

## REPORT

**Theme:** *INVESTIGATION OF THE CONCENTRATION LEVELS OF HEAVY METALS IN WATER, SOIL AND VEGETATION*

**Step 1:** **Determination of the Content of Heavy Metals in Soil of Industrial Regions of Yerevan**

### *ABSTRACT*

The monitoring of the soil in the area of the industrial units situated in the South-Eastern and Southern parts of Yerevan for the purpose of heavy metals (HM) content (Cu, Mo, Zn, Pb, Ni, Co, Mn, Cr) in it was carried out. The samples of the soil were taken in the area situated close to the industrial units and in radial distance from 50 m up to 1,5 km from the depth of 0-20 cm. The concentration of HM in the samples of the soil was determined by emission quantitative spectral methods after the corresponding preparation of samples.

According to the obtained results, the average content of Mo, Pb, Co, Mn, Zn in the investigated areas didn't exceed the generally accepted maximum permissible concentration (MPC). The Cu concentration in the soil in the areas around "Armelectro" plant was lower than MPC and nearly twice as much exceeded in the areas around Scientific and Industrial Amalgamation "NAIRIT", Yerevan Chemical Reactive Factory (YChRP) and Heat Power Station (HPS). The Ni concentration in the area around "Armelectro" plant corresponded to MPC and exceeded a little the MPC in the other investigated areas. The Cr concentration exceeded the MPC 2 - 4 times in all the investigated areas.

Similar investigations were carried out on the territories, remoted from the industrial units. They are regions of Old Nork, "Tsitsernakaberd" park, suburbs, adjoining Yerevan: the North-Western region (Ashtarak city direction), and behind the South-Western housing area. The average content of Cu, Mo, Zn, Pb, Co, and Mn on all the territories, considered as the "background", didn't exceed MPC. The concentration of Ni exceeded MPC in 1,2 times, but Cr - in 2-3 times.

## *PREFACE*

At present it was ascertained, that HM getting into the surroundings, as the result of man' activity (industry, transport, energy production, etc.) are the most dangerous means of the environment pollution [1]. The most important problem is the problem of soil pollution, because soil is the place where the most intensive interaction between alive and non-alive matters takes place, is the ecological group of relations in biosphere and distinguishes itself by extremely perceptibility to antropogenic exposure [2]. The strongest exposure to soils takes place in the cities and industrial zones, where the main sources of environment pollution by HM are concentrated. Such pollution is possible as the result of HM effluent in the atmosphere and in sewage and their intensive dispersion into surroundings. The concrete composition of HM and the quantity of the concentrations depend on the industrial unit and specific features of the technological processes at these industrial units [3]. It was determined that the most HM fall out the into atmosphere as the result of effluents of industrial units in the form of smoke, dust aerosols and in particular, Cu, Mo, Zn, Pb, Ni, Co, Mn, Cr, can be related to them [4]. The gross content especially of these elements was determined close to industrial units of South-Eastern and Southern industrial regions of Yerevan.

## *THE CONTENT OF THE WORK*

Yerevan is related to one of the cities, in the boundaries of which several industrial units being the sources of pollution by HM are situated. For this reason, the city was included in the priority list of cities (in the former SU) according to the degree of soil pollution, by controlled toxicants of industrial origin [5]. The degree of soil pollution was estimated at elements: Pb, Hg, Mg, V, Cu, Ni, Zn. Let's note, that priority toxicants for Yerevan are: Pb, Cu, Ni, Zn, Mn [6]. The South-Eastern and Southern regions of Yerevan, where the number of industrial units are concentrated: Scientific and Industrial Amalgamation "NAIRIT", Yerevan Chemical Reactive Factory and Thermo-Power Station including were chosen for the monitoring. Taking into account the specificity of the industrial units to the list of elements mentioned in the Project - Mo, Cu, Zn, Co - Pb, Mn, Cr, Ni, were added. It should be noted, that the nature of city territory pollution has its specific features. Areas of pollution by different industrial units are overlapped forming the common anomalous district. This circumstance leads to the necessity of using the special methods of investigation, taking into consideration the complicated structure of city territory, and complex nature of pollution [7].

### *A. SAMPLES GATHERING*

In conditions of modern city, samples gathering by standard methods is entailed with great difficulties. The area for samples gathering is limited by existence of buildings, asphalted and concreted places, etc. The samples were gathered in the house yards, along the streets, from the flower-beds, from the city parks and squares. In many cases, the specialists had to be satisfied by the single samples as the territory didn't

permit to select the mixed samples. In individual cases the samples were selected by the "envelope" method. In such cases, representing sample was analyzed. This method permits to estimate the pollution of the city territory and to define the areas for further, more detailed investigation of soil pollution degree in the city boundaries. The samples of the soil were gathered in the direct nearness to the industrial units and in radial distance from 50 m to 1,5 km from the depth 0-20 cm.

### ***B. SOIL SAMPLES PREPARATION***

The gathered samples (0,5 - 1 kg) were placed on the sheets of oil-paper, were thoroughly made small into pieces not bigger than 5 mm, simultaneously taking out the organic remnants, and left them for 24 hours at room temperature (air-dry condition). After that, the sample thoroughly was mixed during 10-15 minutes made even and then the sample of about 100 gr. was chosen by single time quartering, then again mixed and run through the sieve with the cells 0,6 mm in size. The chosen final sample (about 10 gr.) was dried at 120 degrees during 16-20 hours, after that, with the help of electrified polystyrol stick, the organic remnants were selected out of it, and it was thoroughly grinded in jasper mortar. Reduced to powder, the sample was examined by emissive spectral analysis.

### ***C. DETERMINATION OF THE CONCENTRATION OF HM [8]***

The determination of the concentration of gross HM content in the samples was carried out on the diffracting spectrograph FC-13 with the 600 lines/mm lattice. The range of the registrated length of the waves: 250.0 - 350.0 nm. The sample weighing 25 mgr was put in the crater of low graphite electrode. The sample evaporated in the electrical arc of DC at current power 10-25 A and tension current 220 V. For getting the arc discharge the generator DG-2 was used. At spectrograms interpretation the method of stepped weakening of the spectral lines intensity at three order was used.

### ***D. THE RESULTS***

At scheme 1, the map of the part of the city adjoining to "Armelectro" plant, on which the places where from the samples were taken for the analysis are marked by the dots, is displayed. To make the presenting of the results comfortable, all the dots are numerated and each number is displayed at table 1, where all the measured values of the HM concentration in the soils are presented. The similar map-scheme of the part of the city, adjoining to SIA "NAIRIT" (Rubber plant and "Polyvinylatsetat" plant), is presented at the scheme 2. The results of the investigations on this district are presented at the table 2. The findings, presented at the table, are conditionally divided into two groups. The two districts are marked out: the district directly adjoining to these industrial units, and the district, which is remoted from 200 m to 1,5 km. From this table one can see, that the moving off from these units causes the significant reduction of Cu content, the same reduction of Co, Ni, Cr content but in smaller range can be observed.

At the table 3 all the facts, obtained as the result of the investigations of the territories, adjoining to Thermo Power Station, Yerevan Chemical Reactive Plant, and Vitamin Plant are combined.

The territories of the city which are situated far from the units, conditionally considered as the "background", were also investigated. They are the regions of Old Nork, Zoo, "Tsitsernakaberd" park (scheme 3, Table 4), and suburbs also: North-Western district (Ashtarak city direction), the territory behind the South-Western housing area. All together 133 single and 17 mixed samples (5 in each one) were analyzed, as the result - 218 investigated points. At the table, all the mixed samples are marked by the stars.

As one can see from the results presented, the average content of Mo, Pb, Co, Mn, Zn at the investigated territories didn't exceed generally accepted MPC [9, 10]. The content of Cu in the soils on the territory around "Armelectro" plant was lower than MPC and approximately two times exceeded MPC on the territory around SIA "NAIRIT", Yerevan Chemical Reactives Plant and Thermo Power Station. The Ni concentration corresponded the rate of MPC on the territory around "Armelectro" plant and just a little exceeded MPC on the other territories. Cr content exceeded MPC from 2 to 4 times on all the investigated territories.

From the table 4 one can see, that the average content of Cu, Mo, Zn, Pb, Co and Mn on all the territories, considered as the "background" didn't exceed MPC. Content of Ni exceeded MPC in 1,2 times, Cr in 2-3 times. It should be noted, that the average content of Cu on the territory of Zoo exceeded MPC by 50%, and in this view the territory of Zoo turned to be the most polluted place, from all other "background" territories, approaching to the values, obtained in the regions, adjoining to Thermo Power Station.

Table 1.

The content of HM in the territories, adjoining to "Armelectro" plant, mg/kg soil

No	No of sample	Cu	Mo	Zn	Pb	Ni	Co	Mn	Cr
1	1/1	28	2.4	70	4	85	24	420	280
2	1/2	28	1	100	4.2	40	8	240	130
3	1/4	37	1.8	180	8	40	10	420	200
4	1/5	28	1.8	320	8	40	8	200	320
5	1/6	37	2.4	180	12	40	15	420	130
6	1/8	28	3.2	70	4.2	40	10	420	180
7	1/9	28	2.6	130	24	40	10	420	280
8	1/3	15	3.2	70	3.2	52	8	200	120
9	4/23	100	1.8	240	42	70	3.2	750	240
10	5/1	32	1.8	130	24	60	24	830	240
11*	5/2*	24	2.4	100	9	50	13	560	200
12	5/3	24	2	130	24	75	13	1200	350
13	5/4	32	1.8	130	35	32	15	750	180
14*	1/7*	37	3.2	180	24	46	10	500	280
15	4/22	90	4	100	50	42	18	900	100
16	5/5	24	2	100	7.5	42	10	600	100
17	1/10	42	3.2	180	24	40	15	420	280
<b>AVER.</b>		<b>37.29</b>	<b>2.39</b>	<b>141.76</b>	<b>18.06</b>	<b>49.06</b>	<b>12.6</b>	<b>544.12</b>	<b>212.35</b>
MPC		40	4	150	20	45		1500	50

Table 2.

The content of HM in the territories, adjoining to  
Rubber and Polyvinylatsetat plants, mg/kg soil

No of samples	Cu	Mo	Zn	Pb	Ni	Co	Mn	Cr
<b>Adjoining territory</b>								
2/1	90	1.8	75	10	60	10	750	240
2/2	40	0.75	56	4.2	50	-	320	120
2/3	120	0.75	75	13	40	-	420	110
2/4	100	1.8	75	42	42	10	320	130
2/5	200	1.3	180	18	74	3.2	320	180
2/6	30	3.2	130	10	100	10	500	180
2/7	56	2.4	10	13	60	10	1000	110
2/8	87	1.8	100	7.8	34	3.2	750	180
2/9	100	1	240	10	100	10	100	320
2/10	49	2.4	100	7	42	3.2	450	170
2/11	49	1.3	70	7	32	3.2	320	160
2/12	100	1	180	12	40	4.2	400	180
2/13	42	1.8	130	10	40	4.2	500	130
2/14	24	1	130	4.2	40	5.6	500	130
2/15	100	1	100	10	24	4.2	500	70
2/16	87	1.8	180	15	32	1.3	320	90
2/26	110	1.8	70	13	56	1	320	110
2/29	100	1.8	70	2.4	42	18	320	100
2/30	100	0	75	18	56	3.2	420	180
2/32	200	1.8	130	50	75	10	320	180
2/33	100	2	60	10	42	24	420	240
<b>AVER.</b>	<b>89.71</b>	<b>1.55</b>	<b>106.48</b>	<b>13.65</b>	<b>51.48</b>	<b>7.14</b>	<b>441.43</b>	<b>113.85</b>
<b>Remoted territory</b>								
2/17	87	1.3	130	50	48	1.3	320	50
2/18	100	1.3	42	13	56	4.2	560	110
2/19	49	1.8	130	11	32	1.8	400	100
2/20	13	1	180	4.2	42	5.6	500	70
2/21	32	1.8	130	4.2	42	5.6	500	70
2/22	30	1.8	100	7	32	10	320	120
2/23	110	1	130	7	32	10	450	110
2/24	24	1.8	180	4.2	24	4.2	500	150
2/25	42	1.3	100	13	56	10	320	180
2/27	42	1.3	42	52	56	3.2	420	300
2/28	56	0	10	13	56	3.2	420	100
2/31	24	1	80	5	42	4.2	500	130
<b>AVER.</b>	<b>50.75</b>	<b>1.28</b>	<b>104.5</b>	<b>15.3</b>	<b>43.17</b>	<b>5.28</b>	<b>434.17</b>	<b>98.75</b>
<b>MPC</b>	<b>40</b>	<b>4</b>	<b>150</b>	<b>20</b>	<b>45</b>	<b>30</b>	<b>1500</b>	<b>50</b>

Table 3.

The content of HM in the territories, adjoining to HPS, YChRP,  
Vitamin Plant, mg/kg soil

No of samples	Cu	Mo	Zn	Pb	Ni	Co	Mn	Cr
3/1	56	1.8	60	13	56	7.5	560	560
3/2	130	1.8	130	240	32	7.5	560	72
3/3	42	2	75	32	32	3.2	480	180
3/4	56	4.2	100	32	56	3.2	480	180
3/5	75	3	75	32	56	10	900	110
3/6	75	1.8	130	100	56	7	900	130
3/7	180	1.8	180	42	75	7.5	240	180
3/8	100	4.2	130	11	42	18	420	320
3/9	100	1.8	180	18	75	10	420	180
3/10	56	1.8	130	5.6	56	7.5	320	150
3/11	56	1.8	100	4.2	56	10	500	150
3/12	75	1.8	100	2.4	56	13	560	180
3/13	56	2	75	2.4	42	7.5	320	130
3/14	42	0	100	3.2	42	7.5	560	120
3/15	56	1.3	75	2.4	56	7.5	560	240
3/16	56	1.3	75	2.4	100	10	560	240
3/17	56	1.8	75	10	56	7.5	560	240
3/18	130	3.2	240	10	56	7.5	420	560
3/19	90	3.2	130	7.5	56	7.5	420	140
3/20	24	2.4	130	5.6	40	7.5	560	180
3/21	100	3.2	180	2.4	32	10	320	320
3/22	100	2	100	0	42	13	420	150
3/23	75	2	100	18	50	7	560	130
3/24	75	0	60	2.4	42	10	560	100
3/25	56	2	75	10	32	13	750	320
3/26	75	1	42	2.4	32	10	560	70
3/27	32	2.4	130	2.4	42	7.5	560	100
3/28	32	2.4	130	2.4	42	7.5	420	420
3/29*	75	2.8	13	75	42	7	560	72
3/30*	42	1.5	13	13	42	7	750	180
3/31	56	1.3	13	13	24	4.2	750	56
3/32	24	2.4	75	0	32	5.6	420	100
3/33*	90	2	180	5.6	42	7.5	600	140
3/34	42	2.4	130	42	42	7.5	480	180
3/35	18	1.3	75	0	24	5.6	320	130
3/36	130	2.6	180	28	75	7.5	420	180
3/37	100	2.4	180	28	60	7.5	100	200
3/38	42	2.4	100	18	60	10	480	150
3/39	56	2.4	180	42	56	7.5	1000	150
3/40	32	2	100	10	60	7.5	1000	80
3/41	32	2.4	300	10	60	10	1000	80
3/42	42	2	90	5.6	42	7.5	320	180
3/43	10	2	56	0	42	-	320	100
3/44	24	2.4	130	2.4	42	7.5	560	180
3/45	32	3	130	2.4	60	7.5	560	100
3/46	100	2.4	130	7.5	60	7.5	420	240
3/47	18	2.4	100	24	36	10	800	130
3/48	75	2	130	12	42	10	750	240
<b>AVER.</b>	<b>64.5</b>	<b>2.13</b>	<b>112.75</b>	<b>19.88</b>	<b>49.02</b>	<b>8.5</b>	<b>542.92</b>	<b>181.67</b>
<b>MPC</b>	<b>40</b>	<b>4</b>	<b>150</b>	<b>20</b>	<b>45</b>	<b>30</b>	<b>1500</b>	<b>50</b>

Table 4.  
The content of HM in the "background" territories, mg/kg soil

Place	No	No of samp.	Cu	Mo	Zn	Pb	Ni	Co	Mn	Cr
Zoo	1	4/1	32	1	75	5.6	70	10	560	100
	2	4/2	75	1.8	90	13	56	5.6	560	110
	3	4/3	100	2.4	200	18	75	18	560	130
	4	4/4	75	0	200	24	56	5.6	750	130
	5	4/5	42	0.75	130	18	75	7	560	130
	6	4/6	56	2.4	130	13	70	15	900	100
	7	4/7	42	0	120	24	56	5.6	750	130
	8	4/8	90	2.8	75	30	75	18	900	200
	9	4/9	42	3.2	120	18	56	24	1000	130
	10	4/10	48	1.3	240	9	70	10	1000	180
Old Nork	11	4/11	38	3.2	320	56	50	32	600	120
	12	4/12	42	0.75	180	13	50	5.6	560	75
	13	4/13	24	4	90	10	42	9	750	120
	14	4/14	38	1	130	10	70	12	900	200
	15	4/15	32	3.2	75	18	50	10	600	100
	16	4/16	32	3.2	180	10	60	24	420	200
	17	4/17	50	3.4	75	18	56	24	1000	120
	18	4/18	38	2	100	10	70	18	750	240
	19*	4/19*	38	2	100	10	80	13	750	200
	20*	4/20*	32	0.75	100	10	42	12	50	130
	21*	4/21*	56	1.8	100	42	130	13	900	240
S-W suburb	22	4/24	56	4	130	42	100	10	1300	120
	23	4/25	42	1.3	130	5.6	75	9	560	100
	24	4/26	35	1.3	100	7.5	42	24	560	120
	25	4/27	56	1.8	180	42	75	7.5	1000	180
	26	4/28	42	4	180	8	70	13	560	200
	27	4/29	40	2.4	180	7.5	56	3.2	560	100
	28	4/30	48	1.5	180	10	85	13	750	240
	Tsitsernakaberd Park	29*	5/6*	24	1.3	240	0	42	15	320
30*		5/7*	50	1.3	240	5	38	28	370	95
31*		5/8*	24	1.3	75	7.5	36	13	560	83
32*		5/9*	24	2	130	6	50	18	1300	95
33		5/10	24	1.3	100	7.5	38	13	560	90
34		5/11	30	1.5	130	8.3	50	15	1000	130
35*		5/12*	24	1.8	150	13	38	18	560	90
36		5/13	18	1.3	75	5.6	42	18	1300	80
37*		5/14*	24	1.5	180	5.6	40	24	900	130
38		5/15	32	1	180	3.2	42	7.5	600	100
39		5/16	30	1.3	100	3.8	40	13	1000	130
40		5/17	24	0	90	5.6	32	10	500	75
N-W suburb	41	5/18	42	1.3	130	9	42	7.5	750	100
	42*	5/19	28	1	130	0	30	24	420	180
	43	5/20	24	1	100	7.5	46	18	1000	120
	44*	5/21	28	1	130	24	32	24	750	200
	45	5/22	18	2.4	180	4.2	32	13	420	100
	46	5/23	32	2.4	132	10	40	24	900	100
	47	5/24	32	2.4	180	30	32	18	500	80
	48*	5/25	18	2.4	180	2.4	42	24	750	150
	49	5/26	32	1.3	100	2.4	50	18	560	130
	50	5/27	42	1.3	300	3.2	56	24	560	180
	51	5/28	24	2.4	130	5.6	42	24	560	130
	52	5/29	30	1.8	180	3.2	48	20	1000	140
				<b>38.83</b>	<b>1.8</b>	<b>143.69</b>	<b>12.98</b>	<b>54.65</b>	<b>15.42</b>	<b>716.35</b>
MPC			40	4	150	20	45	30	1500	50



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## PLAN

### of the works for the second half of the year on fulfilling the project: INVESTIGATION OF THE CONCENTRATION LEVELS OF HEAVY METALS IN WATER, SOIL AND VEGETATION

According to the content of the Project, in the second half of the year (01.07.96 - 31.12.96) it is supposed to hold the new cycle, including:

1. Plants samples collection and definition of the gross content of heavy metals (HM) in them on the territories of Yerevan, from which the soil samples were collected during the first half of the year.

2. Soils samples gathering and definition of the gross content of HM in them on the territories, adjoining to the mining and metallurgical complex in the city of chemical group of enterprises in the city of Vanadzor (Kirovokan), electrotechnical enterprises of Abovian city, Hrazdan Cement plant and Power Station.

3. Plants samples collection and definition of the gross content of HM in them from the territories, mentioned in the point 2.

Taking into account the necessity of the most complete usage of the Summer-Autumn period of the year for holding the field works, the main attention for this period will be spared to the samples collection. The works on defining the content of HM in them is supposed to fulfill during Autumn-Winter period of 1996-1997.

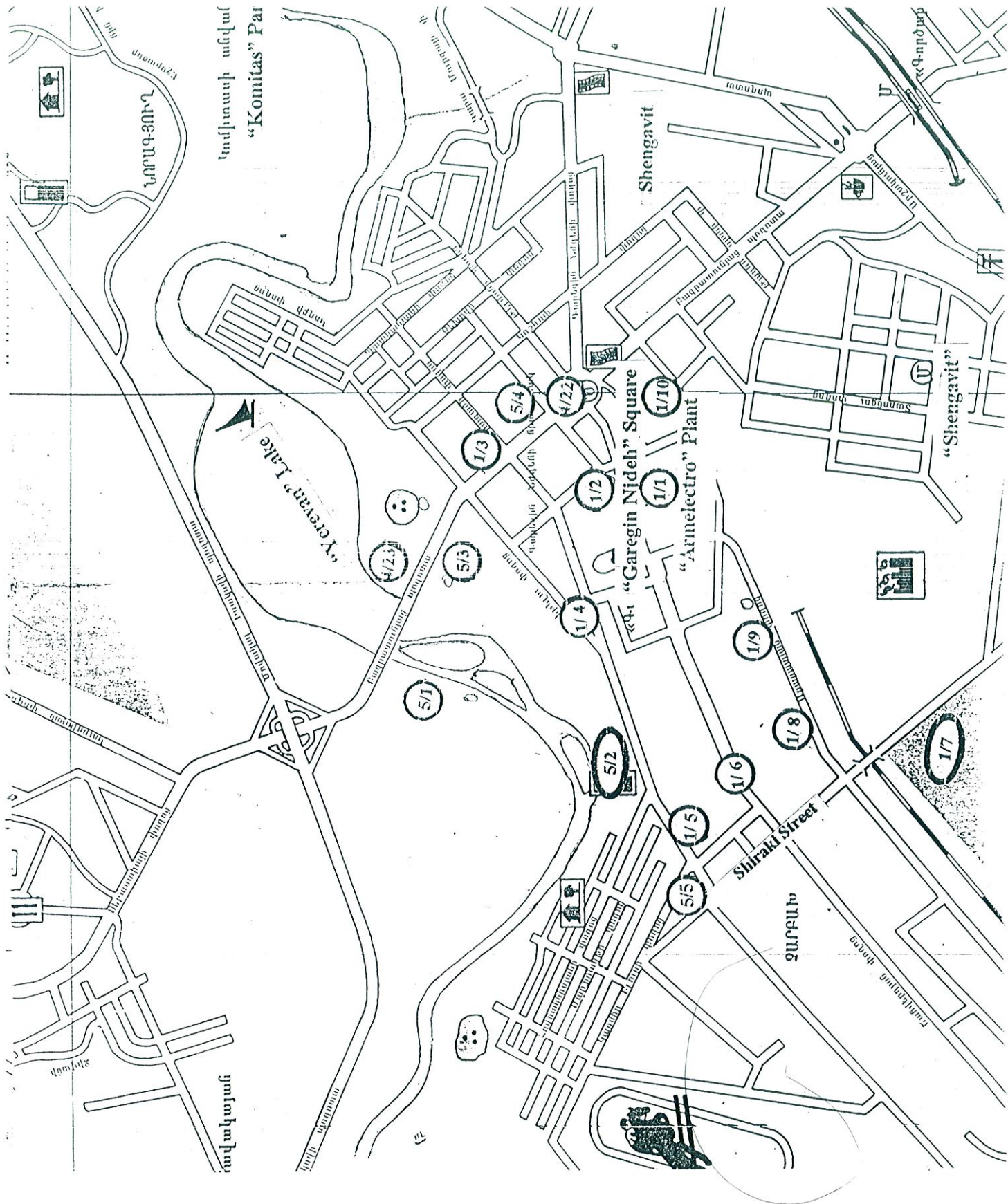
Besides, the works on the organization of the museum of the microorganisms, from the soil microbioty of the heavy polluted territories are planned.

Accumulated during the first half of the year experience, gives us the possibility to content, that planned volume of works can be fulfilled. At the same time, it significantly exceeds the volume of the works of the first half of the year on its labour-consuming character. Having into consideration all mentioned above, I ask you to enlarge the quantity of the staff at one person and consider the possibility of changing the volume of financing, according to the attached calculation:

Payments to participants		
Project Manager: at \$150/month	=	\$900
6 investigators at \$100/month each	=	\$3600
Materials, Field Expenses and overhead	=	\$2000
TOTAL		\$6500

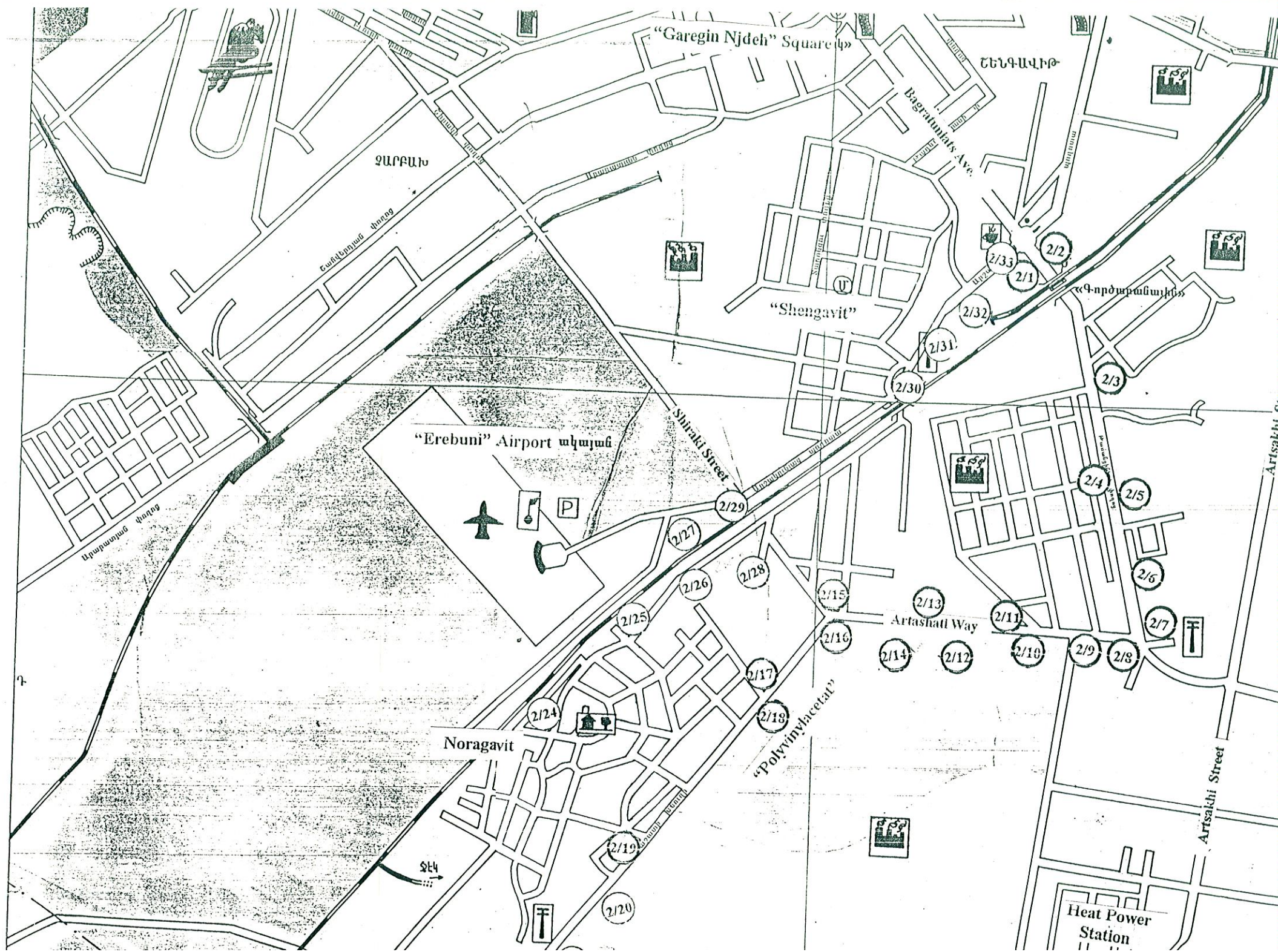


25.06.96.



Scheme 1. The map of the part of the city adjoining to "Armelectro".

○ - Single samples, ○ - Mixed samples



«Garegin Njdeh» Square

Շենգավիտ

Bagrattunians Ave.

ՉԱՐԲԱՆ

Երեւանի օդանավակայան

«Shengavit»

«Գործարանային»

«Erebuni» Airport տնային

Shirak Street

Արտաշատի փողոց

Artashat Way

Noragavit

«Polyimylacetat»

Artsakhi Street

Heat Power Station

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Scheme 3. The map of the "Tsitsernakaberd" park  
 ○ - Single samples, ○ - Mixed samples