SECTION E

FINAL DISPOSAL AND ENVIRONMENTAL STUDY

THE STUDY ON
SOLID WASTE MANAGEMENT
FOR ALMATY CITY
IN THE REPUBLIC OF KAZAKHSTAN

FINAL REPORT

SUPPORTING REPORT

SECTION E

FINAL DISPOSAL AND ENVIRONMENTAL STUDY

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SECTION E

WASTE DISPOSAL AND ENVIRONMENTAL STUDY

CHAPTER 1 PRESENT CONDITION OF FINAL DISPOSAL SYSTEM

1.1 GENERAL VIEW

Currently, only one landfill site, which is located at Karasai Rayon, is authorized for disposal of Almaty City's solid waste. The waste generated in the city should be carried to this site; however, a large amount of waste is illegally dumped to the streets, rivers and vacant lots. Some amount of waste goes to other disposal sites that exist in the Oblast territory, out of the city area, without any permission.

Although the Almaty City Department of Environmental Protection (ACDEP) and the Oblast Department of Environmental Protection have struggled to control and monitor these activities, the present waste disposal system of the city are totally uncontrolled and not in compliance with the existing laws and regulations.

There is a high risk of environmental pollution, such as deterioration of water quality, air pollution including odor and dusts, and appearance of rodents and harmful insects, which may affect the health of residents near the disposal sites.

1.2 PRESENT CONDITION OF THE EXISTING FINAL DISPOSAL SITE AT KARASAI

1.2.1 General

The existing final disposal site is located at 24.5 km from the west edge of the city boundary on the Almaty-Bishkek highway with an area of about 29.2 hectares (ha). According to the result of the topographical survey, the present landfill volume is estimated at approximately 840 thousand cubic meter (m^3) that had accumulated since 1988. The site was originally a state owned property, and it has been rented to and operated by a joint stock company, Parasat, since 8 December 1998. The contract will expire in 2001.

The site is situated in a ravine and has very poor flora and fauna. No residential area exists within 2 km. There are no perennial rivers nearby except dry valleys and the proximate river flows from south to west, about 1 km upstream of the site. It is therefore suitable to fill in the waste in terms of topographical features of the site.

1.2.2 Facilities

There were several facilities provided to properly operate and maintain the disposal site, such as an administration house, inspection bays, a fire prevention reservoir, a fuel and lubricant storage, and a platform for washing containers. However, all facilities except the administration house are decrepit and no longer used. The three monitoring wells at the downstream of landfilling area are also inoperable because of blockage.

Two access roads approach the landfilling area which is located at the elevation of about 50 m down below the administration office site: one is an originally designed road, and the other may have been constructed for ease of access due to its gentle slopes. In winter season, collection vehicles can hardly go down to the landfilling area because of snow even if the road slopes gentler. Consequently, the vehicles dump the waste along the roadside and some of the wastes are stuck down the cliff. These wastes are often ignited spontaneously, and smoke breaks out obstructing the surrounding view.

The landfilling area is approximately 4 or 5 ha at present. A dike built by site soil at the downstream of the area stores dumping waste, which is about 12-15 m in height and 18-20 m in width. In order to prevent discharge of leachate generated from the waste deposits directly to natural streams near the site, two retention ponds exist at the downstream of the landfilling area. The first pond extends 40-50 m with a width of about 15-20 m. The depth of water whose color is reddish brown appears to be 60 to 80 cm. The volume of the pond is thus estimated at 360-800 m^3. There is also a dike whose height is about 2 m at the downstream of this first pond, and three wells for monitoring are installed just on the downstream of the dike. Dimensions of the second retention pond are much smaller than the dimensions of the first one: 3 m in width, 6 m in length and maybe 20 to 50 cm in depth. The final leachate discharging from the second pond is quite small at 200-500 cm^3/s (cubic centimeter per second) and connecting to a creek at the downstream. These ponds are made of silty or clayey site soil; therefore, infiltrated leachate is likely to be as minimum as possible.

1.2.3 Operation and Management

There are 11 people involved in the operation and management of this site: one (1) chief, one (1) foreman, two (2) registrars, three (3) security guards, and four (4) drivers and operators. All trucks coming to the disposal site are checked at the gate and have to submit a coupon to the registrar or chief of the site. Parasat, which is dealing with operation and management of the site as well as waste collection of the city, issues the coupons at their office and changes them at 90 Kazakhstan Tenge (KZT) per cubic meter of waste which each truck carries. Any waste collector can purchase this coupon. Since the site is not equipped with a truck scale, the volume of waste each truck is carrying is usually measured by the registrar's eye. According to the Waste Amount Survey, around 50 to 200 trucks come to the site in a day. Total volume of carried waste is estimated at 250 to 450 tons a day.

Types of carried waste do not seem to be identified at the entrance. There is also neither effective control to prevent toxic and hazardous wastes from entering the site, nor instruction on where the truck goes to dump the waste. In addition, the site office is far from the dumping area and located on a different elevation. Therefore, the truck driver may decide on the tipping method and area, although the waste is dumped from upstream of the site. There is no regular access road inside the landfilling area, but the truck has to pass through only muddy places where the dumped waste is relatively small.

Two bulldozers out of a total of four usually move the waste dumped on the site. However, no cover soil can be seen although one excavator sometimes works. According to the site manager, the age of existing heavy equipment working on the site is more than 15 years; that is, the heavy equipment has been manufactured in the Soviet times. While nobody knows the detailed history of the equipment, it is said that they

came from Russia, Ukraine, Poland and Kazakhstan. Two of the bulldozers have the capacity of 130 HP (horsepower), one 100 HP and the other 75 HP. In addition, one excavator and one water tanker are operating at the site. The excavator tries to get cover soil material from small clayey mounds of the site, and the water tanker sprinkles water on the ground near the site office and the access roads.

More than 100 people pick up valuable materials such as bottles, wood and metals from the waste (Details are discussed in Chapter 4 of this report). Many crows and other birds, and dogs which may be kept by these waste pickers can be observed. It is considerably difficult to achieve a systematic operation of the landfill here.

1.2.4 Environmental Issues

As stated earlier, some amount of leachate trickles from the second retention pond to the downstream. However, the Environmental Survey shows that the double retention system has remarkably improved the leachate quality. The Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) of the first pond were measured at 40's. Contrarily, both parameters of the second one are around 15 that are almost equivalent to the level of rivers in the city (see Chapter 3 for details). In addition, the site soil is categorized into impermeable clay and it entirely covers the landfill area. Therefore, negative impacts on both surface and ground water cannot be clearly observed at the survey.

Meanwhile, the situation on the site shows that unsanitary conditions and generation of smoke, odor, dust and rodents might affect the health of waste pickers, truck drivers and waste loaders. Stagnant wastewater can be seen here and there because of no drainage in the landfilling area. This may result in the breeding of flies and mosquitoes during summer.

1.3 PRESENT CONDITION OF THE TRANSFER STATION IN THE CITY

1.3.1 General

Parasat has been operating and managing this facility as well as the former compost plant that was built 1,500 m down to the south of Severnoe Koltso. The transfer station is located between the Ozet and Aina-Bulak residential areas and 200 m far from Severnoe Koltso. The distance from the site to Ozet and Aina-Bulak is about 800 m and 500 m, respectively. A market for cars and construction materials is located south of the station.

There are two rivers existing near the site: Vesnovka at eastern and Terenkara at western side of the site. These rivers flow from south to north through the residential areas mentioned above.

Piles of waste like two mounds can be seen behind the site. Distance between the two is 200 m. These mounds are remains of former disposal sites, which are composed of collected and dumped waste in the city for 30 years. The shape of both mounds is nearly rectangular. Specifically, the northern mound is about 14 ha, 700 m in length and 200 m in width, and 10 m in height. On the other hand, the southern one is about 7 ha, 500 m in length and 100 to 200 m in width, and 5 to 6 m in height. The area surrounding these mounds is not used for a specific purpose but sometimes used for

pasture of livestock. The surface of mounds is not completely covered with soil although the top of the northern mound is partially faced with concrete. There is a little smell of the waste, but there are no flies in winter season and only a few birds can be seen. The western side of the northern mound has a couple of columns of smoke that go toward the Ozet residential area, further west of the mound.

1.3.2 Facilities

The site for the transfer station originally occupied approximately 2 ha and used to have a transfer system with conveyors and hoppers, warehouse, workshop, and gas station. Old industrial waste, such as construction debris and plastic bottles, and scrapped containers are scattered in and outside of the site, and the area of spreading waste covers more than 5 ha. There is no operating facility in the site during the survey except the administration office near the entrance. This office checks incoming trucks and measures the weight by a truck scale.

1.3.3 Operation and Management

Since the transfer system is not functioning, the edge of the northern mound just behind the station is used for the actual transfer operation; that is, a truck carrying the waste to the station goes up the mound and dumps the waste on the mound. A bulldozer on the mound pushes the dumped waste and drops it from the edge down to a trailer truck waiting below.

Only one person supervises the transfer station and former compost plant simultaneously. It is said that one foreman instructs the site operation in the station. There are around 20 waste pickers working on the site. An efficient transfer work does not take place because huge amounts of waste become an obstacle to move the truck and bulldozer effectively on the site.

1.3.4 Environmental Issues

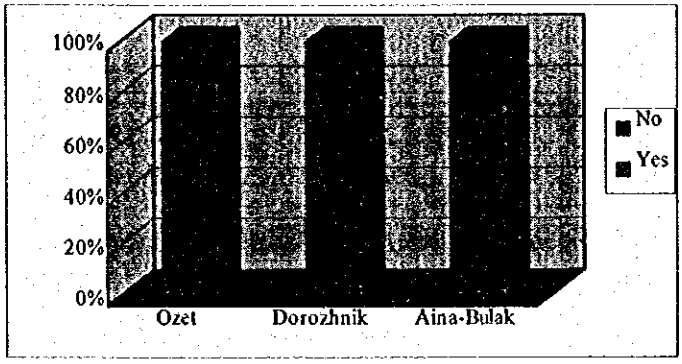
Due to the proximity of residential areas, some negative impacts are predicted; for example, odor and smoke produced in the station or the mounds comprising old dumped waste may intrude on the residential areas and annoy the residents.

A simple questionnaire survey was conducted on 31 March 1999 with the residents near the transfer station, i.e., residents of Ozet, Dorozhnik and Aina-Bulak. Dorozhnik neighbors Aina-Bulak and is located just south of it. Results of the survey are presented in Table 1.3.1 and Figure 1.3.1 below.

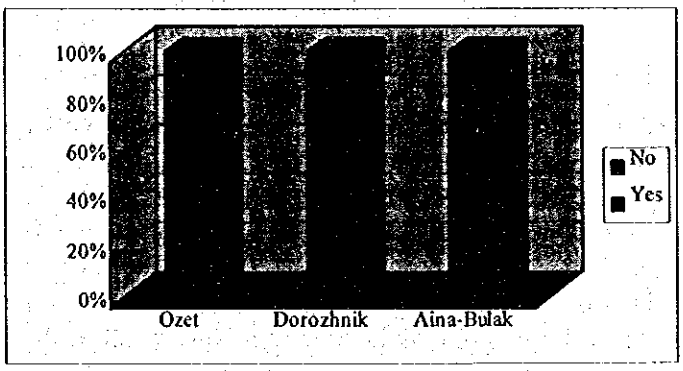
Table 1.3.1 Results of Questionnaire for Residents near the Transfer Station

Question	Answer					
	Ozet		Dorozhnik		Aina-Bulak	
Q1: Do you know the transfer station and/or former compost plant?	Yes: 39 (85%)	No: 7 (15%)	Yes: 23 (88%)	No: 3 (12%)	Yes: 19 (76%)	No: 6 (24%)
Q2: Do you feel unpleasant matters resulting from the transfer station and/or former compost plant?	Yes: 11 (24%)	No: 35 (76%)	Yes: 4 (18%)	No: 22 (82%)	Yes: 10 (40%)	No: 15 (60%)

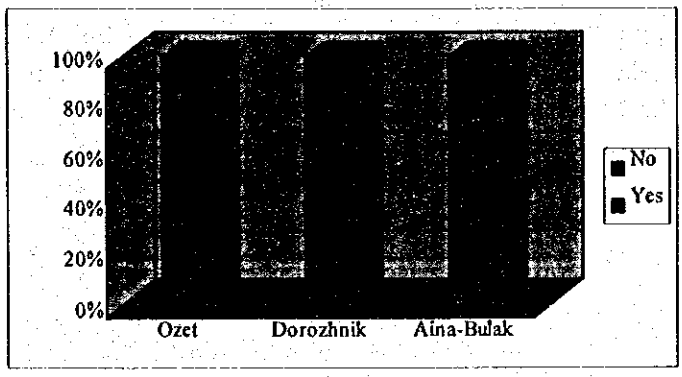
If YES, what kind of matters do you feel unpleasant?	Insects/rodents: 5 Odor: 5 Smoke: 2 Waste goes to the residence: 1		Sometimes smoke: 3 Still odor but less: 1		Odor but not serious: 14 Smoke: 9	
Q3: Have you ever felt unpleasant matters resulting from the transfer station and/or former compost plant?	Yes: 23 (50%)	No: 23 (50%)	Yes: 23 (88%)	No: 3 (12%)	Yes: 19 (76%)	No: 6 (24%)
If YES, what kind of matters have you felt unpleasant?	Odor: 16 Smoke: 12 Flies: 1		Odor: 22 Smoke: 9 Flies: 4		Odor: 18 Smoke: 18 Flies: 1	



Q1:
Know the Transfer Station and/or compost plant?



Q2:
Any unpleasant matters now?



Q3:
Any unpleasant matters before?

Figure 1.3.1 Proportion of the Questionnaire Results by Each Residential Area

This survey shows that about 80-90% of respondents are aware of the existence of transfer station and the former compost plant. Serious impacts that are making the residents unpleasant were not reported, although around 20% of respondents in Ozet and Dorozhnik and 40% of Aina-Bulak's feel uncomfortable with odor and smoke from the transfer station at present. On the other side, more than half of the respondents had a disagreeable experience with odor and smoke when the transfer station and compost plant were normally operating before. Especially, all the respondents in Dorozhnik and Aina-Bulak who know the transfer station and compost plant had felt unpleasant.

No available data were found to study the actual conditions, but by means of observation on the site and results of the interview survey, it can be assumed that concentration of dust and offensive odor tends to worsen the air quality of the place.

The southern slope of the mound, which is located nearer to the station, is covered with soil and planted with seedlings of pine trees. The number of seedlings is, however, about 50-60 and too small to make up the surface, especially in winter season. In addition, the thickness of covered soil seems to be less than 10 cm that cannot wrap up the uneven shape of waste completely. A site observation in summer shows that only a few plants have survived but the surface of mounds are overgrown with weeds.

According to the Environmental Survey, impacts on the ground and surface water by this facility cannot be observed. Details of the survey results are described in Chapter 3 of this report.

1.4 PRESENT CONDITION OF THE ILLEGAL DUMPSITES IN THE CITY

1.4.1 General

There are a large number of illegal dumpsites varying from trash on the streets and riverbanks to a pile of waste in vacant lots in Almaty City. The Sanitary and Epidemiological Center of Almaty City has monitored the situation of these dumpsites a couple of times a month and reported to the *Akim* or Mayor. According to its report as of 30 March 1999, in January through March of this year, 242 unauthorized dumpsites were found, and 254 cases of delays in collection of domestic waste from communal container grounds were reported. These large numbers include relatively small trash.

ACDEP presently recognizes 12 sites, and almost all sites have been closed down with penalty between 4,000 and 10,000 Kazakhstan Tenge (KZT). Other major illegal dumpsites were found during field trips. The list of these dumpsites is given in Table 1.4.1. The locations of the above illegal sites are shown in Figure 1.4.1, and photos showing conditions of these sites are attached in Chapter 1 of Data Book 4.

Table 1.4.1 List of Major Illegal Dumpsites in Almaty City

No.	Location	Size or Capacity	Condition	Remarks
1	Remisovka, south from Al-Farabi Ave., Bostandyskii Rayon	1,000 tons* Along a road side. Length about 500 m.	Construction waste mainly dumped. Some domestic waste. Once Bostandyskii Rayon Akimate removed the waste, but it received only construction waste for land reclamation and future development for recreational facilities.	9,000 KZT penalty*
2	Southwest of a botanical garden, south from Al-Farabi Ave., Bostandyskii Rayon	Approx. 0.5 ha.	Seemed to be closed.	
3	South from Kok-Tobe Mountain, 1 km west to Dostyk Ave., Medeuskii Rayon	1,000 tons*	Liquidated in January 1999. Now used for grazing land. Next to an orchard of apples.	5,000 KZT penalty*
4	A construction lot between "Turksib" Sanatorium and dwelling blocks/dachas, along Gornaya St., Medeuskii Rayon	100 tons* Along a road side. Length about 100 m.	Residents near the site threw the waste. Trucks sometimes come.	4,000 KZT penalty*
5	South-west from Zhetysu residential area, north side of Abai Ave., Auezovskii Rayon	200 tons* Vacant lot about 5-6 ha.	Construction waste mainly dumped, but no new waste. Inside lot of residential complex.	Prohibited. Claim for 1,548,750 KZT*
6	North of Ryskulov Ave, south edge of Shanyrak AK-4, Auezovskii Rayon	Approx. 0.5 ha.	Construction waste mainly dumped. Residential houses within 100-200m.	
7	Zhubanov-Saina St. cross-section, Auezovskii Rayon	100 tons* Vacant lot	Liquidated last year after 3 years in use. Flat land covered with soil.	
8	Territory of "Wallihan" KSK, between Nurmakov-Ayteke and Bi-Kazybek St., Almalinskii Rayon	100 tons* Vacant lot about 0.1 ha.	Liquidated in January 1999. Piles of soil discharged from the next construction site.	5,000 KZT penalty*
9	North of Raiymbek Ave., west side of the city cemetery, Almalinskii Rayon	Approx. 1 ha.	Ongoing site. Wastes from street sweeping in Almalinskii are mainly dumped by the Road Development Dept. of Almalinskii Rayon.	
10	Ten (10) dump sites between railways, and Semipalatinskaya St. and Ryskulov Ave., Zhetysuskii Rayon	5 to 20 tons*	Liquidated. Small amounts remain.	10,000 KZT penalty* Prohibition by ACDEP issued in 1997-98.
11	South of a sludge retention pond from the water heating station, north of Ryskulov Ave., Zhetysuskii Rayon	5,000 tons* Along a roadside.	Liquidated in 1997. Covered with soil in 1998. However, new waste has been dumped on the site.	Full of domestic waste 3 years ago. Rayon Akimate hired a contractor to remove the piled waste for 400,000 KZT.
12	Shanyrak-I, along Bolshy Almatinka River, Zhetysuskii Rayon	Approx. 0.5 ha.	Construction waste and some domestic waste. Seemed to be closed.	

13	North side of Kulagher residential area, close to Sultanka River and a horse riding field, **Zhetysuskii Rayon**	100 tons* Approx. 0.5 ha.	It was a temporary waste transfer station. New wastes seem to be dumped occasionally.	Prohibition by ACDEP issued in 1997-98.
14	Zhansugirov St. along Sultanka River, **Zhetysuskii Rayon**	Approx. 0.5 ha.	Construction waste and some domestic waste. Seemed to be closed.	
15	70th Raz'ezd, Ostroumov St., neighbouring to the military base, **Turksibskii Rayon**	100 tons* Approx. 3-4 ha. Along Karasu River.	Liquidated and covered with soil in 1998 after 3 years in use. Dumped wastes in spring were removed.	
16	Spasskaya St., north side of residential area between drainage and KNS DKP along the high voltage mains, **Turksibskii Rayon**		Inaccessible in winter. According to ACDEP, liquidated and covered with soil in 1998.	
17	Next to the above No. 15 and KNS DKP, power supply under the site, **Turksibskii Rayon**	40 - 50 tons. Approx. 2-3 ha.	**Ongoing site.** About 15 waste-pickers. 1 bulldozer working. 300-400m far from a river. Site office with gate and a security guard at the entrance.	Deputy Akim of Turksibskii Rayon knows this operation.
18	From the east to the northwest of Parhach Lake, **Turksibskii Rayon**	Approx. 3 ha.	Liquidated and covered with soil in 1998 after 5 years in use at the expense of Environment Protection Fund.	
19	Roadside of Krasnogvardeiskaya St., along a riverbank of Karasu River, **Turksibskii Rayon**	Approx. 0.5 ha.	Construction waste, industrial waste and some domestic waste.	

Source: Almaty City Department of Environmental Protection, *"Data on Activities of ACDEP against Illegal Dump Sites,"* February 19, 1999 and JICA Study Team.

Note *: These figures were estimated and/or reported by ACDEP.

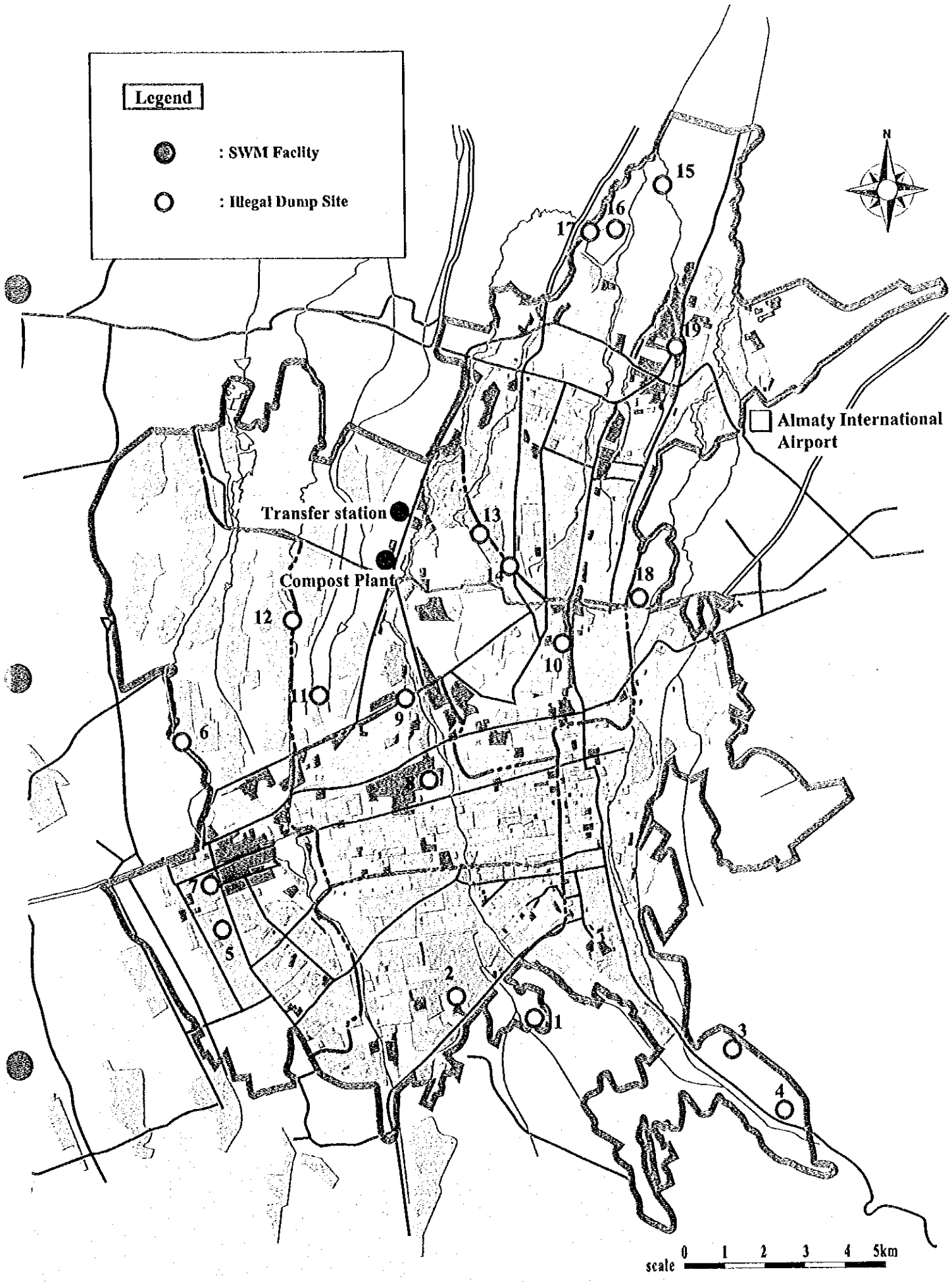


Figure 1.4.1 Locations of Major Illegal Dump Sites in Almaty City

1.4.2 Monitoring and Inspection

While the Sanitary and Epidemiological Center of Almaty City has monitored and reported the existing condition of the street dumps and uncollected waste of communal containers, the situation does not seem to have improved. The reason is the direct result of insufficient container volume and lack of collection frequency.

Simultaneously, Rayon Akimate, a district office under the city, has the function of monitoring and inspection of sanitary and environmental conditions in the Rayon. Some of the above-listed dumpsites, such as sites in Auezovskii and Zhetysuskii Rayons, were forced to close when reported to Rayon Akimate.

However, as far as the major illegal dumpsites are concerned, ACDEP has not been able to catch up with the current situation. One example in Turksibskii Rayon clearly shows this; in other words, a state-run collection company has been operating and maintaining a 2-3 ha dumpsite since January 1999 and not only the chief ecological and sanitary inspector but also the Deputy Akim of Rayon knows this operation. This fact also indicates that the flow of information between the City, Rayon Akimate, and ACDEP has not been established perfectly yet. Otherwise, there might be something wrong with the communication among them.

1.4.3 Environmental Issues

Some of the dumpsites, for example, the east to the northwest of Parhach Lake and the corner of Zhubanov-Saina Street cross-section, had been covered with soil and reclaimed completely. In other dumpsites, even if they have already been liquidated, the remaining waste such as construction debris and a large amount of plastic receptacles and bottles, in particular, are still exposed. Although impacts on the ground and surface water cannot be observed clearly according to the results of the Environmental Survey, these exposed wastes may endanger children who are likely to play at the site. From an aesthetic point of view, these liquidated dumpsites should be covered with soil after moving and gathering the waste.

As a result of site observation, it seems that most sites receive more or less domestic, industrial, commercial, hospital and institutional wastes. Domestic waste may pollute the soil with organic substances while industrial waste may introduce not only organic matter but also toxic elements to the soil. There is lack of information on the soil quality in the above-listed sites although it can be estimated that toxic elements are introduced at these sites by some industries.

1.5 Present Condition of the Existing Final Disposal Sites in Oblast Territory

1.5.1 General

In addition to the above-mentioned dumpsites in Almaty City, it was found that seven (7) sites in the territory of Oblast are operating and receiving waste from the city. Table 1.5.1 below gives a list of the major dumpsites outside of Almaty City, including these seven sites, and their locations are shown in Figure 1.5.1. The names of these

sites are Nika, Barys, Karasu, Enbek, Boraldiy, Rikki and Alatau, and the first six names are names of their operation companies.

These companies originally collected domestic waste from villages or small districts located out of the city boundary. These sites have been accepting wastes not only from the villages but also from the city since one or two years before because they receive tipping fees from incoming trucks.

Except the Alatau site, the Almaty Oblast Department of Environmental Protection had authorized these sites and already recognized the situation. The Department and Rayon Akimate that seems to be also responsible for monitoring the dumpsites, however, has not been able to stop their operations so far.

1.5.2 Facilities

According to a report on state environmental examination that is one of the documents for authorization by the Almaty Oblast Department of Environmental Protection, these sites were designed as a typical type of sanitary landfill. Layer of waste, 0.5 m in height compressed by bulldozers, would be sandwiched by an intermediate insulation layer, 0.2 m in height. In addition, the bottom of the site would be faced by an artificial foundation of clay 0.5 m thick in order to protect the soil and groundwater. Additionally, the sites would have an administration and utility building with a necessary set of rooms, sheds for cars and heavy equipment, a water tank, a septic tank and a catch basin with a skimming pit. The area of sites would be asphalt-covered and fenced. Monitoring wells would also be designed at the upstream and downstream of the site to check the water quality. However, in comparison with these designed facilities, nothing has been provided in the actual sites at all.

1.5.3 Operation and Management

In six (6) sites out of nine (9), i.e., Nika, Barys, Karasu, Enbek, Boraldiy and Alatau, only one bulldozer is used for moving the waste, while a cell type of landfilling with a covering soil is required in the original design. The bulldozer sometimes breaks down, and it is usual that there is no equipment in the site. At the sites of Karasu, Enbek and Boraldiy, site offices with a gate for checking trucks were set up. With respect to site management, the concept of sanitary landfill cannot be found. There are waste pickers in almost all ongoing sites varying from 3-4 to 20 people.

1.5.4 Environmental Issues

In the sites of Nika, Barys, Boraldiy and Enbek, smoke from piles of dumped waste can be seen. Although there is no actual data regarding air quality around these sites, it can be assumed that smoke due to burning the waste tends to worsen the air quality of the place.

The original landfill design requires use of clay foundation to protect the soil and groundwater at the site. Since the actual site conditions are totally different from this requirement, there is a high possibility to contaminate the soil and groundwater due to elusion of some hazardous substances.

Table 1.5.1 List of Major Dumpsites Surrounding Almaty City under the Almaty Oblast Department of Environmental Protection

No.	Name of Management Company / Location	Size or Capacity	Condition	Remarks
1	**NIKA** / 3 km west from the city boundary and approx. 4 km north from a highway to Kaskelen. Oktyabr Selsky Okrug, Karasai Rayon.	Approx. 3 ha. 36,000 m^3/year*	40 m^3/day of waste comes from the city in spring. About 15 waste-pickers and 1 bulldozer working in spring. The site was moved to a new site as described below, 300-400m far from a river.	Certificate No. 3-1127 dated 2.10.98.
	NIKA-2 / 5 km northwest from the above site. Oktyabr Selsky Okrug, Karasai Rayon.	Approx. 3 ha.	Ongoing site. 25-30 trucks/day coming from Bostandyskii and Almalinskii Rayons. About 10 waste-pickers; 1 bulldozer working.	
2	**BARYS** / 10 km west from the city boundary and approx. 3.5 km north from a highway to Kaskelen. Kazakhstan Agricultual Institute (KIZ) Posyolok, Karasai Rayon.	Approx. 0.5 ha. 8,900 m^3/year*	Ongoing site. Dumping to a ravine. About 10 waste-pickers; 1 bulldozer working.	Certificate No. 3-84 dated 28.01.99.
3	**KARASU** / Approx. 2 km west from the city boundary, south side of railway. Karasu Posyolok, Illi Rayon.	Approx. 3 ha (main) and 1 ha (sub). 10,450 m^3/year*	Ongoing site. Construction/ Industrial waste mainly dumped from surrounding factories. Clay ground. 3-4 waste-pickers. When the surface dries up, 1 bulldozer works. 1 collection truck is used. Site office with gate and a security guard at the entrance.	Certificate No. 2-989 dated 25.08.98. Sub-land is illegally used in winter because of accessibility to the mains.
4	**ENBEK** / 21 km north of the city boundary, along the highway to Kapchagai, Illi Rayon.	10 ha. Approx. 300 m from the highway.	Ongoing site. About 12-15 waste-pickers. 1 bulldozer is working. Site office with gate and a security guard at the entrance. Many crows.	The authorization expired in 1998, but site is still used illegally.
5	**BORALDIY** / Approx. 6.5 km west from the city boundary, north side of railway, Boraldiy Posyolk, Karasai Rayon.	Approx. 6 ha (total) and 2 ha (official). 24,700 m^3/year*	Ongoing site. Construction and domestic waste. About 20 waste-pickers. 1 bulldozer working. Site office with gate and a security guard at the entrance. 1 site manager and 3 operators. Many crows.	Started in October 1997. Under consideration of certification.
6	**ATCHIBULAK** / 1.5 km northwest of Atchibulak Selsky Okrug, Illi Rayon.	Approx. 3 ha. 14,000 m^3/year*	Construction waste mainly dumped. Along a canal. Both sides are grazing land. Many cans and bottles. Some industrial waste. No crows / waste pickers. Seemed to be no longer in operation.	Certificate No. 3-1128 dated 2.10.98. Started in August 1998.
7	**RIKKI** / 600 m north of "ENBEK." Energetichesk Selsky Okrug, Illi Rayon.	Approx. 2 ha. 12,500 m^3/year* Approx. 300 m from the highway.	Ongoing site. Dumping to a dry ravine. Domestic/ Industrial/ Construction waste. Some hospital waste. Glass, pet bottles and plastic bags. Many crows.	Certificate No. 3-216 dated 23.02.99.
8	**ALATAU** / Karasai Rayon.	Approx. 7-8 ha.	Ongoing site. Dumping on a slope. Covered with soil.	
9	**OZON** / Talgar Rayon.	No data	No data	Under consideration of certification.

Source: Almaty Oblast Department of Environmental Protection, *"List of Fully Authorized Disposal Sites of Almaty Oblast as of March 1, 1999"* and JICA Study Team.

Note *: These figures were estimated and/or reported by Almaty Oblast Environmental Protection Department.

LEGEND

- ★ : SWM Facility
- : Major Dumpsites Surrounding Almaty City under the Almaty Oblast Department of Environmental Protection
- : Alternatives of Final Disposal Sites
- : City boundary
- : Urbanization area
- : Neighbouring villages
- : Forest, green area and open space
- : Lakes
- : Rivers
- : Railways
- : Roads

ATCHIBULAK (no longer operation)

RIKKI

BORALDAY

ENBEK

NIKA

KARASU

Karasal Disposal Site

Kaskelen

Medeo

Transfer Station

Compost Plant

Talgar

Almaty City

1 2 3 4 5 6 7

N

SCALE 0 2 4 6 8 10km

E - 13

Figure 1.5.1 Major Dumpsites Surrounding Almaty City under the Almaty Oblast Department of Environmental Protection

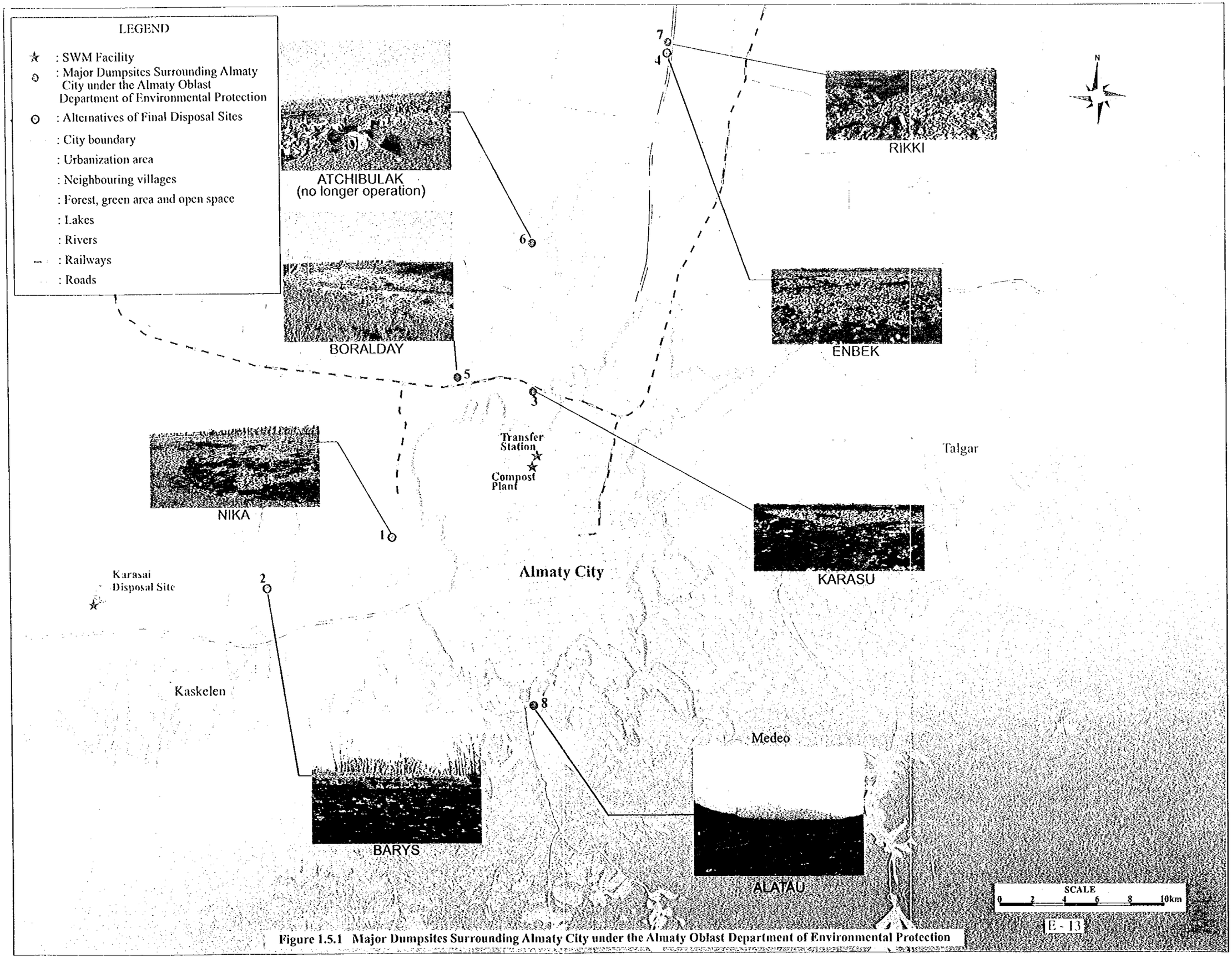


Figure 1.5.1 Major Dumpsites Surrounding Almaty City under the Almaty Oblast Department of Environmental Protection

CHAPTER 2 ENVIRONMENTAL QUALITY OF ALMATY CITY

2.1 WATER QUALITY

2.1.1 Surface Water

Two major mountain rivers, i.e., the Malaya and Bolshaya Almatinkas, go through Almaty City from south to north. They start from the Za-Illi Alatau Mountains and glaciers of these mountains fed mainly the two rivers. Their inflows and tributaries, namely Vesnovka, Remisovka, Kasachka and Karasu, flow in the city in parallel with the two Almatinkas.

There are several monitoring points set up along the two rivers in and outside of Almaty City. The Department of Hydrometeorology in Kazakhstan, in spite of changes of the government structure, has been conducting water quality analysis since 1988. The latest analysis was carried out in November and December 1998, and results of the measurement are summarized in Tables 2.1.1 and 2.1.2, Data Book 4.

In order to assess the river water quality, major indices, i.e., Suspended Solids (SS), Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD), were picked up from the data. The following Figures 2.1.1 and 2.1.2 clearly illustrate that the two rivers were gradually polluted from the upstream to the downstream. This is understandable because the major sources of contaminants seem to be the polluted run-off of surface water and domestic wastewater.

The water quality is categorized into seven depending on a water pollution index (ИЗВ).

Table 2.1.1 Water Categorization Depending on Water Pollution Index

Water Category	Characteristics of Water	Range of Water Pollution Index (ИЗВ)
I	Very Clean	ИЗВ <= 0.3
II	Clean	0.3 < ИЗВ <= 1
III	Moderately Polluted	1.0 < ИЗВ <= 2.5
IV	Polluted	2.5 < ИЗВ <= 4.0
V	Dirty	4.0 < ИЗВ <= 6.0
VI	Very Dirty	6.0 < ИЗВ <= 10
VII	Extremely Dirty	ИЗВ > 10

Source: State Committee of USSR on Hydrometeorology, Kazakhstan National Department of Hydrometeorology, *"Report on the Pollution of Environment in Almaty City,"* 1990.

The definition of the water pollution index is as follows:

$$ИЗВ = \sum_{i=1}^{6} \frac{C_i}{PDK_i * 6}$$

Where, C_i : Average measurement value for each parameter

In order to evaluate the water quality easily, the maximum allowable concentration factor, so called as PDK in Russian abbreviation, is introduced. The PDK is defined as the ratio of a measurement value to the maximum allowable value in each parameter. Since 1988 the PDK has been calculated based on the results of monitoring for the Malaya and Bolshaya Almatinka rivers although some of the months or years lack the data, as shown in Tables 2.1.3 to 2.1.11 and Figures 2.1.1 to 2.1.9, Data Book 4.

Between 1988 and 1998, it seems that a remarkable change of water quality was not observed. Characteristics of each parameter during this period are summarized as follows:

NH_4^-

This parameter is quite stable and marked at PDK of around 0.1 or 0.2 in both Malaya and Bolshaya Almatinkas.

NO_2^-

Although the value for the upstream of both rivers is at an acceptable level; that is, PDK is less than 1.0, the values measured inside the city area are usually more than 1.0 since high values were sometimes recorded especially in summer from June to August.

NO_3^-

The value fluctuated during the period, gradually increasing from the upstream to the downstream. Average PDK is about 0.3 to 0.4 and it is still below the allowable level.

Phenol

The PDK value between 1991 and 1993 was often recorded higher than that of the other years. In 1995 and 1998, the average PDK of all the stretches of Bolshaya Almatinka is acceptable, while the PDK of the middle stretches of Malaya is more than 1.0.

Petroleum Products

This parameter varies from year to year and always exceeds largely. Average PDK value is around 2.0 and 3.0.

Fluoride

The value also fluctuated, so that it is very difficult to find out the tendency during the period. Average PDK value is approximately between 0.4 and 1.6.

Copper

The value for the upper stream of both rivers was always within the allowable level. The level is generally acceptable except a few records in the downstream of Malaya and the middle of Bolshaya.

Zinc

Although it is hard to see the tendency during the period due to insufficient number of data, the value was always within allowable level at around 0.1 to 0.5.

The water quality is categorized into Category II (clean) for the Malaya and Category III (moderately polluted) for the Bolshaya Almatinkas. The Malaya Almatinka is therefore cleaner than the Bolshaya in general. Just for reference, the Japanese water quality standards are presented in Table 2.1.12, Data Book 4. Focusing on the water quality in the city, i.e., Location No. 2 at the Malaya and Locations No. 2 and 3 at the Bolshaya in Figures 2.1.1 and 2.1.2, it is obvious that significantly high values of suspended solids (SS) were recorded for both rivers. While the values of DO and BOD are around 11 mg/l (milligram per litter) and 1.2 mg/l in the two rivers, respectively, those of SS are more than 50 up to 110 mg/l. Based on the Japanese standards, the levels of DO and BOD are categorized into at least A, which is the second best quality, although that of SS is the worst as E.

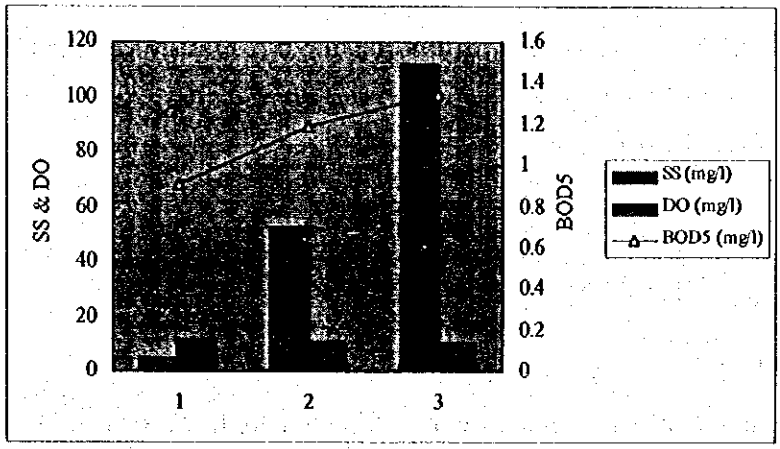


Figure 2.1.1 Water Quality of the Malaya Almatinka River (1998)

Source: Republican State Enterprise Kazhydromet, *"Information Bulletin on the State of Environment Pollution in Almaty City,"* November and December 1998.

Note: Figures "1," "2" and "3" indicate location of the measurement points as follows:
1: 2 km upstream of the city boundary
2: 4 km downstream of the city boundary, in Pokrovka
3: River mouth, 0.5 km downstream of Radio Station No. 5

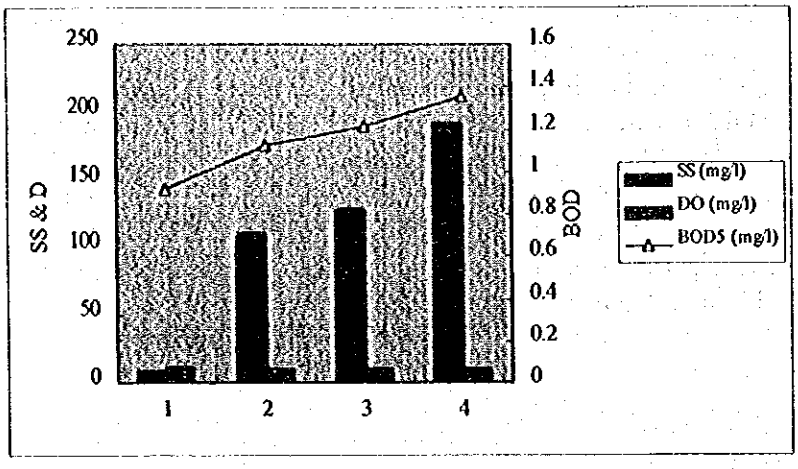


Figure 2.1.2 Water Quality of the Bolshaya Almatinka River (1998)

Source: Republican State Enterprise Kazhydromet, *"Information Bulletin on the State of Environment Pollution in Almaty City,"* November and December 1998.
Note: Figures "1," "2" "3" and "4" indicate location of the measurement points as follows:
1: 9.1 km upstream of the city boundary
2: 0.5 km downstream of AHBK
3: 0.5 km upstream of the city boundary
4: 12 km upstream of the river mouth

2.1.2 Groundwater

Unfortunately, the quality of groundwater in Almaty City has not been given although a water supply company, the Ministry of Geology and related organizations are supposed to keep periodical records. According to a staff engineer of the Vodokanal State Communal Company, which deals with water supply and wastewater treatment in Almaty City, 70% of the city's water supply is provided from the groundwater. The company operates 17 pumping stations comprising 6-10 wells to supply the groundwater for the city with chlorination. Although the depth of groundwater taken used to be 100-150 m, the water is now usually pumped up from 200 m to 300 in depth because of contamination. Therefore, it is said that the quality is presently satisfactory for all domestic purposes, in general, while some of wells provide water that recorded values in excess of the standards in the Environmental Survey (see Chapter 3 for details).

2.1.3 Standards

1) Drinking Water

With respect to drinking-water quality, *Drinking Water and Water Supply for Localities, Hygienic Requirements to Quality of Centralized Water Supply*, SNIP 2.1.4.559-96, Moscow 1996, is widely applied in this country. SNIP, abbreviation of *the Basic Standards, Norms and Regulations* in Russian, established in the age of USSR, covers not only environmental issues, such as water, air, soil, flora and fauna, but regulates also any economic activities. The essence of the water quality requirements in SNIP 2.1.4.559-96 is shown in Tables 2.1.13 to 2.1.17, Data Book 4. In addition to

SNIP, the National Standards called GOST are also used. GOST 2874-82, *Drinking Water: Hygienic Requirements and Quality Control*, regulates the quality of drinking water as shown in Tables 2.1.18 to 2.1.21, Data Book 4.

2) Surface Water

The surface water quality is regulated using the maximum allowable concentration factor (PDK). The maximum allowable value of PDK is as shown below.

Table 2.1.2 Surface Water Pollution Criteria

Pollutants & Water Quality Indices	Maximum Allowable Value	High Level of Pollution (B3)
Dissolved Oxygen (DO)	6.0 mg O_2/l	3.0 mg O_2/l
BOD_5*	3.0 mg/l	15.0 mg/l
Phenol	0.001 mg/l	0.03 mg/l
Petroleum Products	0.05 mg/l	1.50 mg/l
Nitrate ions	9.0 mg/l	10 PDK
Nitrite ions	0.02 mg/l	10 PDK
Ammonium Saline	0.39 mg/l	10 PDK
Fluoride	0.75 mg/l	10 PDK
Copper (Cu)	0.001 mg/l	0.03 mg/l
Zinc (Zn)	0.01 mg/l	10 PDK

Source: Republican State Enterprise Kazhydromet, *"Information Bulletin on the State of Environment Pollution in Almaty City,"* November and December 1998.
Note *: This stands for "Biochemical Oxygen Demand" referred to as BPK in the original text.

2.2 AIR QUALITY

The air quality may be influenced by moving or stationary sources. Moving sources are related mainly to the traffic of motor vehicles while stationary sources are related mainly to industries. There are several monitoring points set up inside the city, and the Department of Hydrometeorology in Kazakhstan has also measured the air quality as well as the water quality since 1988. The data of the measurement from 1988 to 1998 are summarized in Table 2.2.1, Data Book 4.

The survey results show that both average and maximum PDK have been increasing from 1990 up to 1992 or 1993, as illustrated in Figures 2.2.1 and 2.2.2. After 1994 the air quality of the city has reached the allowable level except formaldehyde in average although the maximum PDK of dust and carbon oxide (CO) still exceeded the allowable level, i.e., PDK is 1.0. Both average and maximum PDK of carbon oxide (CO) remarkably declined between 1995 and 1998.

Monthly average of PDK from 1988 to 1998 is shown in Figures 2.2.3 and 2.2.4. These figures clearly indicate that there were higher values of PDK for carbon oxide (CO) during the winter period from October to March. This seems to result from burning coal and woods for heating.

The air quality is regulated using the maximum allowable concentration factor (PDK). The maximum allowable value of PDK is as shown below.

Table 2.2.1 Air Pollution Criteria

Unit: mg/m^3

Pollutants & Air Quality Indices	Maximum Allowable Value of PDK	
	Maximum	Daily Average
Dust	0.5	0.15
Sulfur Dioxide (SO_2)	0.5	0.05
Carbon Oxide (CO)	5.0	3.0
Nitrogen Dioxide (NO_2)	0.085	0.04
Nitrogen Oxide (NO)	0.4	0.06
Formaldehyde	0.035	0.003
Phenol	0.01	0.003
Calcium (Ca)	–	0.3 μg
Copper (Cu)	–	2.0 μg
Nickel (Ni)	–	1.0 μg
Lead (Pb)	–	0.3 μg
Zinc (Zn)	–	50 μg

Source: Republican State Enterprise Kazhydromet, *"Information Bulletin on the State of Environment Pollution in Almaty City,"* November and December 1998.

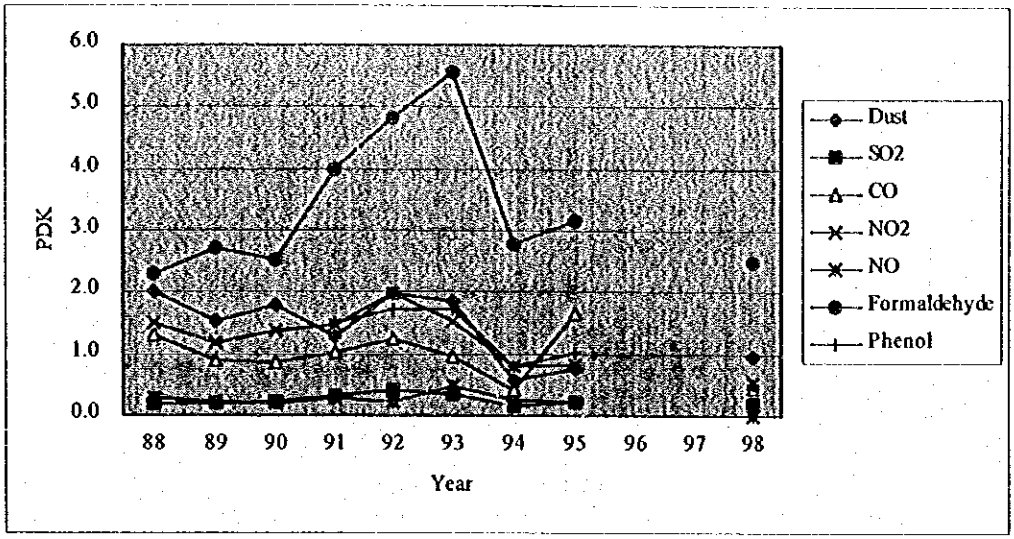


Figure 2.2.1 Average PDK of Air Quality in Almaty City (1988-1998)

Source: Republican State Enterprise Kazhydromet, *"Information Bulletin on the State of Environment Pollution in Almaty City,"* November and December 1998.
National Department of Hydrometorology, Republic of Kazakhstan, *"Information Bulletin on the State of Environment Pollution in Almaty City,"* 1995, 1994, 1993 and 1992.
State Committee of USSR on Hydrometeorology, Kazakhstan National Department of Hydrometorology, *"Report on the Pollution of Environment in Almaty City,"* 1991, 1990, 1989 and 1988.

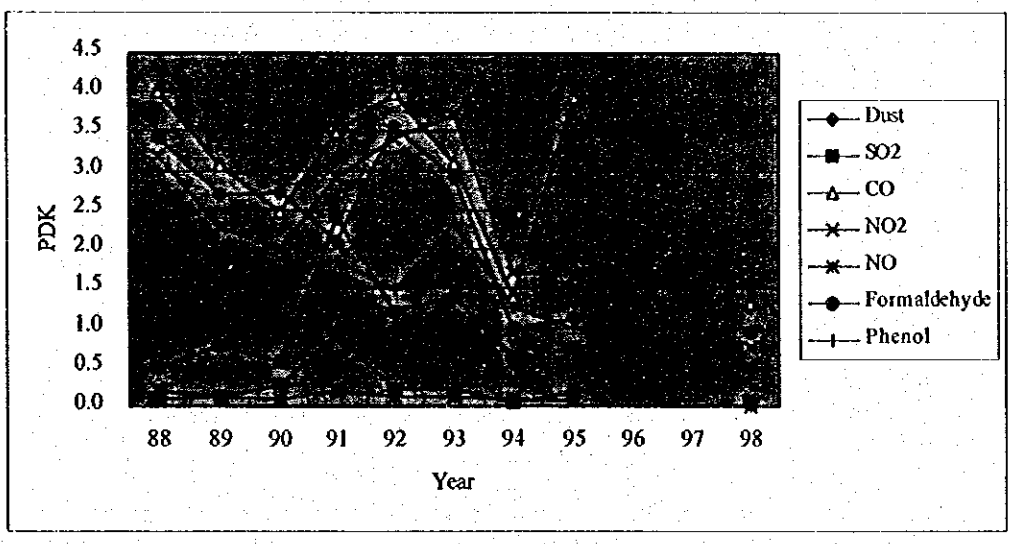


Figure 2.2.2 Maximum PDK of Air Quality in Almaty City (1988-1998)

Source: Republican State Enterprise Kazhydromet, *"Information Bulletin on the State of Environment Pollution in Almaty City,"* November and December 1998.
National Department of Hydrometorology, Republic of Kazakhstan, *"Information Bulletin on the State of Environment Pollution in Almaty City,"* 1995, 1994, 1993 and 1992.
State Committee of USSR on Hydrometeorology, Kazakhstan National Department of Hydrometorology, *"Report on the Pollution of Environment in Almaty City,"* 1991, 1990, 1989 and 1988.

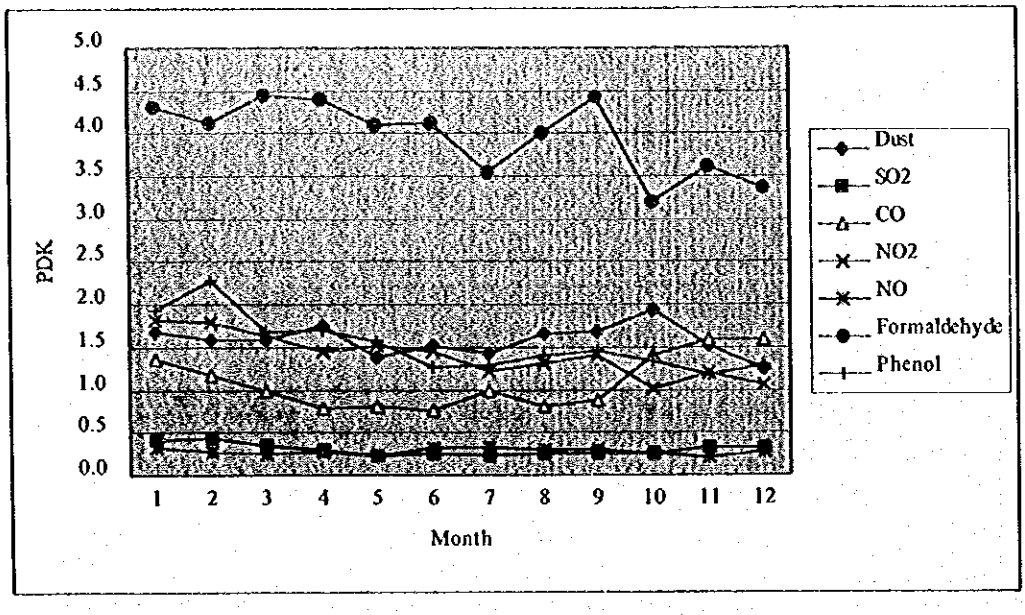


Figure 2.2.3 Monthly Average PDK of Air Quality in Almaty City (1988-1998)

Source: Republican State Enterprise Kazhydromet, *"Information Bulletin on the State of Environment Pollution in Almaty City,"* November and December 1998.
National Department of Hydrometorology, Republic of Kazakhstan, *"Information Bulletin on the State of Environment Pollution in Almaty City,"* 1995, 1994, 1993 and 1992.
State Committee of USSR on Hydrometeorology, Kazakhstan National Department of Hydrometorology, *"Report on the Pollution of Environment in Almaty City,"* 1991, 1990, 1989 and 1988.

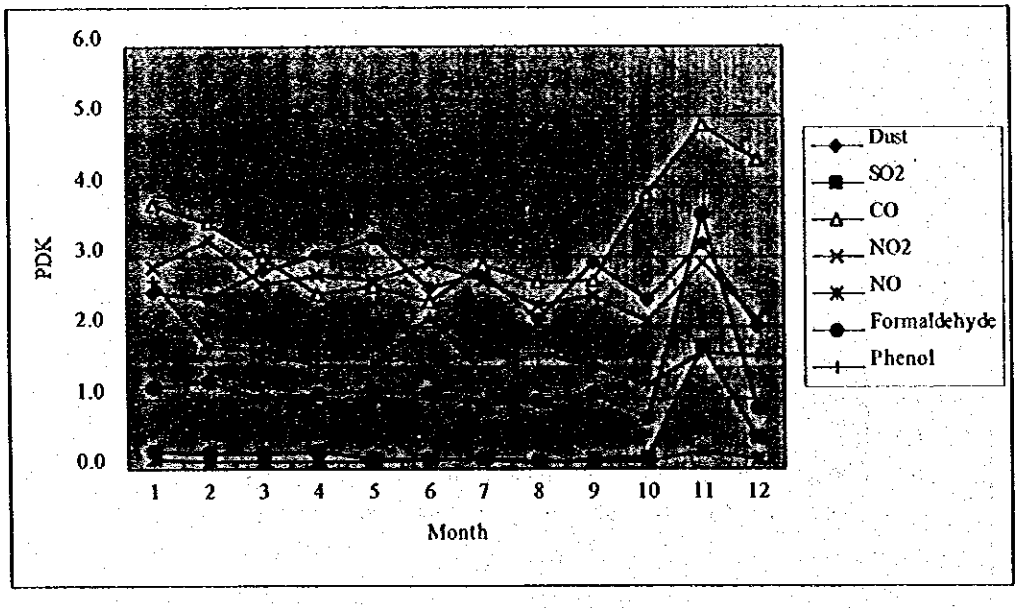


Figure 2.2.4 Monthly Maximum PDK of Air Quality in Almaty City (1988-1998)

Source: Republican State Enterprise Kazhydromet, *"Information Bulletin on the State of Environment Pollution in Almaty City,"* November and December 1998.
National Department of Hydrometorology, Republic of Kazakhstan, *"Information Bulletin on the State of Environment Pollution in Almaty City,"* 1995, 1994, 1993 and 1992.
State Committee of USSR on Hydrometeorology, Kazakhstan National Department of Hydrometorology, *"Report on the Pollution of Environment in Almaty City,"* 1991, 1990, 1989 and 1988.

2.3 SOIL CONTAMINATION

The measurement of soil contamination for Almaty City does not have a long history like the water and air quality survey. A map, *Environment Map of Almaty City*, showing degree of soil contamination is available. This map covers the city area and was made by analyzing samples taken from the surface to a depth of 10 cm of the ground. According to the map, the soil contamination can be observed at pollution sources that are mainly located in industrial areas. These pollution sources are locally distributed, and the area of pollution is spreading out as a center of the sources. The former compost plant is one of the high degrees of contamination; that is, lead, zinc, mercury, fluorine, arsenic and cadmium that are classified into the first degree of hazardous elements were detected in the site. There is no other specific information regarding the soil contamination effected by solid waste.

The degree of contamination is evaluated not by the maximum allowable concentration but by a background concentration, which may be established based on previous data and reasonable levels by experience. The background concentration and degree of soil contamination are shown in Tables 2.3.1 and 2.3.2, respectively.

Table 2.3.1 Background Concentration Applied in the Environment Map of Almaty City

Element	Background Concentration (g/t)
Lead (Pb)	40
Zinc (Zn)	150
Mercury (Hg)	0.05
Fluorine (F)	200
Arsenic (As)	2
Cobalt (Co)	15
Nickel (Ni)	40
Copper (Cu)	40
Molybdenum (Mo)	2
Chromium (Cr)	50
Manganese (Mg)	600
Strontium (Sr)	150
Vanadium (V)	60
Silver (Ag)	0.1
Phosphate (P)	800
Tin (Sn)	5
Tungsten (W)	3

Source: ACDEP, Explanation notes for *"Environmental Map of Almaty City,"* 1998.

Table 2.3.2 Degree of Soil Contamination

Measurement Concentration (g/t)	Degree of Soil Contamination
1.5 – 3 times as much as the Background Concentration	Very Low
3 – 5 times	Low
5 – 10 times	Middle
More than 10 times	High

Source: ACDEP, Explanation notes for *"Environmental Map of Almaty City,"* 1998.

2.4 FLORA

The southern part of Almaty City is designated as one of the areas of the Alatau National Parks. Deciduous and coniferous forests at an altitude of 1,100 to 1,500 m above sea level can be seen in these areas. Many trees, such as apple, apricot, silver birch, poplar and hawthorn, as well as pastures of feather-grass, sheep's fescue, couch-grass, small-reed and thousands of other plants, are vegetated.

In the residential and commercial areas of the city including downtown, there are oaks, poplars, silver birches, apple trees and central Asian willows planted along the roadsides. According to the Sector on Land, Water Resources and Vegetation of ACDEP, there were 3.3 million trees in the city based on the result of the census in 1994. They also mentioned that the area of 'green space' that includes areas for parks and plants decreased from 8,000 ha in 1950's to 5,000 ha at present. A large number of aged plants, lack of new planting and insufficient water supply system for trees are major constraints for development of vegetation in the city. It is said that these result from lack of funds.

2.5 FAUNA

The only place where fauna can be discussed is the southern part of the city. In the mixed forests, roe deer, wild boar, badger, fox, ermine, mouse-like rodents and a wide variety of birds can be seen, if blest with good luck. *The Red Data Book of Kazakhstan* shows that there are 17 species that probably live in this area, in terms of animals. The list of these species is shown in Data Book 4. However, it is considered that these animals no longer exist inside the city boundary. There is no information regarding birds and insects.

CHAPTER 3 ENVIRONMENTAL SURVEY

3.1 OBJECTIVE OF THE SURVEY

Environmental Survey was required as a part of the Study to identify the existing surface and ground water quality in the city that may be affected by solid waste. The Survey will provide basic information required for formulation of the Master Plan and Feasibility Study.

3.2 OUTLINE OF THE SURVEY

The Survey was carried out twice, i.e., once in Phase I in winter and the last in Phase II in summer, by a local consultant under the supervision of the JICA Study Team in order to take into account the seasonal fluctuation of the environment.

As a result of tender, Kazmekhanobr, a local company specialized in water quality survey and environmental analysis, was selected as the consultant to conduct the Survey. The Survey was composed of three parts, as follows:

Part 1: Ground Water Survey I

Water sampling was conducted at wells located near the former compost plant and illegal dumpsites in the city.

Part 2: Ground Water Survey II

Water sampling was conducted at wells located near the existing transfer station.

Part 3: Surface Water Survey

Water sampling was conducted at rivers located closest to the existing transfer station and illegal dumpsites.

Every water sample was analyzed through laboratory tests in terms of the parameters described in the following Section 3.3.

3.3 WORK ITEMS AND CONTENTS

The Environmental Survey was generally carried out in accordance with the technical specifications and as instructed by the JICA Study Team.

Through discussions with an expert of the Almaty City Department of Environmental Protection (ACDEP) and German consultants who had joined a water resources project in ACDEP, the specific locations and numbers of sampling were decided, as shown in Figure 3.3.1. The items and contents of the required work executed for each Part are as given below.

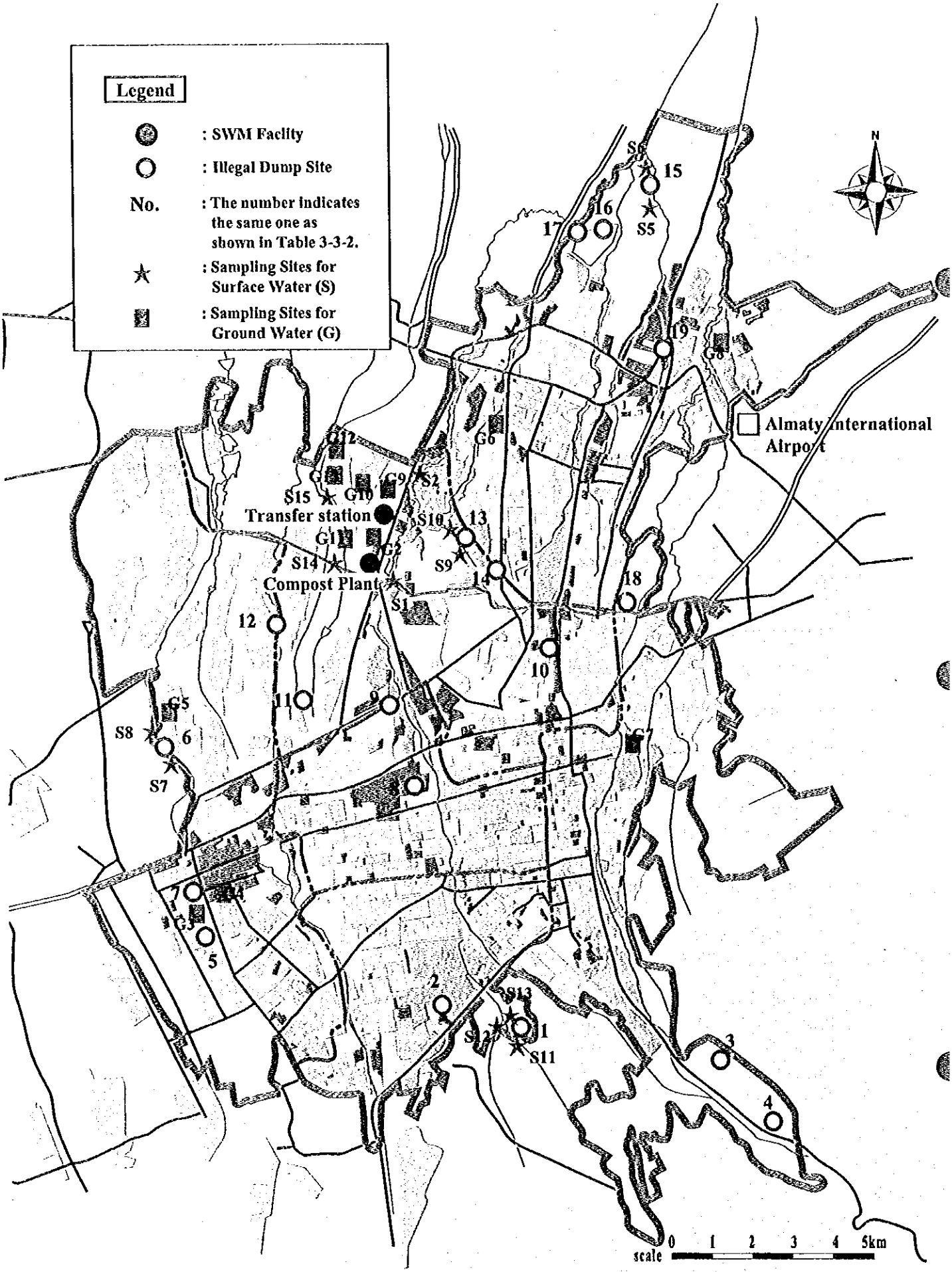


Figure 3.3.1 Locations of Sampling Points for the Environmental Survey

Note : * Some small rivers and water cources are not illustrated, and the locations indicated in the above show the approximate place.

** There are 2 samples (S3, S4) taken from the leachate ponds at the existing final disposal site in Karasal.

3.3.1 Part 1: Ground Water Survey I

Site	Parameter	Number of Samples
One (1) well near the former compost plant	NO_3-N, NO_2-N, Cl^-, Coliform Group Number, General Bacterial Population, CN^-, Hg, Cu, Fe, Mn, Zn, Pb, Cr^{+6}, Cd, As, F, Ca, Mg, Total Hardness, Distillation Residue, Phenol, NH_4-N, pH, Taste, Odor, Color, Turbidity, Sulfide, SO_4^{2-}, COD, BOD, SS, Electric Conductivity (EC), Oxidation-Reduction Potential (ORP)	2 samples/well × 1 well = 2 samples Number of samples indicated above represent only numbers for one season. Total required number of samples is thus 4.
Three (3) wells near the one of the existing illegal dumping sites selected in the city		2 samples/well × 3 wells = 6 samples Number of samples indicated above represent only numbers for one season. Total required number of samples is thus 12.
Three (3) wells selected in the city		2 samples/well × 3 wells = 6 samples Number of samples indicated above represent only numbers for one season. Total required number of samples is thus 12.

3.3.2 Part 2: Ground Water Survey II

Site	Parameter	Number of Samples
Five (5) wells near the existing transfer station	NO_3-N, NO_2-N, Cl^-, Coliform Group Number, General Bacterial Population, CN^-, Hg, Cu, Fe, Mn, Zn, Pb, Cr^{+6}, Cd, As, F, Ca, Mg, Total Hardness, Distillation Residue, Phenol, NH_4-N, pH, Taste, Odor, Color, Turbidity, Sulfide, SO_4^{2-}, COD, BOD, SS, Electric Conductivity (EC), Oxidation-Reduction Potential (ORP)	2 samples/well × 5 wells = 10 samples Number of samples indicated above represent only numbers for one season. Total required number of samples is thus 20.