,60	208,39 327,18 249,03	- 784,60 -
СПАВ,тыс.т	Зимняя межень Половодье Летне-осенняя м.	0,380 0,596 0,454	0,295 0,463 0,352	0,088 0,138 0,104	0,309 0,463 0,358	0,127 0,200 0,153	1,187 1,864 1,419	- 4,47 -
ВВ, тыс. т	Зимняя межень Половодье Летне-осенняя м.	998,4 1567,5 1193,1	771,8 1211,8 922,4	228,0 352,0 272,5	783,0 1229,0 936,0	332,3 521,7 397,1	3113,5 4888,3 3720,8	- 11722,8 -
Cu, т	Зимняя межень Половодье Летне-осенняя м.	191,7 301,0 229,2	146,4 229,8 175,0	43,2 67,9 51,7	148,3 232,8 177,2	63,0 99,0 75,4	590,3 926,8 705,5	- 2222,6 -

Zn, т	Зимняя межень Половодье Летне-осенняя м.	475,4 746,4 568,1	367,5 576,0 439,1	108,5 170,4 129,7	372,6 585,0 445,2	158,2 248,3 189,0	1482,2 2327,0 1771,2	- 5580,4 -
А-ГХЦГ,кг	Зимняя межень Половодье Летне-осенняя м.	347,4 545,4 415,2	267,1 419,4 319,3	79,0 124,0 94,3	270,8 425,2 323,8	115,1 180,7 137,5	1077,5 1691,8 1287,7	- 4057,0 -
Г-ГХЦГ, кг	Зимняя межень Половодье Летне-осенняя м.	263,9 414,3 315,3	203,8 320,0 243,7	60,3 94,6 72,0	207,0 325,0 247,4	87,8 137,8 104,8	822,7 1291,7 983,3	- 3097,6 -
ДДЭ, кг	Зимняя межень Половодье Летне-осенняя м.	65,6 103,0 78,5	50,8 79,7 60,7	14,9 23,5 17,9	51,4 80,7 61,4	21,7 34,1 26,0	204,5 321,0 244,4	- 769,9 -
ДДТ, кг	Зимняя межень Половодье Летне-осенняя м.	311,4 489,0 372,2	240,8 378,0 287,9	71,1 111,5 84,9	243,9 383,0 291,5	103,7 162,8 124,0	970,9 1524,4 1160,0	- 3665,7 -

Таблица 6. Годовые потоки ЗВ в рукавах дельты в зависимости от водности (1961-1993 гг.) (Устьевая область…, 1998).

Вещество	Год

	Маловодный	Многоводный	Среднеклиматический
НУ, тыс.т	41,8	93,6	71,2
Фенолы, т	527,4	1032	784,6
СПАВ, тыс. т	3,0	5,8	4,5
ВВ, тыс. т	7880	15130	11720
Cu, т	1570	2890	2220
Zn, т	3770	7380	5580
А-ГХЦГ, кг	2790	5450	4060
Г-ГХЦГ, кг	2130	4170	3097
ДДЭ, кг	508	994	770
ДДТ, кг	2450	4810	3666

Данные, приведенные в табл. 6, говорят о существенном влиянии водности года на баланс ЗВ в дельте Волги. Практически для всех веществ их потоки в многоводные годы превышают аналогичные показатели для маловодных лет в 2 раза. Это обстоятельство безусловно осложняет выделение трендов и получение прогнозных оценок при анализе даже достаточно длинных рядов наблюдений.

Ранее уже отмечалось, что поток ЗВ, сорбированных на взвеси, относительно мал: для НУ, Cu и Zn он не превышает 5 % от потока ЗВ, растворенных в речной воде. Тем не менее, им нельзя пренебрегать, поскольку эти ЗВ способны накапливаться в донных отложениях (ДО) и при последующем взмучивании переходить обратно в воду. Распределение ЗВ во взвеси по частным потокам в дельте приведено в таблице 7.

Таблица 7. Среднегодовое поступление взвешенных ЗВ в частные потоки в дельте с осредненным гидрографом стока воды за 1961-1993 гг. (Устьевая область …, 1998).

Вещество	Частные потоки					
	№ 1	№ 2	№ 3	№ 4	№ 5	Всего
НУ, тыс.т	1106,30	855,40	252,90	867,20	368,30	3455,0
СПАВ,тыс. т	1,02	0,79	0,23	0,80	0,34	3,2
Cu, т	31,05	24,02	7,10	24,30	10,30	97,0
Zn, т	93,20	73,50	21,30	73,00	31,00	291,0
А-ГХЦГ, кг	107,90	83,40	24,70	84,60	35,00	337,0
Г-ГХЦГ, кг	86,80	67,10	19,80	68,00	28,90	271,0
ДДЭ, кг	46,40	35,90	10,40	36,80	15,50	145,0
ДДТ, кг	233,10	180,20	53,30	182,70	77,60	728,0

При замыкании уравнения баланса ЗВ по основным водотокам дельты было установлено, что только в системе Бахтемир (поток № 1) имеет место дополнительное (2 %) поступление ЗВ из ДО. В остальных четырех потоках процесс имеет обратный знак, т.е. происходит захоронение ЗВ в ДО.

Исходя из концентраций ЗВ в районе с. Верхнее Лебяжье, усредненных за 15 лет, и процентного распределения водного стока по пяти частным потокам в дельте, были выполнены расчеты оттока растворенных и взвешенных ЗВ из дельты на ее морской край. При этом учитывались потери воды в каждой системе (3 %), осаждение взвешенных ЗВ, а также приращение массы ЗВ в результате воздействия антропогенных источников в дельте (Устьевая область …, 1998). Результаты расчетов, а также данные для вершины дельты приведены в таблице 8.

Таблица 8. Отток растворенных и взвешенных ЗВ на морской край дельты (МКД) в годы различной водности (сумма по всем частным потокам за 1977-1992 гг.) (по данным Росгидромета).

Год	Вещество	Растворимые ЗВ			Взвешенные ЗВ	
		Вершина дельты (А)	МКД (В)	В/А	Вершина дельты	МКД
Маловодный	НУ, тыс.т	41,83	41,86	1,00	2,31	1,83
	Фенолы, т	527,4	552	1,05	-	-
	СПАВ, тыс. т	2,95	3,21	1,09	0,002	0,001
	ВВ, тыс. т	7880	6012	0,76	-	-
	Cu, т	1570	1340	0,85	64,6	45,9
	Zn, т	3770	4020	1,07	194	154
	ДДЭ, кг	508	765	1,51	118	93
	ДДТ, кг	2450	3696	1,51	636	501
	А-ГХЦГ, кг	2786	2709	0,97	179	142
	Г-ГХЦГ, кг	2130	2010	0,94	152	120
Многоводный	НУ, тыс.т	93,60	92,73	0,99	4,43	3,50
	Фенолы, т	1033	1074	1,04	-	-
	СПАВ, тыс. т	5,77	6,22	1,08	0,004	0,003
	ВВ, тыс. т	15130	11514	0,76	-	-
	Cu, т	2886	1940	0,67	124	98
	Zn, т	7377	7860	1,07	372	293
	ДДЭ, кг	994	1520	1,53	227	178
	ДДТ, кг	4810	7370	1,53	1216	960
	А-ГХЦГ, кг	5453	5290	0,97	343	270
	Г-ГХЦГ, кг	4170	4045	0,97	290	230
Среднеклиматический	НУ, тыс.т	71,22	72,45	1,02	3,46	2,71
	Фенолы, т	785	820	1,04	-	-
	СПАВ, тыс. т	4,47	4,84	1,08	0,003	0,003
	ВВ, тыс. т	11723	8940	0,76	-	-
	Cu, т	2223	1970	0,89	97	76
	Zn, т	5580	5950	1,07	291	230
	ДДЭ, кг	770	1166	1,51	145	114
	ДДТ, кг	3666	5540	1,51	728	571
	А-ГХЦГ, кг	4060	4037	0,99	337	264
	Г-ГХЦГ, кг	3100	3004	0,97	270	213

Таблица 9. Сток ЗВ из дельты Волги в море в среднеклиматический год за период 1995-2004 гг. (Характеристика загрязнения …, 2006).

Вещество	Сток ЗВ

	Вершина дельты (А)	МКД (В)	В/А
НУ, тыс.т	54,03	56,36	1,04
Фенолы, т	970	1050	1,09
СПАВ, тыс. т	6,63	8,04	1,22
Fe, т	46,64	50,56	1,09
Zn, т	9200	9160	1,00
Cu, т	1780	1523	0,85
А-ГХЦГ, кг	-	-	-
Г-ГХЦГ, кг	100	90	0,90
ДДТ, кг	180	120	0,67
ДДЭ, кг	30	20	0,67

1.2. Концентрации загрязняющих веществ в воде на устьевом участке р. Волги.

Как отмечалось в предыдущем разделе, за последние 10-15 лет заметно сократился сток многих ЗВ в дельту р. Волги и, соответственно, в Северный Каспий. Это наиболее ярко проявилось в потоках хлорорганических пестицидов, которые уменьшились более, чем в 100 раз. Естественно, это повлекло уменьшение концентраций ЗВ в воде, что можно видеть из таблицы 10, где показана динамика концентрации приоритетных ЗВ в вершине дельты за период 1977-2007 гг.

В таблице 10а представлены концентрации ряда тяжелых металлов, не вошедшие в таблицу 10, за период 1995-2004 гг.

В таблице 11 представлены концентрации ЗВ в западной части дельты р. Волги.

Сопоставление концентраций ЗВ в воде в вершине дельты и на морском крае дельты (МКД) за период 1995-2004 гг. показало, что для ряда веществ (в частности, Hg и Г-ГХЦГ) наблюдается заметное увеличение концентраций (табл. 12). В то же время содержание Cr и Mn снижается почти в 2 раза. Содержание большинства элементов остается практически неизменным.

1.3. Загрязнение донных отложений

Исследования содержания загрязняющих веществ в ДО Нижней Волги были начаты ИВП РАН в 1997 г. Анализ пространственно-временной изменчивости содержания ТМ в донных отложениях Нижней Волги показывает существенную неоднородность их распределения по территории. Даже в одном створе содержание ТМ в донных отложениях может отличаться на порядок (Бреховских и др., 1999; Бреховских и др., 2005). Например, в створе у п. Сероглазка в сентябре 1998 г. на расположенной в 70 м от левого берега реки станции содержание Zn равнялось 69,4 мкг/г; в 200 м от левого берега его содержание уменьшалось до 7,2 мкг/г и опять возрастало до 66,1 мкг/г на станции, расположенной в 80 м от правого берега. В 1997 г. на этой же станции содержание ТМ было более однородным (рис. 1, 2).

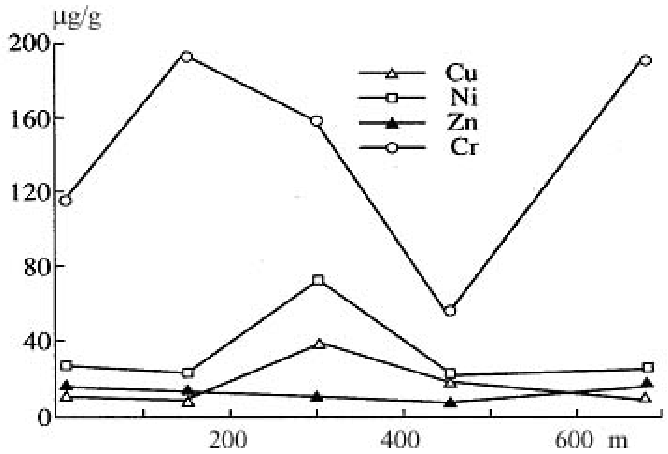


Рис. 1. Содержание тяжелых металлов в донных отложениях по сечению реки в створе у с. Соленое Займище в 1997 г. Расстояние по ширине реки отсчитывается от правого берега.

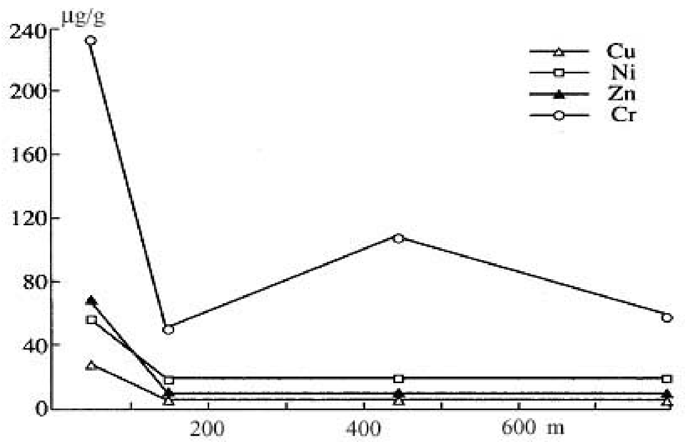


Рис. 2. Содержание тяжелых металлов в донных отложениях по сечению реки в створе у с. Цаган-Аман в 1997 г. Расстояние по ширине реки отсчитывается от правого берега.

Для разных лет неоднородность распределения содержания ТМ различна. В русловой части устойчиво неоднородным является распределение содержания Zn с коэффициентами вариации равным 1,14 в 1997 г. и 0,65 в 1998 г. Высокие значения коэффициента вариации для Mn и Cd являются следствием низких концентраций этих металлов в донных отложениях, на многих станциях они обнаруживались на уровне следовых количеств. Наиболее однородным является распределение содержания Cd. Для различных участков Нижней Волги коэффициент вариации для Cd варьирует в пределах 0,07-0,15.

По длине реки на отдельных ее участках многие микроэлементы в донных отложениях распределены достаточно равномерно (рис. 3).

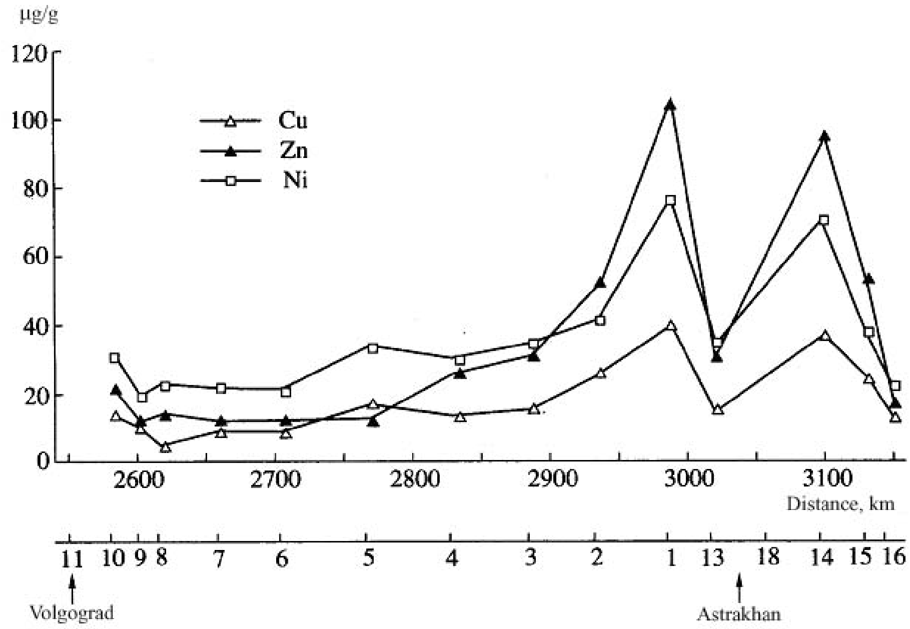


Рис. 3. Распределение концентрации металлов в донных отложениях по длине руслового участка р. Волги осенью 1997 г.

Распределение в 1998 г. ТМ по длине рассматриваемого участка реки характеризуется пониженными значениями в верхней части участка. Устойчиво повышенные значения содержания почти всех ТМ в донных отложениях наблюдаются ниже п. Сероглазка и в верхней части дельты в районе г. Астрахани. Здесь существует устойчивый очаг загрязнения между п. Сероглазка и вершиной дельты (с. Верхнелебяжье), где непосредственно в районе реки нет крупных промышленных предприятий, а площади орошаемого земледелия не превышают средних для этого района. Однако на растоянии около 10 км от реки расположен Астраханский ГКК (п. Аксарайский), который, по-видимому, и является основной причиной повышенного содержания некоторых ТМ в районе. Из исследованных металлов концентрации Cu и Ni в целом не превышают природный фон. Почти не наблюдается превышение фона также для Zn и Pb: превышение фона наблюдалось соответственно в четырех и одном случае из 47. Однако значительно более часто фиксировались случаи превышения фона для Mn и Cr - 40 и 43 % соответственно. Таким образом, эти два элемента (к ним следует добавить Fe) накапливаются в донных отложениях Нижней Волги в наибольшей степени.

Донные отложения в водотоках дельты в рук. Бахтемир и Кировском канале также характеризуются достаточно низким уровнем загрязнения металлами по сравнению с фоном. В рук. Бахтемир содержание ТМ в донных отложениях близко к отмеченному выше в Астрахани. IIри приближении к култучной зоне наблюдается рост концентраций Cu, Zn и Ni, но даже в этом случае концентрации указанных микроэлементов были на уровне фоновых или ниже их. Ряд убывания содержания металлов в составе донных отложений может быть представлен в следующем виде: **Fe>Mn>Cr>Ni>Zn>Cu>Co>Mo>Pb>Cd**. Этот ряд отличается от подобного ряда для взвешенных веществ, в котором Pb и Cu занимают третье и четвертое места в ряду убывания концентраций. Динамика изменения содержания ТМ в донных отложениях дельты по годам представлена в таблице 13.

Таблица 13. Содержание тяжелых металлов (мкг/г сухого вещества) в донных отложениях дельты Волги (по данным Росгидромета и ИВП РАН).

Годы	Fe	Mn	Zn	Cu	Pb	Ni	Co	Cd
1993				6,8	1,9	240,8		0,07
1994				8,6	1,3	1,4		0,43
1995	1560	1399,0		10,4	1,9	452,4		0,08
1996	1500	1200,0		11,7	2,1			0,10
1997	28102	791,6	48,4	22,5	13,2	44,6	4,6	1,50
1998		420,8	31,5	14,7	6,1	34,0	7,3	
1999	23963	412,3	54,0	19,9	11,3	44,9	5,5	
2000		543,3	62,0	22,6	11,2	43,3	12,6	
2001		185,2	28,1	9,4	14,2	13,2	5,3	
2002		797,3		62,4	2,9	45,8		0,01
2004	24308	491,4	55,1	22,8	17,8	35,7	0,0	
2008	5923			31,9	2,7	41,3	0,3	0,03

Основными определяющими факторами скорости процесса аккумуляции ТМ в донных отложениях являлись особенности гранулометрического состава в каждой конкретной точке, а также гидродинамические процессы и морфометрия реки. Из-за высокой турбулентной активности на стрежне р. Волги обычно содержание здесь в донных отложениях большинства ТМ, за исключением Mo и Cd, более низкое, чем в прибрежных частях реки.

В донных отложениях водотоков дельты Волги происходит с большей или меньшей интенсивностью аккумуляция ТМ, за исключением Mo и Cd. Наиболее вероятной причиной накопления ТМ в донных отложениях водотоков дельты является уменьшение гидродинамической активности вследствие дробления р. Волги на отдельные рукава, данные по которым были сгруппированы по потокам низовьев: 1- коренное русло р.Волги от с. Светлый Яр до вершины дельты у с. Нижнелебяжье; 2 - Волго-Каспийский канал (ВКК), как продолжение коренного русла Волги в пределах дельты; 3 - рук. Бузан, водоток 1-го порядка, вбирающий в себя сток, проходящий через водотоки Волго-Ахтубинской поймы; 4 - рук. Ахтуба, маловодный водоток, сильно эвтрофированный, со слабым течением; 5 - рук. Кизань, водоток 1-го порядка и его продолжение в дельте; 6 - рук. Болда и его продолжение в виде банков дельты (табл. 14).

Таблица 14. Соотношение (в %) концентраций тяжелых металлов в донных отложениях коренного русла и водотоков дельты р. Волги

Водотоки	Mn	Fe	Cr	Co	Ni	Cu	Zn	Mo	Cd	Pb
коренное русло Волги	100	100	100	100	100	100	100	100	100	100
ВКК	129	116	101	117	108	117	125	81	91	189

рук. Бузан	149	142	106	144	123	122	146	77	92	192
рук. Ахтуба	110	98	129	86	96	87	93	96	101	99
рук. Кизань	160	121	109	132	119	124	145	69	86	191
рук. Болда	176	152	81	140	122	137	156	64	87	210

Выделяются своей контрастностью два рукава: Бузан и Ахтуба. В первом наблюдались практически по всем металлам максимальные концентрации, а во втором – наименьшие, за исключением Mo, Cd и Cr, которые очевидно накапливаются в донных отложениях. По-видимому, в рукаве Ахтуба, который сильно эвтрофирован, большинство микроэлементов утилизируется различными представителями биоты (высшая водная растительность, планктон, донные организмы). Прослеживается обратная связь между концентрациями Mo и Cd и гидродинамической активностью водотоков.

Следует также подчеркнуть большую степень сходства в величине концентраций ТМ для западных рукавов дельты Волги с ее коренным руслом. Восточные рукава дельты (Бузан, Болда) выделяются большими концентрациями ТМ по сравнению с западными (рис. 4а,б,в; рис.5а,б,в). В целом, в наибольшей степени в донных отложениях водотоков дельты Волги аккумулируются такие элементы, как Pb, Mn, Fe, Co, Zn, Cu. Два элемента - Mo и Cd, по-видимому, потребляются гидробионтами дельты, что приводит к снижению их концентраций в донных отложениях.

Анализ отдельных слоев отобранных колонок донных отложений на различных участках низовий Волги не позволяет сделать однозначного вывода о накоплении или вымывании ТМ в многолетнем разрезе, хотя в большинстве случаев нижние слои загрязнены больше, чем верхние, независимо от фракционного состава донных отложений. Такое распределение может быть следствием, как проникновения и накопления ТМ в более глубоких слоях, так и следствием депонирования загрязненных слоев более чистыми.

Корреляционный анализ выявил наличие устойчивых связей между концентрацией металлов в донных отложениях и их фракционным составом. В коренном русле р. Волги концентрации Fe, Co, Ni и Cu имеют значимую положительную связь с долей мелких частиц размером 0,001-0,005 мм, коэффициент корреляции r = 0,76-0,79. Для Cd и, особенно, Mo коореляционные связи отрицательны почти со всеми остальными металлами и долей мелких фракций в донных отложениях. В целом для всех металлов в донных отложениях коренного русла Волги, кроме Mn и Cr, можно говорить о существовании значимых связей с фракционным составом донных отложений.

Уже в тот период нами отмечалось достаточно низкое содержание в ДО многих микроэлементов, в частности Cu и Zn. Оно было намного ниже существующих нормативов (Нормы и критерии, 1996; Экологический энциклопедический словарь, 1999). Эти нормативы приведены в таблице 15.

Таблица 15. Значения ПДК для тяжелых металлов в почвах и донных отложениях пресноводных водоемов.

Элемент	ПДК для почв, мг/кг	ПДК для ДО, мг/кг	Норматив для ДО (Голландия), мг/кг		
			Целевой	Стандарт	Предельный
1	2	3	4	5	6
Cd	2	0.8	0.8	4	30
Cu	55	35	25	70	400
Ni	85	35			
Pb	30	85	50	125	700
Cr^{3+}	100	100	100	125	600
Zn	100	140	180	750	2500

Экспедиции ИВП РАН в 2007-2008 гг. на Нижней Волге показали, что продолжается процесс снижения концентраций ТМ как в русловой части р. Волги, так и в ее дельте. Эта тенденция прослеживается для всех основных микроэлементов (Cu, Zn, Ni, Pb, Cr, Cd), причем как по сравнению с ПДК для ДО (Нормы и критерии, 1996), так и с целевыми нормативами для ДО (Forsner et al., 1992).

Этот факт является чрезвычайно важным для экологии Нижней Волги, т.к. он свидетельствует об отсутствии интенсивных накопительных процессов. Конечно, как уже отмечалось выше, на тех участках дельты, где в ДО преобладают мелкодисперсные частицы, содержание ТМ возрастает по сравнению с соседними участками. Но при этом все равно концентрации приоритетных микроэлементов в несколько раз меньше ПДК.

2. Поступление загрязняющих веществ в Каспийское море с территории Республики Дагестан.

Самими крупными природными водотоками Дагестана, впадающими в Каспий, являются три реки: Терек, Сулак и Самур. Их суммарный сток составляет примерно 15 км^3/год, однако в нижнем течении рек заметная часть стока забирается на хозяйственные нужды. Особенно это касается р. Самур, средний годовой сток которой равен примерно 2 км^3/год, однако до моря доходит в лучшем случае только третья его часть. Сведения о качестве вод рр. Терек, Сулак и Самур взяты из «Бюллетеня о состоянии водных ресурсов Республики Дагестан за 2007 год», выпускаемого ФГУ «Дагводресурсы». Для ориентировочной оценки стока растворенных (в том числе загрязняющих веществ) рр. Терек и Сулак использовались данные ГУ «Дагестанский ЦГМС» (Росгидромет) – средняя концентрация и расход воды за период 1978-2007 гг. на устьевых створах (г/п Аликазган на р. Терек; г/п Главный Сулак на р. Сулак). Оценка стока растворенных веществ по р. Самур не производилась в связи с забором большей его части на хозяйственные нужды и отсутствием гидрохимических наблюдений на устьевом участке реки.

2.1. Сточные воды.

Для характеристики загрязнения Каспийского моря сточными водами с территории Республики Дагестан использовались следующие материалы: бюллетень ФГУ «Дагводресурсы» «О состоянии водных ресурсов Республики Дагестан» за 2007 г., данные Дагестанского ЦГМС (Росгидромет), данные государственной статистической отчетности по форме 2-ТП (водхоз) за 2007 г., а также государственные доклады «О состоянии окружающей среды РД» за 2003-2006 гг.

Анализ названных материалов позволяет утверждать, что одной из ключевых экологических проблем в РД продолжается оставаться загрязнение Каспийского моря и впадающих в него рек неочищенными или недостаточно очищенными сточными водами. Основными источниками поступления указанных вод являются объекты жилищно-коммунального хозяйства, производственной и сельскохозяйственной деятельности, а также ливневые стоки.

В 2007 г. в поверхностные водные объекты РД (в т.ч. в Каспийское море) было сброшено 975,53 млн. $м^3$ сточных вод. Из общего объема сброшенных вод загрязненные воды составили 74,77 млн. $м^3$ или 7,66%, в том числе: загрязненные без очистки - 10,70 млн. $м^3$ (1,10%), недостаточно очищенные - 64,06 млн. $м^3$ (6,56%). Ни одно из очистных сооружений предприятий и канализации РД не очищало сточные воды в 2007 г. до нормативно очищенного состояния. Большая часть вод (92,34 % или 901,06 млн. $м^3$) сбрасываемых в поверхностные водные объекты считается нормативно чистой без очистки и представляет собой сбросы рыбоводных прудов и мелиоративных систем.

Общая мощность очистных сооружений в 2007 году составила 65,48 млн. $м^3$, в том числе перед сбросом в водные объекты – 63,45 млн. $м^3$. Из-за большой перегрузки очистных сооружений канализационных систем городов или отсутствия таковых (в гг. Избербаш, Дербент, Дагестанские огни) не обеспечивается эффективная очистка сточных вод. Наибольший объем загрязненных сточных вод сбрасывается в Каспийское море МУП «ОСК городов Махачкала – Каспийск» – 52,51 млн. $м^3$, что составляет 70% суммарного значения по РД.

Вследствие активного хозяйственного воздействия во многих бассейнах рек на сегодня сложилась неудовлетворительная экологическая обстановка, особенно в части, касающейся качества поверхностных водных ресурсов: вода многих рек и водоемов загрязнена химическими веществами, солями тяжелых металлов, биогенными веществами, пестицидами, органическими соединениями. Особенно неблагоприятная ситуация складывается в маловодные периоды, когда вследствие истощения водных ресурсов резко возрастает нагрузка загрязнениями водных объектов. Наибольшую хозяйственную нагрузку испытывают на себе такие крупные речные системы, как Терек, Сулак и Самур. Содержание в их водах меди, фенола и нефтяных углеводородов превышает ПДК в несколько раз. В последнее время наблюдается тенденция к некоторому снижению загрязненности рек. Тем не менее, в основном реки можно отнести к категории «грязная» – «умеренно загрязненная».

Особую тревогу вызывает санитарно-гигиеническое состояние поверхностных водных объектов РД, в т.ч. Дагестанского побережья Каспийского моря. Так в 2007 году по данным ФГУЗ «Центр гигиены и эпидемиологии в РД» по санитарно-химическим показателям процент несоответствия воды водоемов 1 категории – 14,3% , 2 категории - 30,1% и моря – 15,9%. По санитарно-бактериологическим показателям процент несоответствия воды водоемов 1 категории составил 58,3%, водоемов 2 категории – 13,5 % и моря – 34,1%.

Сложившаяся обстановка объясняется, в первую очередь, или недостаточным форсированием большинства мероприятий по строительству и расширению канализационных сетей и сооружений в городах Махачкала, Каспийск, Избербаш, Дербент, Дагестанские огни, Кизилюрт, Кизляр, Буйнакск или полным их игнорированием.

В ходе проведении инвентаризации объектов хозяйственной деятельности, расположенных на территории РД, сбрасывающих загрязненные сточные воды и оказывающих наибольшее негативное воздействие на морскую среду Каспийского моря и его побережье, в соответствии с требованиями Задания, нами было выбраны следующие объекты, общим числом 10:

1) МУП «Очистные сооружения канализации гг. Махачкала и Каспийск» (загрязненных сточных вод – 52,51 млн $м^3$, из них недостаточно очищенных – 52,51 млн $м^3$, без очистки – нет).

2) МУП «Дербентгорводоканал» (загрязненных сточных вод – 4,5 млн $м^3$, из них без очистки – 4,5 млн $м^3$).

3) МУП «Городские очистные сооружения канализации г. Избербаш» (загрязненных сточных вод – 1,8 млн $м^3$, из них без очистки – 1,8 млн $м^3$).

4) МУП «Горводоканал г. Кизилюрт» (загрязненных сточных вод – 3,98 млн $м^3$, из них недостаточно очищенных – 3,98 млн $м^3$, без очистки – нет).

5) МУП «Водоканалхоз г. Буйнакск» (загрязненных сточных вод – 3,75 млн $м^3$, из них без очистки – 3,75 млн $м^3$).

6) МУП ЖКХ пос. Бавтугай (г. Кизилюрт) (загрязненных сточных вод – 0,29 млн $м^3$, из них недостаточно очищенных – 0,29 млн $м^3$).

7) МУП «Горводоканал г. Дагестанские огни» (загрязненных сточных вод – 0,19 млн $м^3$, из них без очистки – 0,19 млн $м^3$).

8) ОАО «Дагнефтепродукт» (загрязненных сточных вод – 0,09 млн $м^3$, из них недостаточно очищенных – 0,09 млн $м^3$, без очистки – нет).

9) Каспийская ТЭЦ, филиал «ДГ» ОАО «ЮГК-ТГК-8» (загрязненных сточных вод – 0,05 млн $м^3$, из них без очистки – 0,05 млн $м^3$).

10) Махачкалинская ТЭЦ, филиал «ДГ» ОАО «ЮГК-ТГК-8» (загрязненных сточных вод – 0,05 млн $м^3$, из них без очистки – 0,05 млн $м^3$).

Сброс загрязненных сточных вод непосредственно в Каспийское море от указанных объектов составляет 56,7 млн $м^3$, в т.ч. недостаточно очищенных – 50,3 млн $м^3$, без очистки – 6,4 млн $м^3$.

Количество загрязненных сточных вод, поступающих в рр. Сулак, Шураозень и Дагвагчай в 2007 году составило 8,2 млн $м^3$ (из них недостаточно очищенных – 4,3 млн $м^3$, без очистки – 3,9 млн $м^3$), в т.ч. в р. Сулак – 4,3 млн $м^3$, из них недостаточно очищенных – 4,3 млн $м^3$, без очистки – нет.

2.2. Вынос веществ речным стоком.

В разделе приводятся данные по концентрациям веществ в воде рек, впадающих в Каспийское море (табл. 16), и по стоку этих веществ (табл. 17) за период 1978-2007 гг. (по данным наблюдений Росгидромета).

Таблица 16. Средние значения концентраций веществ в воде за период 1978-2007 гг. (по данным Росгидромета).

Вещество	Река		
	Волга	Терек	Сулак
Нефтепродукты, мг/л	0,23	0,22	0,09
Фенолы, мг/л	0,0	0,004	0,003
СПАВ, мг/л	0,03	0,02	0,01
Железо, мг/л	0,19	0,07	0,06
Медь, мкг/л	7,0	4,0	3,0
Цинк, мкг/л	30,0	10,0	10,0
Марганец, мкг/л	1,0	10,0	10,0
Азот аммонийный, мг/л	1,22	0,19	0,13
Азот нитратный, мг/л	0,39	4,16	2,29
Фосфаты, мг/л	0,04	0,01	0,005
Кремнекислота, мг/л	2,3	5,2	2,8

Таблица 17. Сток веществ в Каспийское море (тыс. т/год) за период 1978-2007 гг. (по данным Росгидромета).

Вещество	Река		
	Волга	Терек	Сулак
Нефтепродукты	60,9 (97,8%)	0,98 (1,6%)	0,44 (0,6%)
Фенолы	3,84 (99,2%)	0,02 (0,5%)	0,01 (0,3%)
СПАВ	7,51 (98,2%)	0,07 (0,9%)	0,07 (0,9%)
Железо	51,6 (98,8%)	0,3 (0,6%)	0,3 (0,6%)
Медь	1,69 (98,0%)	0,02 (1,0%)	0,02 (1,0%)
Цинк	6,97 (99,0%)	0,03 (0,5%)	0,03 (0,5%)
Марганец	0,33 (85,0%)	0,02 (6,0%)	0,03 (9,0%)
Азот аммонийный	15,4 (99,5%)	0,84 (0,3%)	0,65 (0,2%)
Азот нитратный	100,2 (77,0%)	18,5 (14,3%)	11,4 (8,7%)
Фосфаты	9,6 (99,2%)	0,05 (0,6%)	0,02 (0,2%)

Кремнекислота	596,6 (94,1%)	23,2 (3,7%)	14,1 (2,2%)

Из таблицы 17 следует, что практически для всех веществ (за исключением марганца и нитратного азота) вклад р. Волги в суммарный сток веществ в Каспийское море составляет 95-99%.

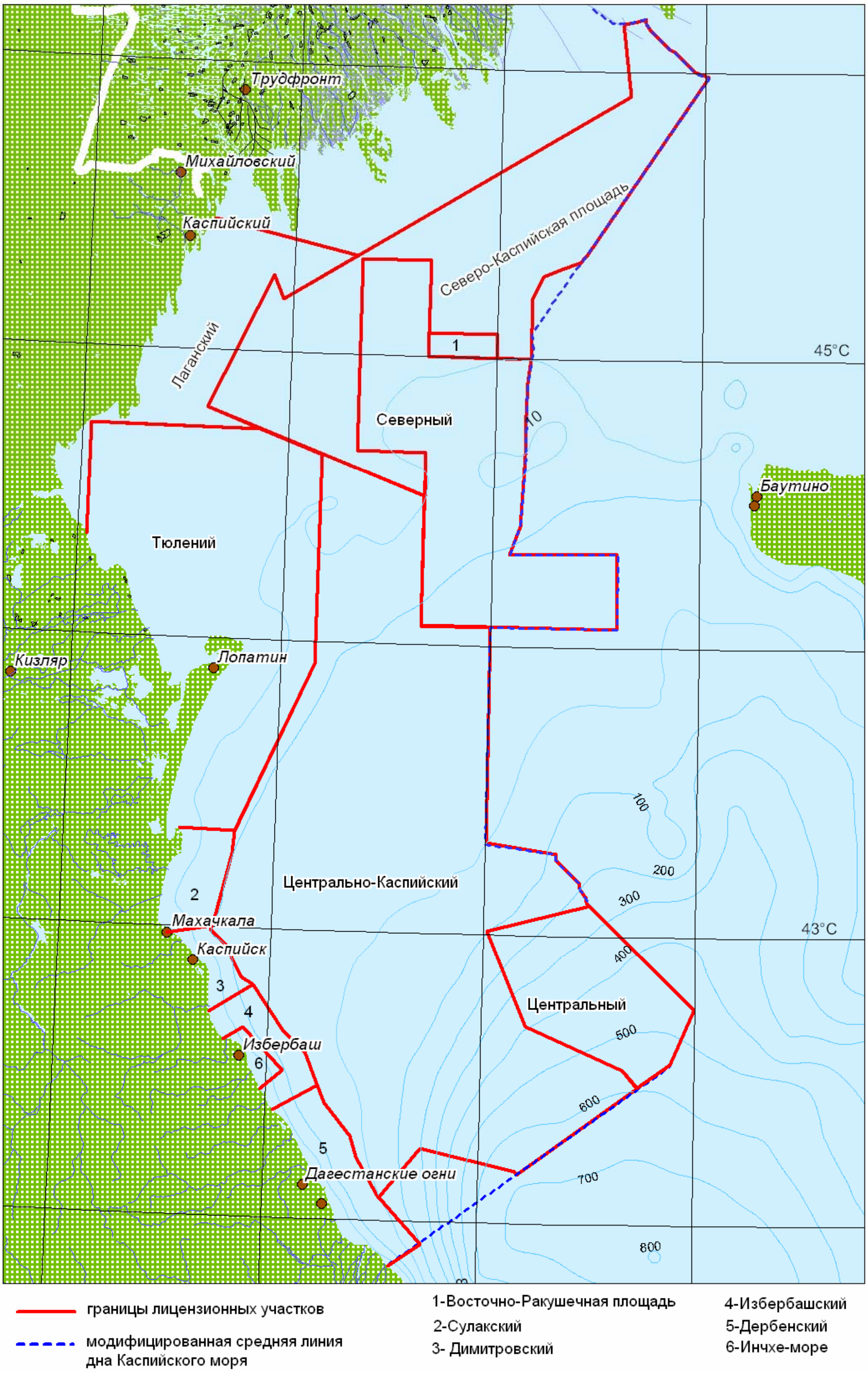

Трудфронт
Михайловский
Каспийский
Северо-Каспийская площадь
Лаганский
1
45°C
Северный
10
Баутино
Тюлений
Кизляр
Лопатин
100
200
2
Центрально-Каспийский
300
Махачкала
43°C
Каспийск
400
3
Центральный
4
Избербаш
500
6
600
5
Дагестанские огни
700
800
границы лицензионных участков
модифицированная средняя линия дна Каспийского моря
1-Восточно-Ракушечная площадь
2-Сулакский
3- Димитровский
4-Избербашский
5-Дербенский
6-Инчхе-море

Рис. 6. Схема расположения участков в российском секторе недропользования Каспийского моря.

3. Загрязнение северной части Каспийского моря.

В разделе рассмотрены характеристики загрязнения трех районов: акватории морской части Волго-Каспийского канала (ВКК), акватории, прилегающей к западному побережью Северного Каспия (участок «Тюлений») и открытой части Северного Каспия (участок «Северный»). Схема расположения участков представлена на рис. 6.

3.1. Загрязнение морской части Волго-Каспийского канала.

Особенности распределения ЗВ в воде и донных отложениях данного района можно проиллюстрировать на примере двух основных компонентов – нефтяных углеводородов (НУ) и меди, которые всегда остаются приоритетными ЗВ (табл. 18). Как видно из этой таблицы средняя концентрация НУ в воде на всей акватории полигона в июне 2008 г. была одинаковой, а осенью наблюдалась заметная разница по районам. Содержание Cu в июне было максимальным в центральном районе, а осенью – и в южном районе. Что касается донных отложений, здесь тоже наблюдаются отклонения концентраций по районам от средней по всему полигону, но эти различия находятся в пределах 15 %.

Таблица 18. Средние концентрации НУ и меди в воде и донных отложениях морской части Волго-Каспийского канала в июне и октябре 2008 г. (по данным Росгидромета).

Объект		Горизонт	Вода			
			НУ (мг)л		Cu (мкг/л)	
			июнь	октябрь	июнь	октябрь
Весь полигон		поверх.	0,06	0,08	4,8	11,0
		дно	0,06	0,08	4,7	9,0
Районы	Северный	поверх.	0,05	0,12	4,3	6,0
		дно	0,06	0,10	3,7	5,0
	Центральный	поверх.	0,06	0,07	5,9	13,0
		дно	0,06	0,06	6,0	11,0
	Южный	поверх.	0,06	0,07	3,8	13,0
		дно	0,06	0,07	3,9	11,0
Объект			Донные отложения			
Весь полигон			3,90	3,37	14,3	17,5
Районы	Северный		3,45	2,97	13,5	17,0
	Центральный		3,96	3,20	16,4	19,7

	Южный	4,20	3,94	12,4	15,1

Для оценки качества водной среды в морской части ВКК использовался подход, основанный на сравнении выявленного уровня загрязнения с нормативами (ПДК), установленными для рыбохозяйственных водоемов. Для оценки качества ДО использованы зарубежные нормы содержания ЗВ в морских осадках – «голландские листы» (ГЛ). Определяли также повторяемость концентраций, превышающих ПДК. Результаты анализов проб воды и донных отложений, выполненных в июне и октябре 2008 г., представлены в табл. 19 и 20.

Таблица 19. Средняя концентрация загрязняющих веществ и повторяемость концентрации, превышающей ПДК, в водах морской части Волго-Каспийского канала в июне и октябре 2008 г. (по данным Росгидромета).

Нормируемый показатель	Средняя концентрация		Повторяемость концентрации, превышающей ПДК,%	
	июнь	октябрь	июнь	октябрь
БПК$_5$, мг/л	2,84	2,97	92	88
P-PO$_4$, мкг/л	36,5	21,9	0	0
N-NO$_3$, мкг/л	62,8	75,3	0	0
N-NO$_2$, мкг/л	2,2	2,3	0	0
N-NH$_4$, мкг/л	28,7	38,2	0	0
НУ, мг/л	0,06	0,08	56	76
Фенолы, мг/л	0,003	0,003	100	96
СПАВ, мг/л	0,03	0,04	0	0
Fe, мкг/л	100,3	0,134	96	100
Mn, мкг/л	4,7	3,9	0	0
Zn, мкг/л	11	17	0	0
Cu, мкг/л	5	11	44	72
Ni, мкг/л	27,8	13,1	100	84
Cd, мкг/л	0,03	0,28	0	0
Pb, мкг/л	0,7	0,4	0	0
Hg, мкг/л	0,01	0,01	0	0
Co, мкг/л	1,5	1,0	0	0
Нафталин, мкг/л	0,463	0,336	0	0
Бенз(а)пирен, мкг/л	0,0167	0,0036	100	20

Как видно из табл. 19, концентрации трех веществ – фенолов, никеля и бенз(а)пирена – летом превышала ПДК во всех (100 %) пробах воды, отобранных в исследуемом районе. В осенний период такой процент превышения отмечался только у железа.

Следует отметить, что в XX столетии основными ЗВ в водах Каспия были нефтепродукты и хлорорганические пестициды (ХОП). Результаты исследований в 2008 г. указывают, что в настоящее время содержание этих веществ в морской части ВКК заметно снизилось. Так, концентрация нефтепродуктов в воде не превышала 1,5 ПДК, присутствие пестицидов ГХЦГ и ДДТ вообще не было обнаружено. На большинстве станций в пробах донных отложений ХОП также отсутствовали.

Таблица 20. Средняя концентрация загрязняющих веществ, нормируемых за рубежом («ГЛ»), и повторяемость концентрации, превышающей норму, в донных отложениях морской части ВКК в июне и октябре 2008 г. (по данным Росгидромета).

Нормируемый показатель	Средняя концентрация		Повторяемость концентрации, превышающей норму, %		«ГЛ»
	июнь	октябрь	июнь	Октябрь	
Нефтепродукты, мг/кг	4,03	3,37	0	0	50
Фенол, мг/кг	0,05	0,06	60	52	0,05
Хром, мг/кг	0,5	0,8	0	0	100
Цинк, мг/кг	6,0	9,6	0	0	140
Медь, мг/кг	14,7	17,5	0	0	35
Никель, мг/кг	25,5	29,3	0	12	35
Кадмий, мг/кг	0,07	0,08	0	0	0,8
Свинец, мг/кг	2,2	1,4	0	0	85
Ртуть, мг/кг	0,02	0,02	0	0	0,3
Кобальт, мг/кг	0,5	0,6	0	0	20
Олово, мг/кг	48,9	37,2	96	96	20
Бенз(а)пирен, мкг/кг	0,010	0,029	0	0	25
Сумма ПАУ, мкг/кг	18,68	11,74	0	0	1000

Результаты анализа содержания ЗВ в донных отложениях морской части ВКК свидетельствуют об относительно благоприятной обстановке. Сравнение с зарубежными нормами показывает, что донные осадки исследуемого района являются относительно чистыми, хотя в части проб концентрация фенолов и олова превышала зарубежные нормативы в 1,5-2,0 раза.

3.2. Загрязнение акватории, прилегающей к западному побережью Северного Каспия (участок «Тюлений).

В данном разделе рассмотрена динамика показателей загрязнения морской среды за период 2001-2008 гг. (летний сезон). Результаты анализов проб воды (поверхностный слой) и донных отложений на исследованном участке представлены в табл. 21. Приведенные данные позволяют сделать выводы об изменчивости отдельных показателей.

Нефтяные углеводороды. Концентрация НУ была минимальной в 2001 г., а затем держалась в среднем на уровне 1,2 -1,6 ПДК, за исключением 2004 г.2007 г., когда она достигала почти 3 ПДК (ПДК = 50 мкг/л). В донных отложениях разброс значений гораздо больше, чем для воды, но в последние годы (2006-2008 гг.) концентрация НУ не превышала 10 мг/кг.

Фенолы. Характерной, т.е. наиболее часто повторяющейся концентрацией фенолов в воде была величина 2 мкг/л (2 ПДК). Концентрация фенолов в ДО участка «Тюлений» в 2001-2003 гг. была достаточно стабильной, а затем она резко возросла и так же резко снизилась, оставаясь на уровне 0,04-0,06 мкг.

СПАВ. В период 2001-2006 гг. наблюдалось снижение содержания СПАВ в воде, но затем оно стало возрастать и в 2008 г. достигло уровня 2001 г. Что касается концентрации СПАВ в ДО, то тенденция ее снижения наблюдающаяся в 2001-2006 гг., сохранилась и в последующие годы. При этом средняя концентрация СПАВ в 2007-2008 гг. оказалась примерно на порядок ниже, чем в 2001-2003 гг.

Железо. Наиболее яркими чертами многолетних изменений содержания Fe в морской воде на данном участке в 2001-2008 гг. следует считать резкое повышение его концентрации в 2002-2003 гг., обусловленное катастрофическим паводком на р. Терек (2002 г.) и ослаблением водообмена между Северным и Средним Каспием (2003 г.). Резкое увеличение содержания Fe в донных отложениях наблюдалось в 2005 г. В 2008 г. по сравнению с предыдущим годом концентрация Fe в воде снизилась в 4 раза, а в донных отложениях практически не изменилась.

Марганец. Содержание Mn в воде резко повысилось в 2002-2003 гг. (по тем же причинам, что и у Fe , при этом оно было достаточно высоким и в донных отложениях). В последующий период в обеих средах наблюдалось заметное понижение уровня загрязнения.

Цинк. Динамика содержания Zn в воде такая же, как у Fe и Mn (резкий рост в 2002-2003 гг. с последующим понижением).

Медь. Для Cu характерными были плавные колебания ее концентрации в воде в 2001-2006 гг., которые сменились резким ростом концентрации в 2007-2008 гг. Следует также отметить относительно высокий уровень содержания Cu в донных отложениях в 2005-2008 гг. по сравнению с периодом 2001-2003 гг.

Свинец. Концентрация Pb в воде держалась на уровне 1-2 мкг/л в период 2003-2006 гг., а затем возросла в 2 раза. В ДО содержание Pb было относительно высоким в 2001-2003 гг., а затем оно резко снизилось в 2006-2008 гг.

Кадмий. У Cd наблюдался рост его концентрации в воде в 2002-2003 гг. (как и у Cu), который затем сменился резким снижением (такая же картина наблюдалась и в донных отложениях).

В целом результаты исследований уровня загрязнения морской среды на участке «Тюлений» в 2001-2008 гг. указывают на широкий размах межгодовых колебаний концентрации ЗВ в воде и ДО. Это вполне объяснимо, если учесть широкую изменчивость природных условий и антропогенной нагрузки, свойственных данному району Каспийского моря.

3.3 Загрязнение открытой части Северного Каспия (юго-восточный сектор участка «Северный»).

В разделе представлены данные по содержанию ЗВ в воде и донных отложениях юго-восточного сектора участка «Северный». Данные получены на 20 станциях и усреднены за периоды 1998-2003 гг. и 2006-2008 гг.(табл.22, 23).

Таблица 22. Средняя концентрация загрязняющих веществ в воде (мкг/л) и донных отложениях (мг/кг) на участке «Северный» в 1998-2003 гг. и 2006-2008 гг. (по данным Росгидромета).

Вещество	1998-2003 гг.		2006-2008 гг.	
	Вода	ДО	Вода	ДО
Нефтяные углеводороды	46,0	6,0	19,8	5,1
Фенолы	1,06	0,02	0,2	4,4
СПАВ	6,5	22,4	0,0	0,0
Фосфор общий	41,8	-	29,7	-
Азот общий	477	-	497	-
Железо	49,9	-	9,4	-
Марганец	2,2	-	1,2	-
Цинк	4,5	11,8	3,9	6,7
Никель	1,8	10,0	1,5	6,4
Медь	2,2	7,1	2,4	3,2
Свинец	2,9	4,1	1,5	4,1
Кадмий	0,5	1,3	0,1	0,2
Ртуть	0,18	0,02	0,0	0,01

Таблица 23. Средняя концентрация пестицидов в воде (нг/л) и донных отложениях (мкг/кг) на участке «Северный» в 2206-2008 гг. (по данным Росгидромета).

Вещество	Вода	Донные отложения
ДДТ	0,30	0,07
ДДЕ	0,07	0,03
А-ГХЦГ	0,001	0,036
Г-ГХЦГ	0,03	0,02

Анализ данных табл. 22 позволяет сделать ряд важных выводов об изменениях состояния морской среды в открытой части Северного Каспия. Так, за последний период резко снизилось содержание в воде нефтяных углеводородов (в 2,3 раза), фенолов (в 5 раз) и СПАВ. Что касается тяжелых металлов, заметно уменьшились концентрации железа и кадмия (в 5 раз) и ртути, концентрация которой снизилась с 0,18 мкг/л до нуля. В то же время содержание меди и некоторых других металлов практически не изменилось. В донных отложениях резко снизилось (практически до нуля) содержание СПАВ, но столь же резко возросло содержание фенолов (на два порядка). Содержание тяжелых металлов также снизилось, но в меньших масштабах (в среднем в 2 раза). Эти факты свидетельствуют об определенном улучшении экологической обстановки в Северном Каспии.

4. Современная экологическая обстановка в северной части Каспийского моря и ее возможные изменения в ближайшем будущем.

Экологическая обстановка в российском секторе недропользования Каспийского моря зависит от сочетания друг с другом природных и антропогенных факторов, воздействующих на морскую среду, а также от чувствительности, устойчивости и уязвимости морских экосистем к этому воздействию.

Из внешних природных факторов на экологическую обстановку в основном влияют изменения климата, определяющие динамику теплового и водного баланса моря, а также интенсивность водообмена между Северным и Средним Каспием. Из числа термических факторов экологическое значение имеет суровость зим. Состоянием увлажнения бассейна Волги определяется объем годового стока реки – главного фактора, влияющего на функционирование экосистемы Северного Каспия. Противофазный характер колебаний биологической продуктивности в Северном и Среднем Каспии определяется водообменном между этими частями моря. При уменьшении водообмена биопродуктивность Северного Каспия повышается, а Среднего Каспия – снижается. При увеличении водообмена наблюдается обратная картина.

Рыбный промысел, зарегулирование речного стока, биологическое и химическое загрязнение морской среды являются основными факторами антропогенного воздействия на рассматриваемую акваторию. Основным источником загрязнения морской среды для рассматриваемой акватории, по-видимому, являются речной сток, сброс коллекторных и дренажных вод с оросительных систем и судоходство.

Экологическое состояние акватории в какой-либо момент времени определяется сложным сочетанием природных и антропогенных факторов. Например, зарегулирование стока усилило зависимость жизнедеятельности пресноводного и солоноватоводного комплексов от изменений климата. Уровень загрязнения морской среды Северного Каспия так же, как и уровень его биологической продуктивности, зависит не только от поступления веществ с речным стоком, но и от водообмена между Северным и Средним Каспием. Важным фактором, влияющим и на биологическую продуктивность вод и на состояние их загрязнения, является обмен взвешенными частицами между водой и донными отложениями, который в свою очередь зависит от стока наносов и штормовой активности.

Исключительная сложность структурно-функциональной организации биологических сообществ на рассматриваемой акватории, обусловленная наличием в ее пределах двух разнокачественных экосистем (северо- и среднекаспийской), а также высокая динамичность природно-хозяйственной обстановки требуют проведения разносторонних и регулярных исследований для оценки и прогноза будущих изменений, обусловленных повышением антропогенной нагрузки в связи с расширением масштабов нефтегазодобывающей деятельности.

В настоящее время **реальную угрозу** экологической безопасности российского сектора недропользования Каспийского моря представляют нерациональный рыбный промысел и виды-вселенцы, в совокупности наносящие ощутимый урон рыбным запасам.

Основной **потенциальной угрозой** являются аварийные разливы нефти (а также подводные газовые выбросы, обусловленные техногенной дестабилизацией недр), вероятность возникновения которых будет возрастать по мере освоения новых месторождений. Следовательно, загрязнение морской среды, влияние которого на экологическую обстановку сегодня оценивается как второстепенное, в любой момент может стать ведущим фактором антропогенного воздействия на морские экосистемы.

Основной поток загрязняющих веществ в российском секторе направлен от дельты Волги на Дербентскую котловину. Это обусловлено тем, что преобладающей формой миграции загрязнителей является взвесь. Условия, вызывающе замедление этого потока, одновременно способствуют накоплению загрязнителей в «живом веществе», вызывая периодические вспышки заболеваемости рыб токсикозом.

Поток загрязняющих веществ с одной стороны проходит через природные фильтры, а с другой стороны подпитывается из посторонних источников. Учитывая особенности циркуляции вод в Северном и Среднем Каспии, можно предполагать, что этими источниками являются потоки загрязнителей из казахстанского сектора недропользования.

В этих условиях выявление источников поступления, отслеживание путей и оценка интенсивности переноса загрязняющих веществ в российском секторе недропользования Каспийского моря следует рассматривать как важнейшие превентивные меры, направленные на обеспечение экологической безопасности Каспийского моря.

В соответствии с климатическим прогнозом на период до 2015-2020 гг. на Северном Каспии ожидается усиление континентальности климата, сопровождающееся уменьшением объема речного стока. В этих условиях произойдет снижение моря до отметки -28,0 м и повышение средней солености на 1,0-1,5 ‰. Как следствие (а также учитывая зарегулирование стока) уменьшатся запасы полупроходных рыб, в настоящее время составляющих основу промысла в Волго-Каспийском бассейне.

Дальнейшее развитие морского транспорта и нефтегазодобычи (включая обустройство и эксплуатацию месторождений им. Ю. Корчагина и В. Филоновского) приведет к усилению антропогенной нагрузки, связанной с этими видами деятельности, на экосистему Северного Каспия. В условиях нормального функционирования производственных объектов и полномасштабного использования принципа нулевого сброса экологические последствия повышения антропогенной нагрузки не будут ощущаться. По-прежнему основным фактором, обусловливающим негативные изменения экосистемы Северного Каспия, будет выступать биологическое загрязнение.

В случае возникновения аварийных разливов нефти (представляющих основную угрозу экосистеме Северного Каспия со стороны нефтегазодобычи), вероятность которых будет возрастать по мере введения в эксплуатацию новых месторождений, их негативные экологические последствия будут сильнее ощущаться в период 2020-2030 гг. В период до 2015-2020 гг. гидрологические условия будут препятствовать накоплению ЗВ в Северном Каспии и способствовать их выносу в глубоководную часть моря.

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ДО р. Болда, р. Бушма, р. Бузан, 2008

		г/кг нефтпр	мг/кг АПАВ	фен.общ. мг/кг	Pb мг/кг	Cd мг/кг	Cu мг/кг	Mn мг/кг
	1	2	3	4	5	6	7	8
	17	0,02	5,3	0,1	2,68	0,06	7,58	261
	18	0,02	4,3	0,1	1,06	0,06	4,63	138
	19	0,25	8,2	0,2	7,51	0,11	14,4	496
	20	0,23	9,8	0,5	3,1	0,06	9,71	388
	21	0,07	8,9	0,2	4,46	0,1	11,2	358
	22	0,04	8,2	0,1	4,23	0,1	10,5	341
	23	0,02	4,3	0,1	3,03	0,06	7,28	214
	24	0,02	2,7	0,1	2,55	0,07	7,95	240
	25	0,03	6,6	0,1	4,14	0,09	10	339
	26	0,03	0,2	0,1	3,05	0,08	4,49	196
	27	0,05	3,1	0,1	5,38	0,08	7,49	260
	28	0,02	1,2	0,1	3,19	0,09	6,45	286
	29	0,02	3,9	0,1	3,72	0,09	10,1	314
	30	0,02	1,7	0,1	1,55	0,04	4,33	219
19а		0,07	7,1	0,3	5,63	0,1	14,2	451
19б		0,09	7,4	0,2	4,41	0,09	11,8	358
		0,0625	5,18125	0,15625	3,730625	0,08	8,881875	303,6875

		Feобщ мг/кг	Ni мг/кг	Cr общ мг/кг	Zn мг/кг	Co мг/кг
	1	9	10	11	12	13
	17	13260	16,7	15,5	17	9,2
	18	7620	7,41	10,2	10,9	6,45
	19	18750	32,3	23,3	34,3	13
	20	14190	26,1	16,3	27,5	9,67
	21	19800	30,3	28,1	30,6	11
	22	16310	29,7	21,3	21,2	10,9
	23	12670	15,1	14,5	13,7	9,74
	24	13060	13	14,6	16,7	8,06
	25	17650	29,1	22,6	23,5	10,3
	26	10340	18,7	12,5	11,2	7,07
	27	13660	21,2	15,7	16,9	7,33
	28	13960	23,1	17,9	15,3	7,88
	29	18000	27,9	20,5	22,6	9,37
	30	10730	17,3	13,4	13	4,98
19а		22520	34,1	26,8	35,2	10,1
19б		20380	34,6	21,3	35,5	10,2
		15181,25	23,53813	18,40625	21,56875	9,078125

ДО р. Болда, р. Бушма, р. Бузан, 2008

Среднее	0,0625	5,18125	0,15625	3,730625	0,08	8,881875	303,6875
Стандартн	0,0182	0,73735	0,027339	0,398181	0,004916	0,789849	23,87497
Медиана	0,03	4,8	0,1	3,455	0,085	8,83	300
Мода	0,02	4,3	0,1	#N/A	0,06	#N/A	358
Стандартн	0,072801	2,9494	0,109354	1,592723	0,019664	3,159395	95,49989
Дисперсия	0,0053	8,698958	0,011958	2,536766	0,000387	9,981776	9120,229
						0,202102	0,330226
Интервал	0,23	9,6	0,4	6,45	0,07	10,07	358
Минимум	0,02	0,2	0,1	1,06	0,04	4,33	138
Максимум	0,25	9,8	0,5	7,51	0,11	14,4	496
Сумма	1	82,9	2,5	59,69	1,28	142,11	4859
Счет	16	16	16	16	16	16	16

Среднее	15181,25	23,53813	18,40625	21,56875	9,078125
Стандартн	1020,573	2,049405	1,298379	2,16602	0,501417
Медиана	14075	24,6	17,1	19,1	9,52
Мода	#N/A	#N/A	21,3	#N/A	#N/A
Стандартн	4082,292	8,197621	5,193518	8,664081	2,005666
Дисперсия	16665105	67,20099	26,97263	75,06629	4,022696
Эксцесс	-0,608112	-0,89479	-0,72277	-1,178138	0,139149
Асимметрі	0,051367	-0,364497	0,379732	0,4978	-0,235125
Интервал	14900	27,19	17,9	24,6	8,02
Минимум	7620	7,41	10,2	10,9	4,98
Максимум	22520	34,6	28,1	35,5	13
Сумма	242900	376,61	294,5	345,1	145,25
Счет	16	16	16	16	16

ДО р. Волга, рук. Бахтемир 2008 г.

		г/кг	мг/кг	мг/кг	Pb	Cd	Cu
		нефтпр	АПАВ	фенолы об	мг/кг	мг/кг	мг/кг
	1	2	3	4	5	6	7
	1	0,02	5,2	0,1	4,32	0,05	8,48
2ЛБ		0,03	4,35	0,4	5,2	0,13	12,5
2ПБ		0,03	1,35	0,1	2,52	0,05	2,5
	3	0,02	0,2	0,1	2,92	0,05	0,45
	4	0,02	0,02	0,1	6,53	0,04	6,37
	5	0,04	0,2	0,1	2,38	0,03	5,6
	6	0,02	0,6	0,1	5,33	0,09	15,7
	7	0,02	0,02	0,1	2,03	0,05	0,73
7А		0,02	3,1	0,4	6,85	0,08	15,5
	8	0,03	3,5	0,4	7,23	0,12	15,4

		Mn	Feобщ	Ni	Cr общ	Zn	Co
		мг/кг	мг/кг	мг/кг	мг/кг	мг/кг	мг/кг
		8	9	10	11	12	13
	1	377	16500	29,2	22,2	26,1	8,22
2ЛБ		438	21710	40,4	26,6	41,2	11,7
2ПБ		244	13030	13,6	12,8	13,5	6,21
	3	127	5260	11	8,5	11,9	4,69
	4	210	11120	21	14	21,1	7,09
	5	203	8490	17,2	12,8	17,1	5,69
	6	441	24010	41,9	23,6	47,3	14,1
	7	82,5	4510	6,38	7,56	9,95	4,2
7А		832	22220	40,5	24,6	45,2	13,2
	8	530	23530	42,1	24,1	46	14

Описательная статистика для содержания ТМ в ДО р.Бахтемир в 2008 г

	г/кг	мг/кг	мг/кг	Pb	Cd	Cu
	нефтпр	АПАВ	фенолы об	мг/кг	мг/кг	мг/кг
Среднее	0,025	1,854	0,19	4,531	0,069	8,323
Стандартн	0,002236	0,629926	0,045826	0,626366	0,010899	1,938669
Медиана	0,02	0,975	0,1	4,76	0,05	7,425
Мода	0,02	0,2	0,1	#N/A	0,05	#N/A
Стандартн	0,007071	1,992002	0,144914	1,980743	0,034464	6,13061
Дисперсия	5E-05	3,968071	0,021	3,923343	0,001188	37,58438
Эксцесс	0,571429	-1,372411	-1,22449	-1,75604	-0,570445	-1,741598
Асимметрı	1,178511	0,631113	1,035098	0,053805	0,87902	0,028703
Интервал	0,02	5,18	0,3	5,2	0,1	15,25
Минимум	0,02	0,02	0,1	2,03	0,03	0,45
Максимум	0,04	5,2	0,4	7,23	0,13	15,7
Сумма	0,25	18,54	1,9	45,31	0,69	83,23
Счет	10	10	10	10	10	10

	Mn	Feобщ	Ni	Cr общ	Zn	Co
	мг/кг	мг/кг	мг/кг	мг/кг	мг/кг	мг/кг
	348,45	15038	26,328	17,676	27,935	8,91
	71,11682	2402,666	4,478267	2,290085	4,866918	1,249319
	310,5	14765	25,1	18,1	23,6	7,655
	#N/A	#N/A	#N/A	12,8	#N/A	#N/A
	224,8911	7597,896	14,16152	7,241883	15,39055	3,950693
	50576,03	57728018	200,5487	52,44487	236,8689	15,60798
	1,141811	-1,729842	-1,909097	-1,889794	-2,01669	-1,851133
	1,026224	-0,141094	-0,05657	-0,17594	0,2321	0,300194
	749,5	19500	35,72	19,04	37,35	9,9
	82,5	4510	6,38	7,56	9,95	4,2
	832	24010	42,1	26,6	47,3	14,1
	3484,5	150380	263,28	176,76	279,35	89,1
	10	10	10	10	10	10

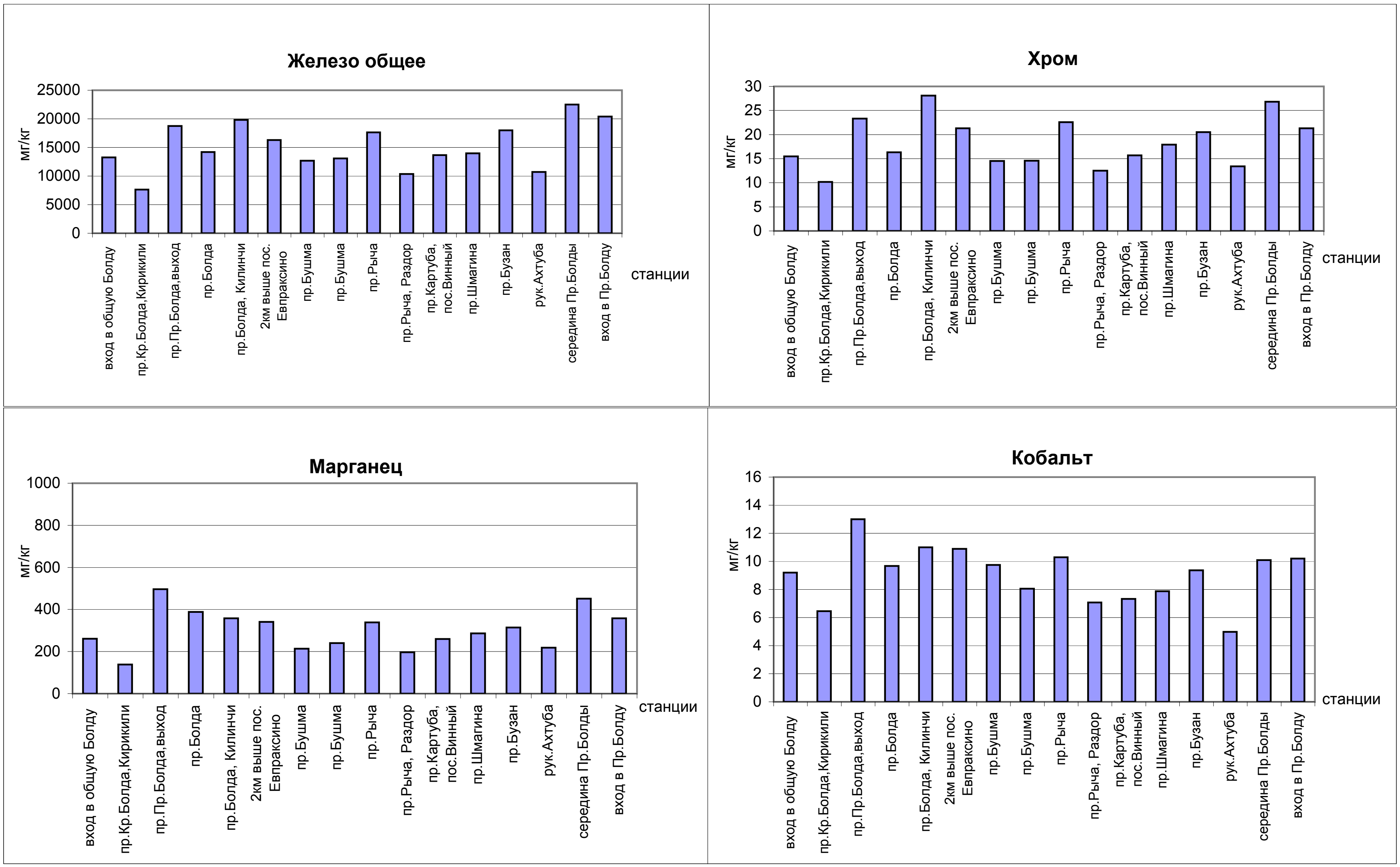


Рис. 5а. Содержание загрязняющих веществ в донных отложениях рукавов Болда, Бушма, Бузан в 2008 г

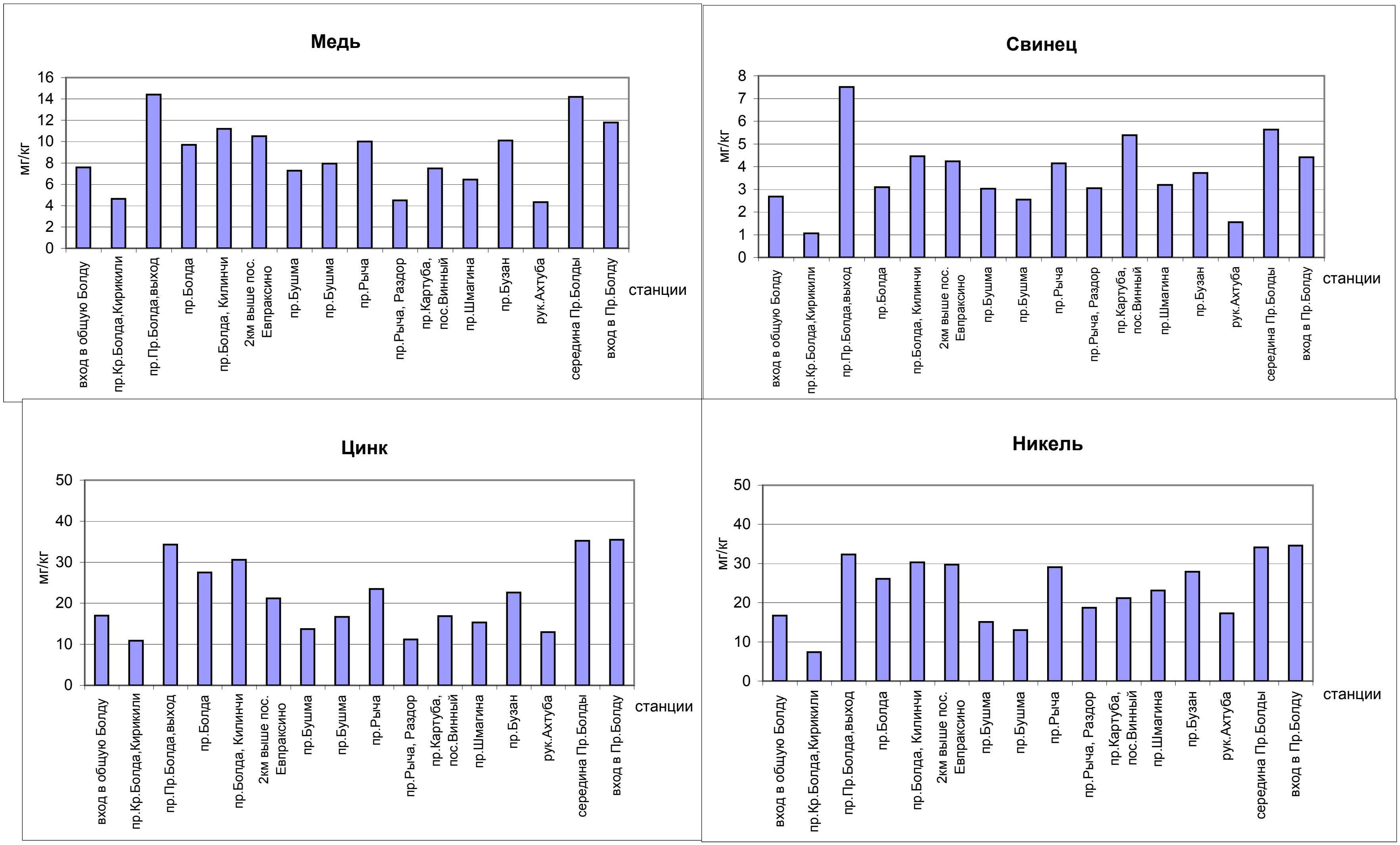


Рис. 5б. Содержание загрязняющих веществ в донных отложениях рукавов Болда, Бушма, Бузан в 2008 г.

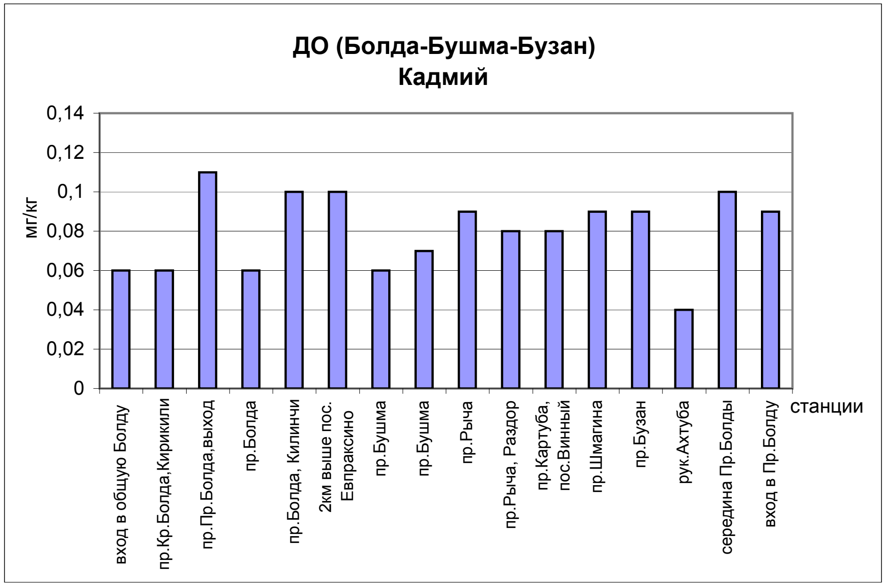
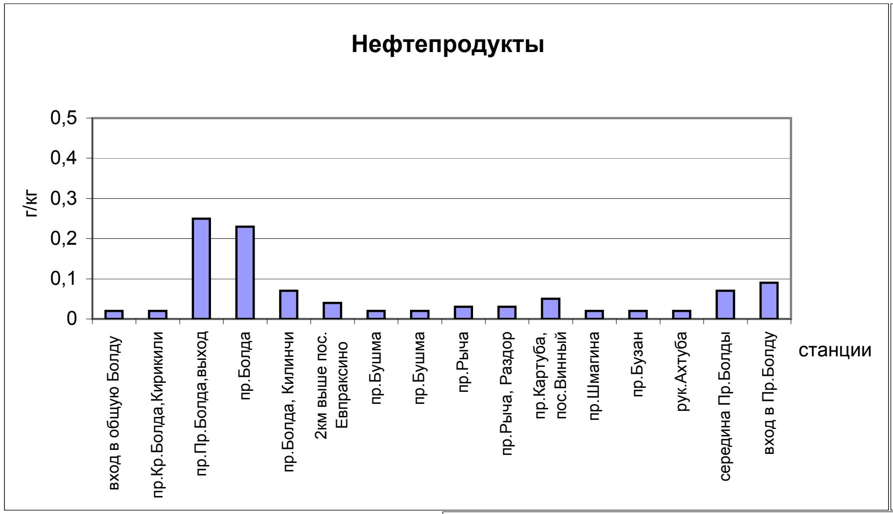
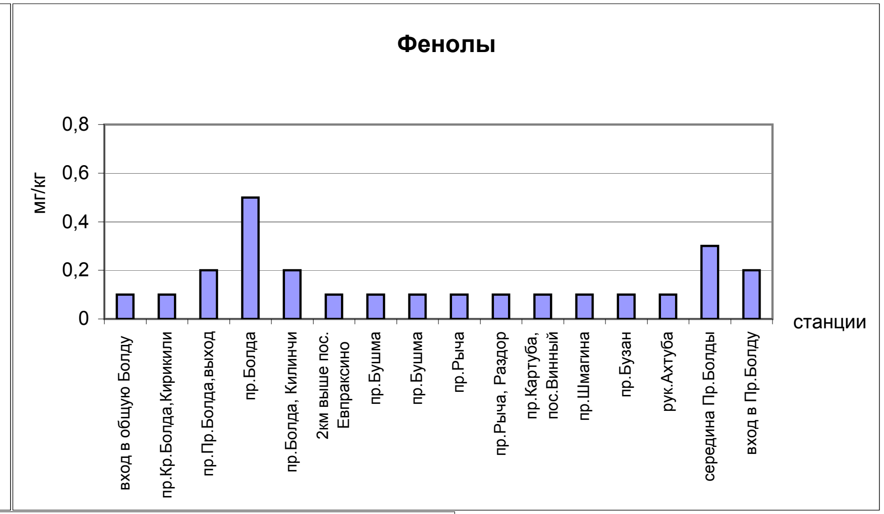


Рис. Содержание кадмия в донных отложениях рукавов Болда, Бушма, Бузан в 2008 г.





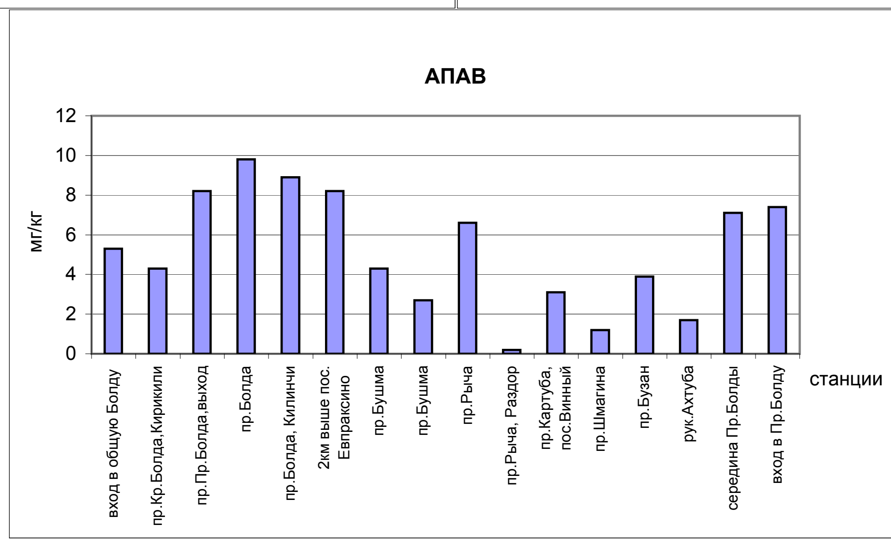
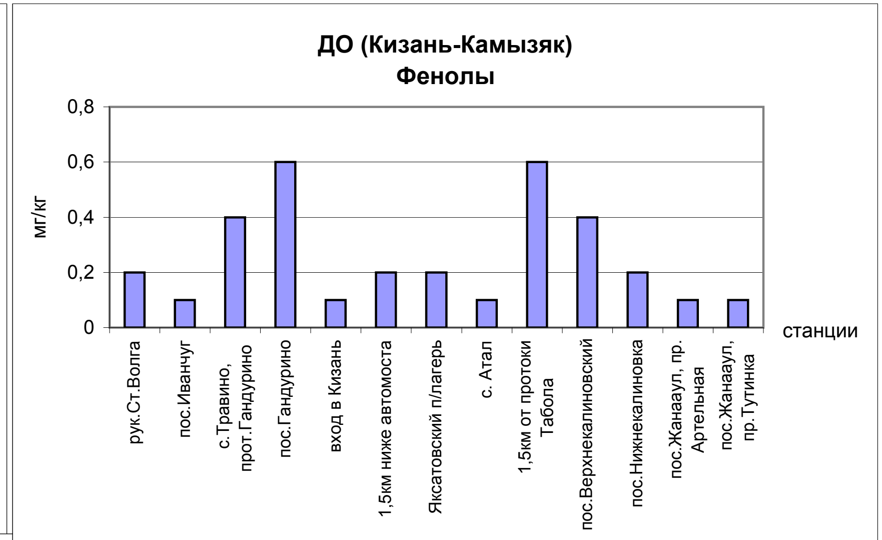


Рис. 5в. Содержание загрязняющих веществ в донных отложениях рукавов Болда, Бушма, Бузан в 2008 г.



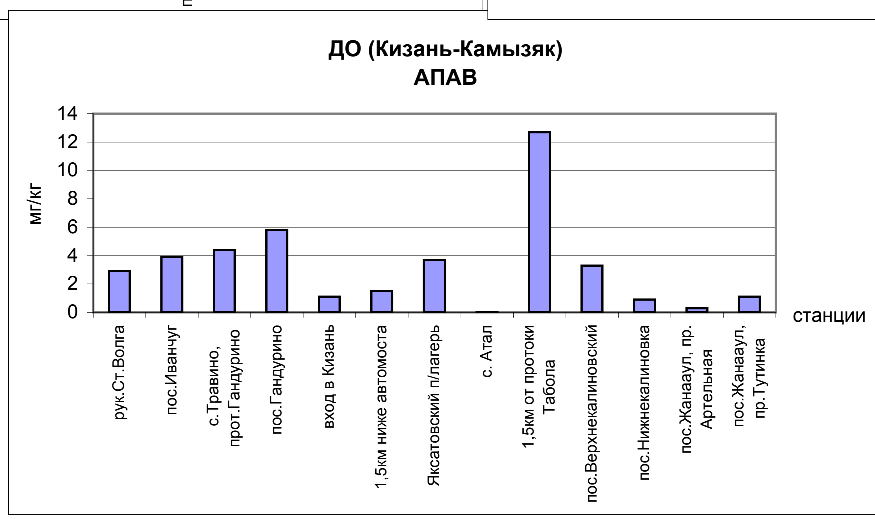


Рис. Содержание загрязняющих веществ в донных отложениях рукавов Кизань-Камызяк в 2008 г.

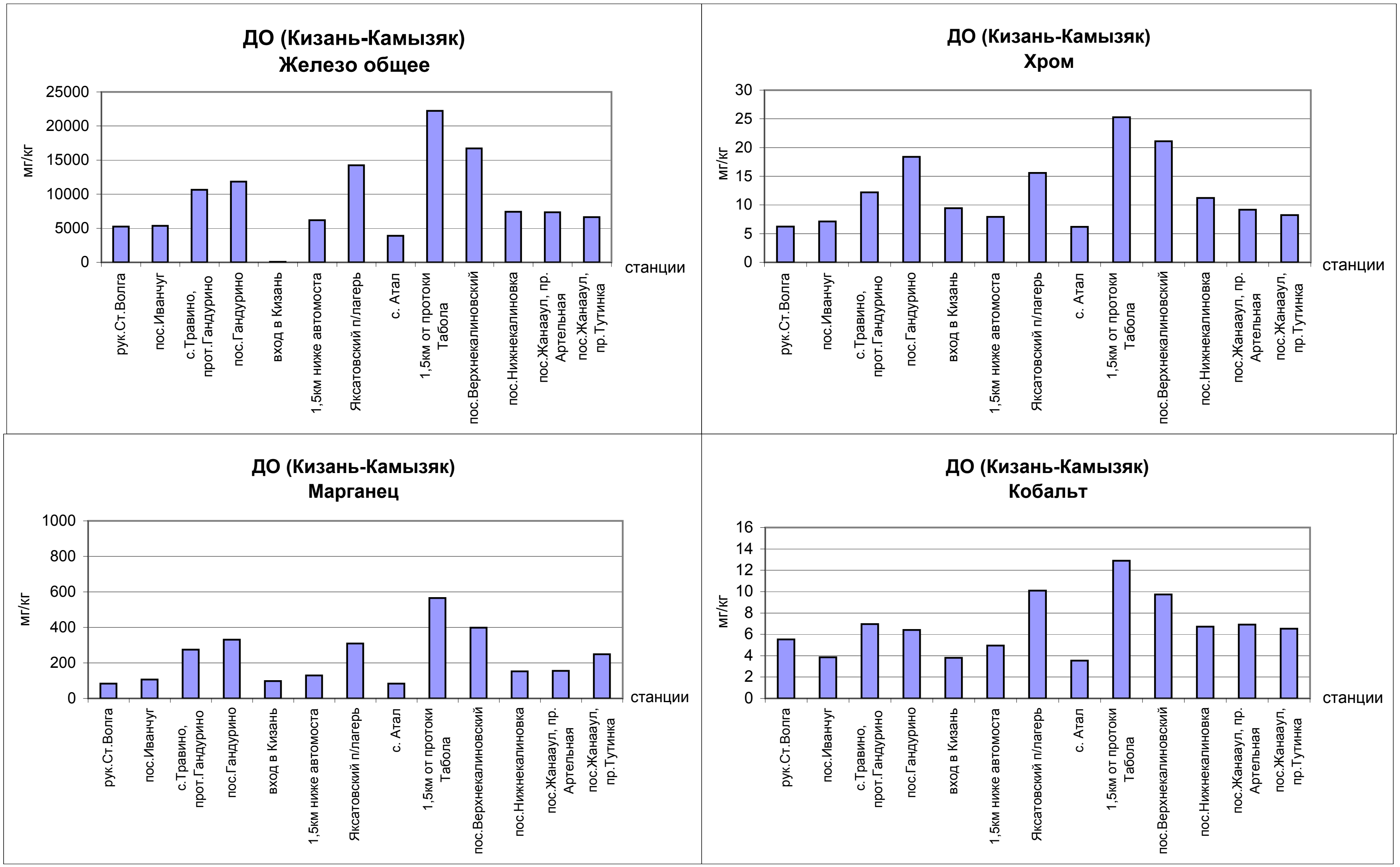
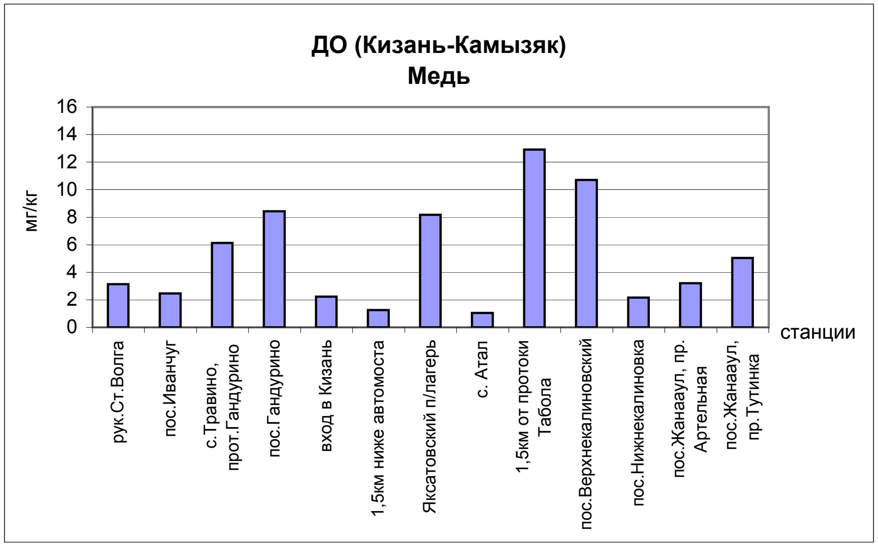
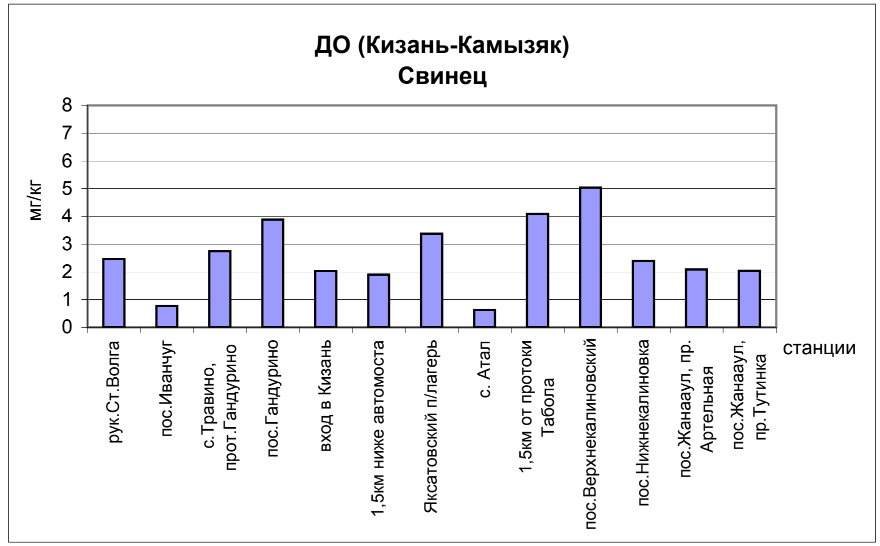
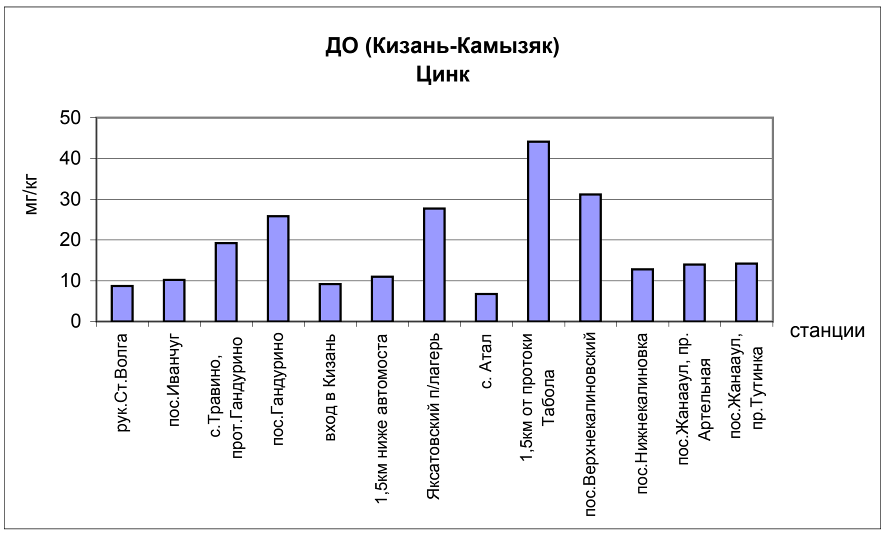


Рис. Содержание загрязняющих веществ в донных отложениях рукавов Кизань, Камызяк в 2008 г.







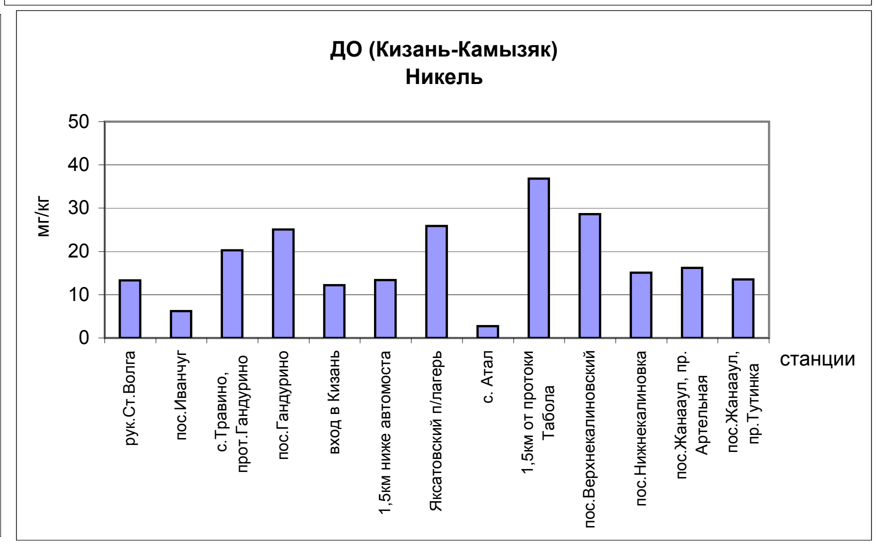


Рис. Содержание загрязняющих веществ в донных отложениях рукавов Кизань, Камызяк в 2008 г.

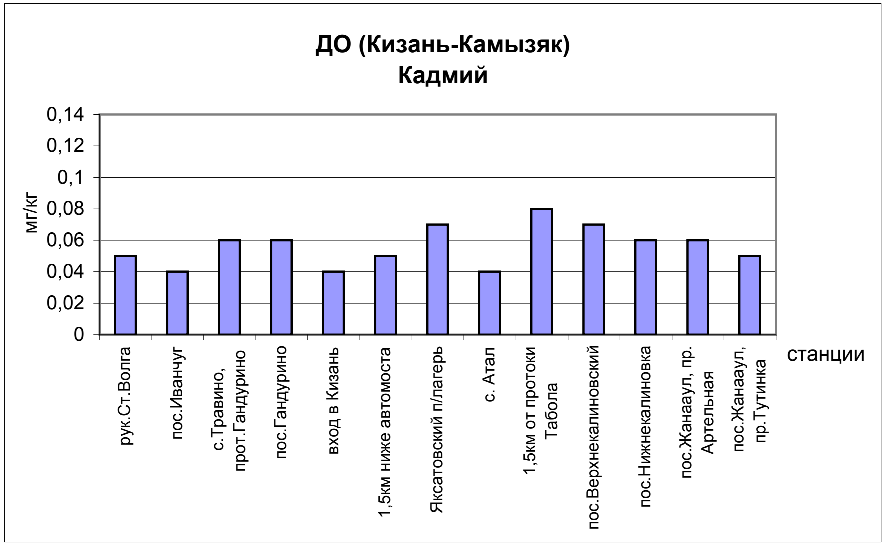


Рис. Содержание кадмия в донных отложениях рукавов Кизань, Камызяк в 2008 г.

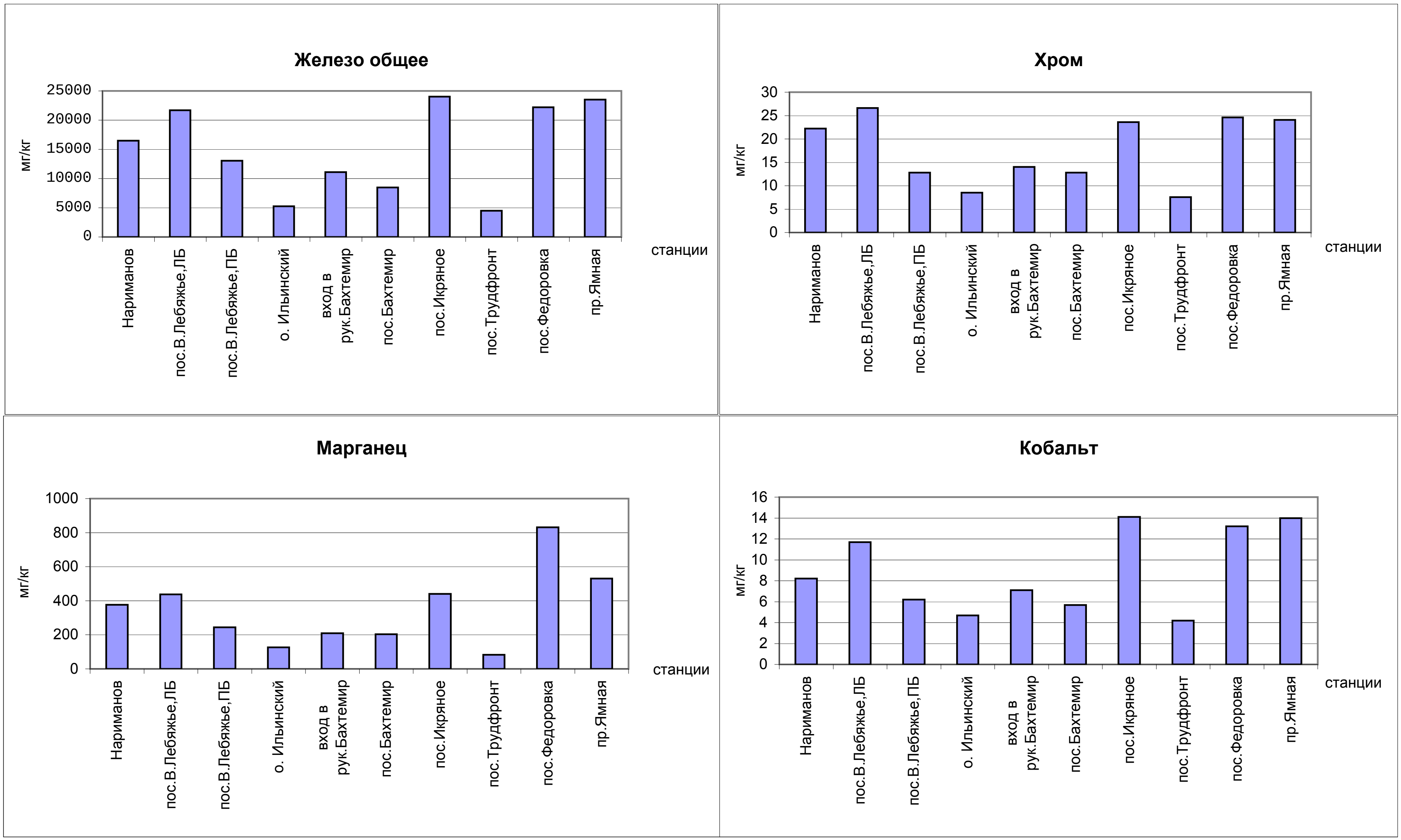


Рис. 4а. Содержание загрязняющих веществ в донных отложениях рукава Бахтемир в 2008 г.

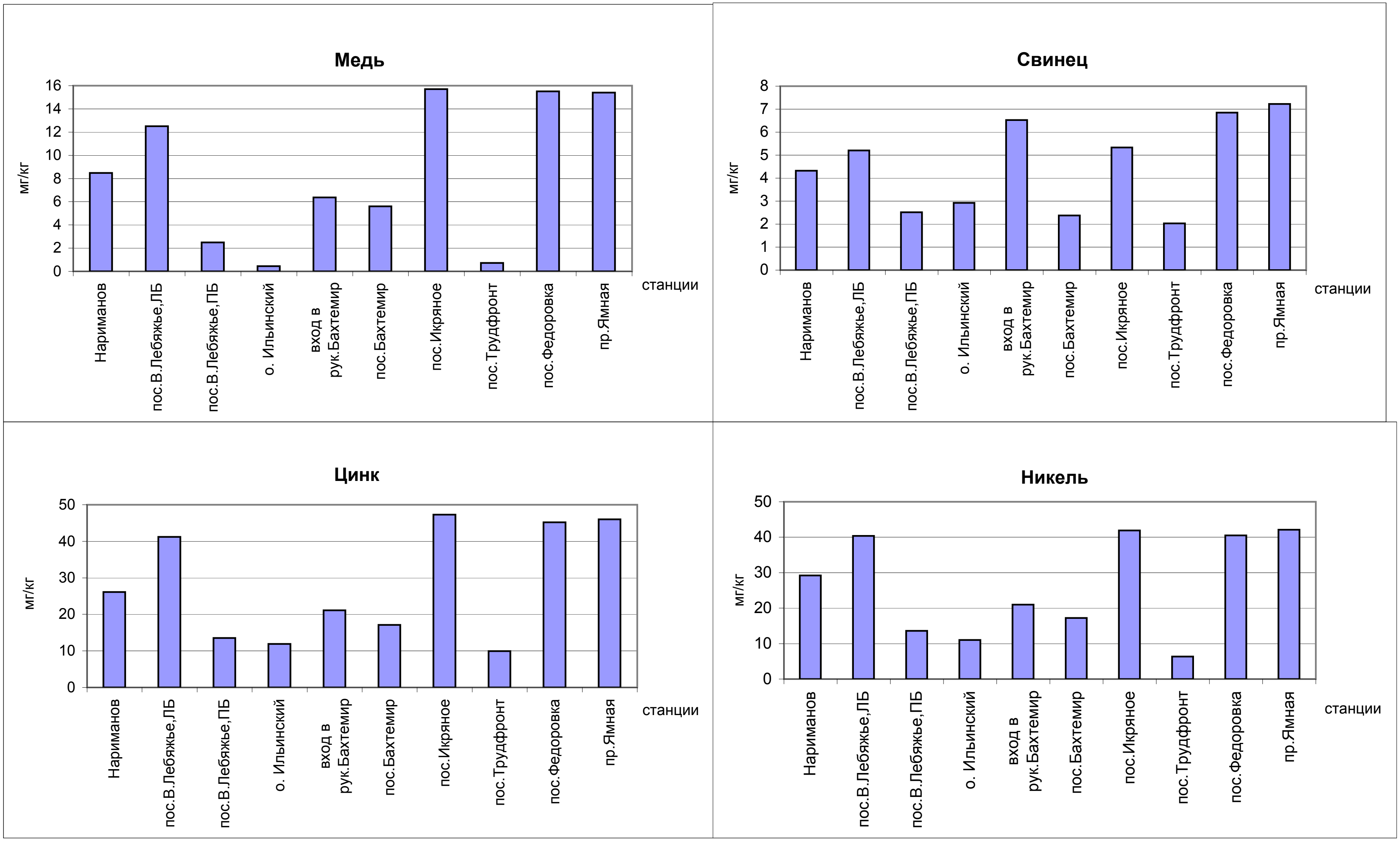


Рис. 4б. Содержание загрязняющих веществ в донных отложениях рукава Бахтемир в 2008 г.

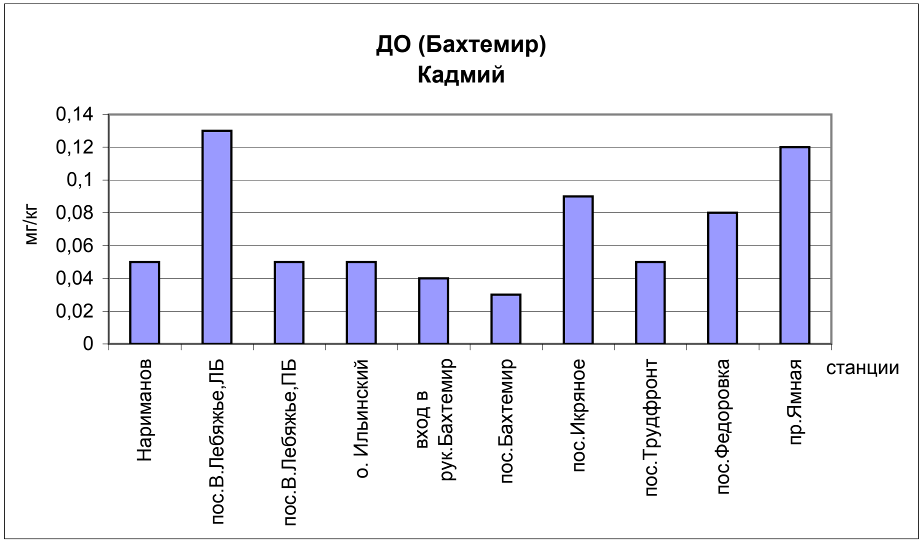
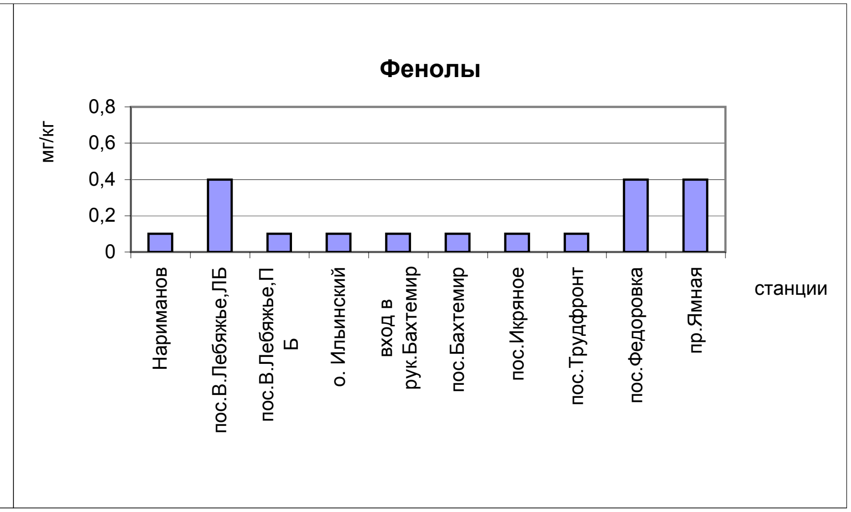


Рис. Содержание кадмия в донных отложениях рукава Бахтемир в 2008 г.



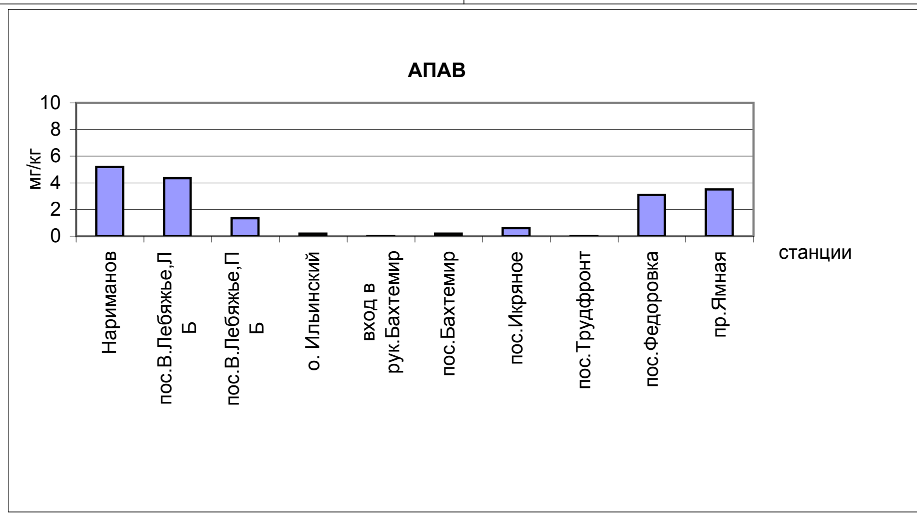


Рис. 4в. Содержание загрязняющих веществ в донных отложениях рукава Бахтемир в 2008 г

Перечень станций для отбора проб воды и ДО в дельте р. Волги, август 2008 г.

№ст.	Местоположение
1	Нариманов
2ЛБ	пос.В.Лебяжье,ЛБ
2ПБ	пос.В.Лебяжье,ПБ
3	о. Ильинский
4	вход в рук.Бахтемир
5	пос.Бахтемир
6	пос.Икряное
7	пос.Трудфронт
7А	пос.Федоровка
8	пр.Ямная
10	рук.Ст.Волга
10А	пос.Иванчуг
10Б	с.Травино, прот.Гандурино
11	пос.Гандурино
0К	вход в Кизань
1К	1,5км ниже автомоста
2К	Яксатовский п/лагерь
3К	с. Атал
4К	1,5км от протоки Табола
5К	пос.Верхнекалиновский
6К	пос.Нижнекалиновка
7К	пос.Жанааул, пр. Артельная
8К	пос.Жанааул, пр.Тутинка
17	вход в общую Болду
18	пр.Кр.Болда,Кирикили
19	пр.Пр.Болда,выход
20	пр.Болда
21	пр.Болда, Килинчи
22	2км выше пос. Евпраксино
23	пр.Бушма
24	пр.Бушма
25	пр.Рыча
26	пр.Рыча, Раздор
27	пр.Картуба, пос.Винный
28	пр.Шмагина
29	пр.Бузан
30	рук.Ахтуба
19А	середина Пр.Болды
19Б	вход в Пр.Болду

ДО р. Волга, рук. Старая Волга, р. Кизань-Камызяк 2008 г.

Станции	г/кг нефтпр	мг/кг АПАВ	мг/кг фенолы об	Pb мг/кг	Cd мг/кг	Cu мг/кг	Mn мг/кг
1	2	3	4	5	6	7	8
10	0,02	2,9	0,2	2,47	0,05	3,14	83,8
10а	0,02	3,9	0,1	0,77	0,04	2,46	106
10б	0,03	4,4	0,4	2,74	0,06	6,14	275
11	0,03	5,8	0,6	3,89	0,06	8,44	331
ок	0,02	1,1	0,1	2,03	0,04	2,22	97,3
1к	0,02	1,5	0,2	1,9	0,05	1,26	130
2к	0,04	3,7	0,2	3,38	0,07	8,18	310
3к	0,02	0,02	0,1	0,62	0,04	1,04	83,7
4к	0,11	12,7	0,6	4,09	0,08	12,9	565
5к	0,02	3,3	0,4	5,04	0,07	10,7	399
6к	0,02	0,9	0,2	2,4	0,06	2,15	152
7к	0,02	0,3	0,1	2,09	0,06	3,21	156
8к	0,03	1,1	0,1	2,04	0,05	5,03	249

Станции	Feобщ мг/кг	Ni мг/кг	Cr общ мг/кг	Zn мг/кг	Co мг/кг
	9	10	11	12	13
10	5230	13,3	6,25	8,72	5,52
10а	5350	6,21	7,14	10,2	3,86
10б	10650	20,3	12,2	19,2	6,96
11	11830	25,1	18,4	25,8	6,41
ок	90,2	12,2	9,45	9,22	3,81
1к	6200	13,4	7,93	11	4,95
2к	14240	25,9	15,6	27,7	10,1
3к	3880	2,7	6,19	6,76	3,54
4к	22220	36,8	25,3	44,1	12,9
5к	16730	28,6	21,1	31,2	9,74
6к	7430	15,1	11,2	12,8	6,73
7к	7360	16,2	9,19	14	6,92
8к	6620	13,5	8,24	14,2	6,54

Описательная статистика для содержания ТМ в ДО в
р. Волга, рук. Старая Волга, р. Кизань-Камызяк 2008 г.

	нефтпр	АПАВ	фенолы общ.	Pb	Cd	Cu	Mn
Среднее	0,030769	3,201538	0,253846	2,573846	0,056154	5,143846	225,9846
Стандартн	0,006837	0,929614	0,05141	0,350565	0,003497	1,063717	40,57968
Медиана	0,02	2,9	0,2	2,4	0,06	3,21	156
Мода	0,02	1,1	0,1	#N/A	0,06	#N/A	#N/A
Стандартн	0,024651	3,35177	0,185362	1,263979	0,012609	3,835285	146,3121
Дисперсия	0,000608	11,23436	0,034359	1,597642	0,000159	14,70941	21407,23
Эксцесс	10,82876	5,289199	-0,135926	-0,076363	-0,61944	-0,408037	0,802877
Асимметрі	3,209305	2,05143	1,088121	0,352393	0,282591	0,853248	1,093547
Интервал	0,09	12,68	0,5	4,42	0,04	11,86	481,3
Минимум	0,02	0,02	0,1	0,62	0,04	1,04	83,7
Максимум	0,11	12,7	0,6	5,04	0,08	12,9	565
Сумма	0,4	41,62	3,3	33,46	0,73	66,87	2937,8
Счет	13	13	13	13	13	13	13

	Feобщ	Ni	Cr общ	Zn	Co
Среднее	9063,862	17,63923	12,16846	18,06923	6,767692
Стандартная ошибка	1649,496	2,611736	1,697416	3,068264	0,76068
Медиана	7360	15,1	9,45	14	6,54
Мода	#N/A	#N/A	#N/A	#N/A	#N/A
Стандартное отклоне	5947,342	9,41675	6,12012	11,06278	2,742669
Дисперсия выборки	35370877	88,67517	37,45586	122,3852	7,522236
Эксцесс	0,69324	0,031875	0,159509	1,03237	0,666921
Асимметричность	0,877626	0,485099	1,085627	1,250438	0,963273
Интервал	22129,8	34,1	19,11	37,34	9,36
Минимум	90,2	2,7	6,19	6,76	3,54
Максимум	22220	36,8	25,3	44,1	12,9
Сумма	117830,2	229,31	158,19	234,9	87,98
Счет	13	13	13	13	13

Таблица 2. Суммарный сток растворенных загрязняющих веществ в вершине дельты Волги (г/с Верхнее Лебяжье) за 1997-2007 гг. (по данным Росгидромета).

Год		Сток ЗВ														
	W, $км^3$	НУ, тыс. т	Фенолы, т	СПАВ, тыс. т	ОВ, тыс. т	ХПК, тыс. т	PO_4 тыс. т	NO_3 тыс. т	NO_2 тыс. т	NH_4 тыс. т	Cu, тыс. т	Zn, тыс. т	А-ГХЦГ, кг	Г-ГХЦГ, кг	ДДЭ, кг	ДДТ, кг
1977	197	47,3	591	3,9	619	7988	5,3	245	2,9	88,7	1,8	0,8				
1978	278	50,0	556	2,8	1215	10397	12,7	55	0,6	105,4	1,9	5,6				
1979	318	22,3	1908	6,4	1275		4,2	146	14,6	187,6	5,7	3,2				
1980	255	25,5	255	10,2	645		3,7	277	28	10,2	3,3	6,6				
1981	292	35,0	584	5,8	1180		11,4	96	3	8,8	2,9	6,1				
1982	222	46,6	444	4,4	1079	3450		143	4	6,7	1,3	3,3				
1983	229	116,8	458	2,3	790	3555	7,9	106	7	25,2	2,8	5,9	1132	1359	679	8150
1984	221	26,5	221	2,2	714	4067	4,9	142	11,6	17,7	2,2	0,2	449	674		3145
1985	297	95,0	1288	5,9	734	5450	17	164	22	17,8	2,4	0,9	900	1800	2100	8600
1986	295	94,4	590	3	1328	4740	5,3	118	21	17,7	2,7	15,3	890	1200	1190	4150
1987	279	125,6	1116	2,8	910	4250	6,7	98	10,3	22,3	1,4	11,4				840
1988	230	161,0	460	2,8	3496						1,1	5,2				780
1989	225	63,0	383	2,9							1,2	4,1				1530
1990	318	149,5	1272	3,5							1,7	7,3	17500	11500		2500
1991	321	51,4	642	12,8						105,9	1,6	2,9				
1992	245	51,5	490	9,8					7,5	80,9	1,2	2,5				
1993	283	56,6	566	8,5						90,6	2	3,1				
1977-1993 ср	265	71,6	696	5,3	1165	5487	7,9	145	11	56,1	2,2	5	4174	3307	1323	3712
1995-2004 ср	251	54,0	970	6,6							1,8	9,2		100	30	180
2001	281	39,3	843	8,4			3,7	36,5	4,8	2,8	0,3	2,8				
2002	261	13,1	783	15,7			9,7	26,1	3,9	2,6	1,6	19,8				
2003	250	17,5	750	5			8	80	9,8	17,5	0,5	15,5		62		
2004	261	28,7	522	7,8			10,4	104,4	4,4	3,9	1,3	3,1		204		86
2005	254	20,3	507	7,6			9,4	55,8	4,6	5,1	2	4,3	380	337		254
2006	208	10,4	416	6,2			9,4	60,3	4,6	4,2	0,8	2,1	312	374		333
2007	282	14,1	282	8,5			15,2	59,2	5,1	7,8	1,7	2,8		7		20
2001-2007 ср	257	20,5	586	8,5			9,4	60,3	5,3	6,3	1,2	7,2	346	197		173

Таблица 2а. Суммарный сток ТМ в вершине дельты за 1995-2004 и 2001-2007 гг.
(по данным Росгидромета и ИВП РАН).

Год	W, км³	Металлы, т								
		Fe	Mn	Cr	Pb	Mo	Co	Ni	Cd	Hg
1995-2004	251	46600	232	220	238		198	1160	68,6	7,3
2001	281	48146	702,5	786,8	843		843	3821,6	309,1	23,9
2002	261	75690	548,1	208,8	339		652,5	914	156,6	2,6
2003	250	30000	275	250	200		50	850	25	3,5
2004	261	46980	234,9	52,2	209		78,3	653	26,1	4,4
2005	254	65940	117,5	117,5	203	228,2	25,4	583	126,8	6,8
2006	208	49920	228,8	104	104	228,8	20,8	3328		4,8
2007	282	37580	704,3	112,7	338	253,5	56,3	845		6,7
2001-2007	257	48146	401,6	233,1	319	236,8	246,6	1571	128,7	7,5

Таблица 10а. Концентрации ТМ в вершине дельты за 1995-2004 и 2001-2007 гг. (по данным Росгидромета и ИВП РАН).

Год	W, км³	Металлы, мкг/л								
		Fe	Mn	Cr	Pb	Mo	Co	Ni	Cd	Hg
1995-2004 ср	251	190	1,3	1,1	1,2		1	5,6	0,4	0,03
2001	281	110	2,5	2,8	3		3	13,6	1,1	0,09
2002	261	290	2,1	0,8	1,3		2,5	3,5	0,6	0,01
2003	250	120	1,1	1	0,8		0,2	3,4	0,1	0,01
2004	261	180	0,9	0,2	0,8		0,3	2,5	0,1	0,02
2005	254	260	0,7	0,7	0,8	0,9	0,1	2,3	0,5	0,03
2006	208	240	1,1	0,5	0,5	1,1	0,1	16		0,02
2007	282	460	2,5	0,4	1,2	0,9	0,2	3		0,02
2001-2007 ср	257	237	1,6	0,9	1,2	0,9	0,9	6,3	0,4	0,03

Таблица 10. Концентрации загрязняющих веществ в вершине дельты Волги (г/с Верхнее Лебяжье) за 1977-2007 гг. (по данным Росгидромета и ИВП РАН).

Год		Концентрация ЗВ									
	W, км³	НУ, мг/л	Фенолы, мкг/л	СПАВ, мг/л	NH_4 мг/л	Cu, мкг/л	Zn, мкг/л	А-ГХЦГ, нг/л	Г-ГХЦГ, нг/л	ДДЭ, нг/л	ДДТ, нг/л
1977	197	0,24	3	0,02	0,45	9	4				
1978	278	0,18	2	0,01	0,39	7	20				
1979	318	0,07	6	0,02	0,59	18	10				
1980	255	0,10	1	0,04	0,04	13	26				
1981	292	0,12	2	0,02	0,03	10	21				
1982	222	0,21	2	0,02	0,11	6	15				
1983	229	0,51	2	0,01	0,08	12	26	5	6	3	36
1984	221	0,12	1	0,01	0,06	10	1	2	3		14
1985	297	0,32	4	0,02	0,06	8	3	3	6	7	29
1986	295	0,32	2	0,01	0,08	9	52	3	4	4	14
1987	279	0,45	4	0,01		5	41			1	3
1988	230	0,70	2	0,01		4,7	23				3,4
1989	225	0,28	2	0,01		3,9	18				6,8
1990	318	0,47	4	0,01		5,3	23				8
1991	321	0,16	2	0,04	0,33	5	9				
1992	245	0,21	2	0,04	0,33	5	10				
1993	283	0,20	2	0,03	0,32	7	11				
1977-1993	265	0,27	2,5	0,02	0,22	8,1	18,4	3,3	4,8	3,8	14,3
1995-2004	251	0,20	4	0,03	0,04	6,6	36	1	0,4	0,11	7
2001	281	0,14	3	0,03	0,01	4	10				
2002	261	0,05	3	0,06	0,01	6	76				
2003	250	0,07	3	0,02	0,07	2	62		0,25		
2004	261	0,11	2	0,03	0,15	5	12		0,78		0,33
2005	254	0,08	2	0,03	0,02	8	17	1,5	1,33		1
2006	208	0,05	2	0,03	0,02	4	10	1,5	1,8		0,6
2007	282	0,05	1	0,03	0,03	6	10		0,07		0,07
2001-2007	257	0,08	2	0,03	0,04	5	28		0,7		0,5

Таблица 11. Концентрации загрязняющих веществ в воде в западной части дельты р. Волги по данным Росгидромета (Характеристика загрязнения..., 2006).

Годы	НУ, мг/л		Фенолы		Cu, мкг/л		Zn, мкг/л	
	Верхняя зона	Средняя зона	Верхняя зона	Средняя зона	Верхняя зона	Средняя зона	Верхняя зона	Средняя зона
1995	0,46	0,15	3,0	2,5	12,5	11,7	32,3	41,0
1996	0,21	0,30	3,3	5,0	8,1	7,3	41,0	26,4
1997	0,28	0,23	10,3	8,5	6,9	6,6	34,5	30,7
1998	0,20	0,26	3,7	3,0	5,1	5,9	47,9	41,7
1999	0,05	0,06	6,3	7,5	4,6	4,7	29,3	22,6
2000	0,36	0,36	4,3	4,5	3,4	4,1	16,2	16,4
2001	0,17	0,18	5,3	5,0	6,9	9,1	9,1	8,6
2002	0,08	0,11	3,7	4,5	12,7	11,0	72,8	76,9
2003	0,13	0,15	3,0	2,0	1,7	2,1	44,3	74,3
2004	0,12	0,09	1,7	1,5	5,2	4,5	23,8	21,1
Среднее	0,21	0,19	4,5	4,4	6,7	6,7	35,1	36,0

Таблица 21. Средняя концентрация загрязняющих веществ в поверхностном слое воды и в донных отложениях на участке "Тюлений" в 2001-2008 гг. (по данным Росгидромета).

Год	Концентрация в воде, мкг/л									Концентрация в донных отложениях, мг/кг								
	НУ	Фенолы	СПАВ	Fe	Mn	Zn	Cu	Pb	Cd	НУ	Фенолы	СПАВ	Fe	Mn	Zn	Cu	Pb	Cd
2001	29	2,0	43	26	4,0	8,3	2,1	4,0	0,3	30	0,095	22	1000	54	8,6	3,7	18,3	1,0
2002	75	2,1	51	310	32	51	3,0	-	1,0	47	0,105	17,5	1560	53	13,0	8,3	24,6	1,3
2003	64	2,1	33	245	36	38	4,1	2,0	2,0	18	0,10	19,7	970	45	8,3	4,2	17,5	1,0
2004	140	3,6	-	25	3,0	9,0	3,2	2,3	0,5	-	-	-	-	-	-	-	-	-
2005	71	3,2	27	70	6,0	5,0	1,6	1,1	0,01	104	0,16	8,3	16500	5,6	2,2	12,5	7,4	0,13
2006	65	0,2	16	47	3,5	4,6	1,0	1,8	0,2	10	0,055	8,6	3200	12,5	6,9	19,0	3,6	0,09
2007	120	3,0	30	200	5,0	9,4	7,6	4,0	0,15	4,1	0,04	2,0	2100	11,3	9,3	14,6	1,0	0,16
2008	80	2,1	47	50	13	4,1	10,5	2,5	0,15	3,0	0,05	2,2	2000	17,4	4,4	17,5	1,2	0,18

Таблица 9. Сток загрязняющих веществ из дельты Волги в море в среднеклиматический год за период 1995-2004 гг. (Характеристика загрязнения …, 2006)

Вещество	Вершина	Морской край дельты			B/A
		Западная часть	Восточная часть	Сумма (В)	
НУ, тыс.т	54,03	35,1	21,26	56,36	1,04
Фенолы, т	970	640	410	1050	1,09
СПАВ, тыс. т	6,63	3,94	4,1	8,04	1,22
Fe, тыс. т	46,64	29,53	21,03	50,56	1,09
Zn, т	9200	5667	3495	9162	1,00
Cu, т	1780	1015	508	1523	0,85
Cr, т	223	117	69	186	0,83
Pb, т	241	203	163	366	1,51
Co, т	198	195	115	310	1,57
Cd, т	69	77	45	122	1,77
Mn, т	232	172	101	273	1,18
Ni, т	1160	938	554	1492	1,29
Hg, т	7,3	9,7	5,7	15,4	2,10
ДДЭ, кг	30	23,6	5,9	29,5	0,98
ДДТ, кг	180	56	68	124	0,56
А-ГХЦГ, кг	-	-	-	-	-
Г-ГХЦГ, кг	82	27,1	59,9	87	1,06

Таблица 12. Концентрации загрязняющих веществ в вершине и на морском крае дельты (МКД) за период 1995-2004 гг.по данным Росгидромета (Характеристика загрязнения…, 2006).

Вещество	Вершина	Морской край дельты			В/А
		Западная часть	Восточная часть	Среднее (В)	
НУ, мг/л	0,21	0,23	0,023	0,23	1,10
Фенолы, мкг/л	3,8	4,3	4,3	4,3	1,13
СПАВ, мг/л	0,025	0,025	0,033	0,029	1,16
Fe, мг/л	0,19	0,19	0,2	0,195	1,00
Zn, мкг/л	36,1	37,1	37,6	37,4	1,04
Cu, мкг/л	6,6	6,3	5,0	5,7	0,86
Cr, мкг/л	1,28	0,66	-	-	0,52
Pb, мкг/л	1,65	1,57	-	-	0,95
Co, мкг/л	1,37	1,25	-	-	0,91
Cd, мкг/л	0,5	0,43	-	-	0,86
Mn, мкг/л	1,3	1,04	-	-	0,52
Ni, мкг/л	6,1	6,0	-	-	1,00
Hg, мкг/л	0,033	0,04	-	-	1,21
ДДЭ, нг/л	0	0,1	0,1	0,1	-
ДДТ, нг/л	0,65	0,25	0,8	0,5	0,77
А-ГХЦГ, нг/л	0	0	0	0	0,00
Г-ГХЦГ, нг/л	0,28	0,18	0,73	0,45	1,60

Примечание. В тех случаях, когда отсутствуют данные по восточной части МКД, отношение В/А рассчитано по концентрации для западной части.