

POLLUTION OF WATER BY HEAVY METALS AT THUONG DINH INDUSTRIAL AREA

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Underground water and situation of it's exploitation in Hanoi in general and Thuong Dinh area in particular

Earlier of this century, the French had conducted investigation, survey and come to the decision of using underground water to be the source for life, municipal industry. By early of 1950s, the amount of exploitation per day was about 37,000 m³. In 1960s, capacity reached 142,000 m³/day and 170,000 m³/day in 1970s. Since 1985, thanks to the intergovernmental co-operation program between Vietnam and Finland, water distribution system has been considerably ameliorated, area of wells at old plants has been widened and many have been newly built, namely, Mai Dich, Ngoc Ha, Phap Van, Luong Yen, Ha Dinh, Yen Phu,... In 1995, the amount of exploitation in the south of Red River reached the level of more than 400,000 m³/day. Table 1 shows water exploitation capacity in the south of Red River from 1990-1995.

Table 1: Amount of underground water exploitation in southern Red River (x 1000 m³/day) [2]

Month Year	1	2	3	4	5	6	7	8	9	10	11	12
1990	410	410	413	413	413	398	446	450	452	424	433	435
91	441	456	444	455	455	461	438	427	470	469	469	493
92	410	410	412	411	419	419	407	407	407	407	408	407
93	393	463	397	419	391	447	503	471	461	432	445	418
94	437	470	408	454	439	468	445	458	453	427	438	419
95	402	466	417	435	438	439	441	453				

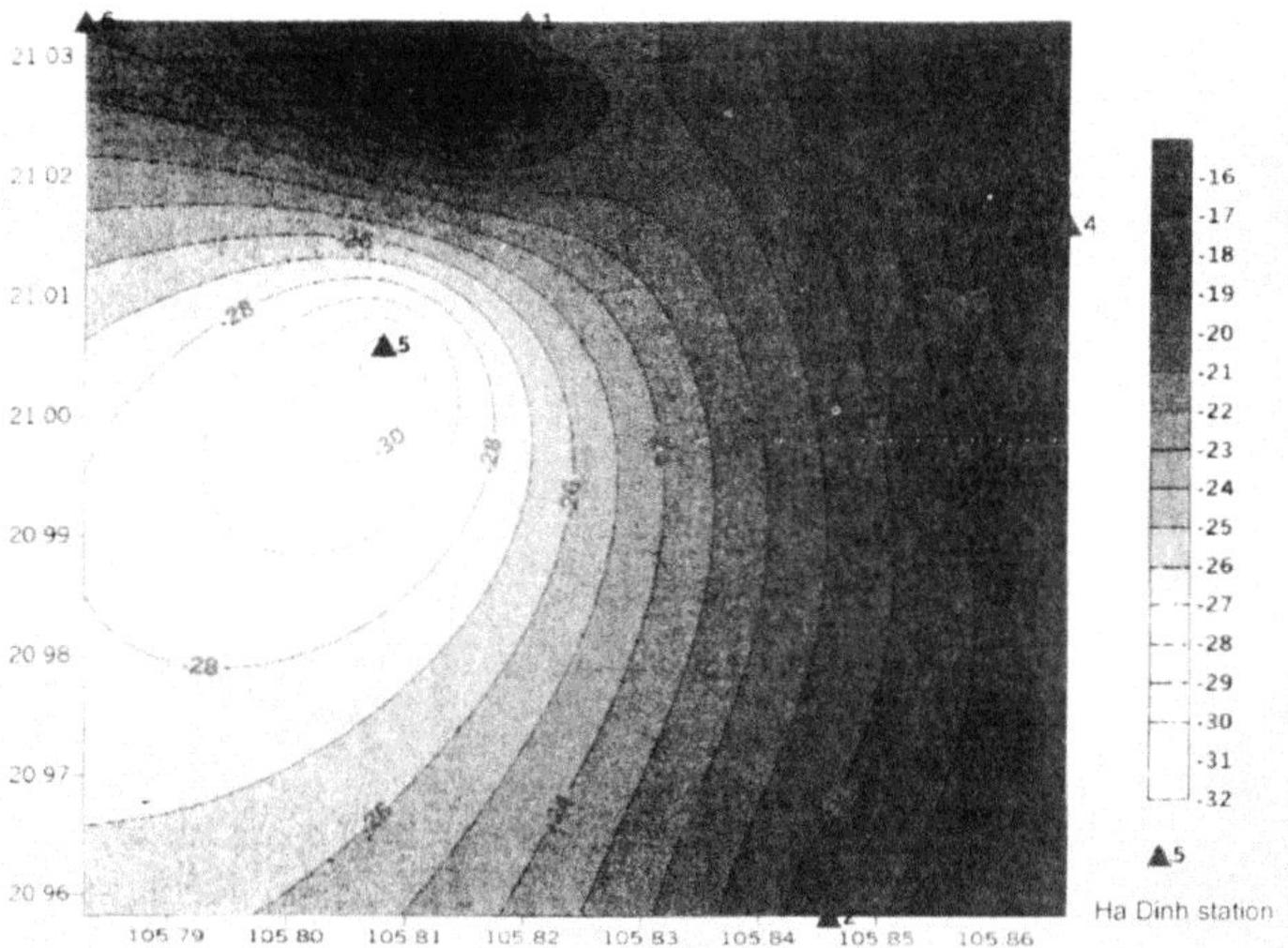
Hanoi is the city and the only area in Vietnam using 100% of underground water to be the source for life and industry as well. Presently, the exploitation of it in Hanoi has been carried out under different forms and at different scales.

Large water exploitation is focused at Hanoi Water Business Company (HWBC). 8 areas with the total of 130 wells of this company create a capacity of up to several

thousands of m³ per day. Smaller-scale exploitation is done at industrial drilling wells, of which, the capacity is 200 to 1000 m³ per day. Currently, there are about 200 drilling wells of this kind in the South of Hanoi, from which, water exploitation at Thang Long Cigarette Factory (TLCF), Haso Company, Sao Vang Rubber Company (SVRC), Hanoi Mechanical Company (HNMC), and Dong Xuan Company in Thuong Dinh industrial area gains the capacity of about 50,000 m³ per day. Since 1983, thanks to UNICEF sponsor, rural clean water program has been implemented with small drilling holes arranged for both urban and rural households. It is estimated that there are more than 7,000 drilling holes of this kind and the water capacity exploited from these holes is approximate to that exploited from other industrial drilling wells.

Heavy metal pollution in water at Thuong Dinh industrial zone

CONTOUR LINE OF UNDERGROUND WATER LEVEL OF HANOI (9-1998)



Not only does Thuong Dinh industrial area have Ha Dinh water plant with the capacity of 25,000 m³ per day alone, but it also has within it's area other industrial drilling wells at Thang Long Company Factory, SVRC, Haso Company, Thuong Dinh Footwear Company (TDFC), HNMC, Dong Xuan Company,... and thousands of other minor drilling

holes for which whoever pays just VND 1 million can create. The exploitation of underground water has caused ground sink, spoilt the water proof ability of the above clay layers. Thuong Dinh locates at the area with a sinking level of 10-20 mm per annual. Figure 1 is the picture of lowering underground water of water containing floor Q_{II-III} (8.1995) within Hanoi area. The underground water level in Ha Dinh is the lowest, creating a pulling hole to which dissolves contaminated water from surrounding areas.

Thuong Dinh industrial area as well as Hanoi city uses underground water for life and production. Many researchers conduct analyses on heavy metal concentration at 8 underground wells expanses. Table 2 is the analytical results of the concentration of 8 heavy metals at 8 underground water wells expanses in Hanoi in the dry and rainy seasons.

Table 2: Heavy metal concentration in water of wells within Hanoi area [7]

Area of Wells	Season	Concentration (in ppb), R- Rainy season, D- Dry season							
		Cu	Pb	Fe.10 ³	Mn	Ni	Cd	As	Hg
Luong Yen	R	2,15	15,8	2,23	228	1,48	2,36	55,0	0,41
	D	21,5	33,7	2,15	400	8,1	2,51	55,7	0,85
Trong Mai	R	3,39	13,7	4,69	181	2,49	1,34	31,1	0,85
	D	11,9	31,9	5,35	260	7,10	2,47	78,1	1,11
Ngo Si Lien	R	1,71	7,45	1,39	579	3,37	1,78	20,3	0,25
	D	7,72	33,6	1,12	940	11,9	2,63	52,1	1,08
Ngoc Ha	R	3,34	16,8	0,3	16	3,31	0,59	44,5	0,06
	D	7,50	35,4	0,53	1200	7,56	2,94	42,4	1,13
Yen Phu	R	6,63	735	5,12	249	305	1,83	412	0,51
	D	15,9	37,0	4,69	420	7,48	2,70	404	0,82
Ha Dinh	R	1,75	16,2	7,64	95	3,74	0,52	219	2,21
	D	20,3	36,3	8,51	140	8,31	2,60	281	1,07
Phap Van	R	2,58	15,0	5,27	109	2,42	0,24	304	0,27
	D	10,7	44,1	4,32	15	5,85	2,24	348	1,51
Mai Dich	R	6,8	16,8	6,9	16	3,31	1,49	21,6	0,56
	D	7,77	34,1	0,26	1020	5,46	2,19	48,2	1,01
TCVN 5944-1995		1000	50	1-5	100-500		10	50	1

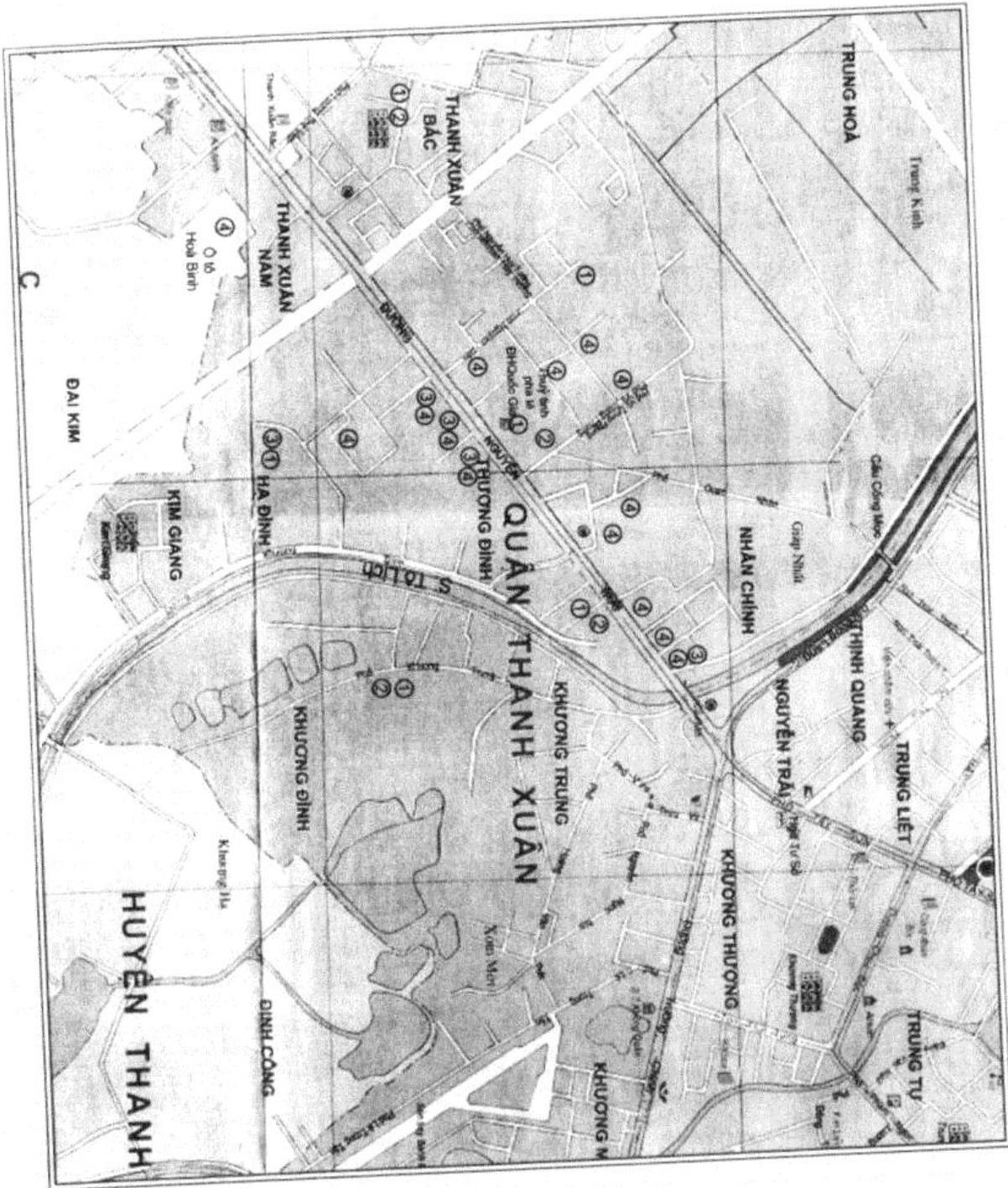
Diagram of Water Sample Spots within Thuong Dinh Industrial Area

In dry season, the concentration of heavy metals is higher than that in the rainy season. These concentrations in the two seasons at 8 drilling wells vary significantly. Accordingly, the penetration of surface water does occur. Results from Table 2 demonstrate that the concentrations of such metals as Cd, Cu, Ni and Pb are lower than Vietnam standard 5944-1995 (TCVN 5944-1995), while the concentrations of Fe, Mn and As are much higher than the above -mentioned standard at a great deal.

In order to find the laws of contaminant pervasion of heavy metals in underground water at different water bearing layers, samples were taken from industrial wells at 70-

Pollution of water by heavy metals...

100m-deep and from UNICEF's wells at 30-40m-deep. Two sample were collected at each drill well, one - directly collected from the well without treatment, and the other - after treatment. Diagram of water sample collected at Thung Dinh area is illustrated at Fig 2.



PLACES OF WATER SAMPLES AT THUNG DINH INDUSTRIAL AREA
 scale 1:1000

- LEGEND**
- ① Sample of drinking water
 - ② Sample of industrial drill well water
 - ③ Sample of UNICEF drill well
 - ④ Sample of waste water

Analytical results of heavy metal concentration at Table 3 reveal no major differences in concentrations between those at industrial wells and those at UNICEF ones. This warns about the risks of damages of impervious layer, separating underground from surface water. Untreated water is heavily contaminated with Fe, Mn and As. Concentration of those items after treatment reach drinking water standard. Concentration of Arsenic element after treatment is reduced and reaches drinking water standard thanks to the Arsenic absorption by iron glue. Therefore contamination of Arsenic element in drinking water is not a major problem as given at such recent assessments by several scientists.

Table 3: Concentration of heavy metals in drill wells (9-1999) (U - untreated; T- after treated)

No	Element Sample areas		Concentration (in ppb)							
			Cu	Pb	Zn	Fe.10 ³	Mn	Cd	As	Hg
1.	HaDinh Water Plant	U	7	7	5	11	140	1	507	1
		T	3	25	120	0,17	80	16	45	3,3
2.	HASO Company	U	53	15	7	18,7	320	1,3	349	0,79
		T	3	3	2	0,81	10	0,0		
3.	SVRC	U	5	12	10	1,74	140	3	121	0,59
		T	4	5	5	0,34	20	7		
4.	HNMC	U	14	2	5	4,3	220	2,6	426	107
		T	4	8	20	0,43	20	0,0		
5.	Mr. Tien	U	19	4	2800	18,2	350	3,5	161	1,3
		T	19	4	4100	0,08	20	0,0	43	4,5
6.	Mr. Quang	U	5	2	30	16,4	160	3,7	152	1,24
		T	20	5	10	0,04	180			
7.	Miss. Hong	U	5	7	15	21,1	440	2,5	347	6,28
		T	2	5	8	0,17	130	0,0	47	4,2
8.	Mr. Vinh	U	4	6	12	18,9	750	3,2	355	3,25
		T	7	5	30	0,02	1700		142	4,2
9.	Prof. Truong	U	5	7	67	18,4	720	3	250	2,4
		T	7	5	3	0,03	880	0,0	46	3,2
TCVN 5944 - 1995			1000	50	5000	1-5	100- 500	10	50	1

Heavy metal pollution in waste water in Thuong Dinh area

Thuong Dinh industrial area is characterized with industries of mechanics, foodstuff, tobacco, chemical, textile, shoe leather,... Surface water pollution caused by waste water at Thuong Dinh area is of great level.

Industrial waste water causing surface water pollution mainly derives from such industries as mechanics, textile-garment-shoe leather, foodstuff and tobacco (Tab. 4). Im-

fact of industrial waste water at Thuong Dinh area on To Lich river water is appraised by chemico-hydraulic criteria, says, concentration of suspended matter, DO, pH, concentration of heavy metals. Table 5 proves that in To Lich river waste water, DO falls from 3-5mg/l to 1,5-3mg/l; high levels of BOD₅, COD are also found. BOD₅ of To Lich river water at the end of drainage sewer increases sharply from 15-20 mg/l to 20-25 mg/l, correspondingly, the value of COD from 20-45mg/l to 40-180 mg/l, this figure at Kim Giang is even up to 380 mg/l. Concentration of Cr⁺⁶ is rather high.

Table 4: Analytical results of waste water at some factories at Thuong Dinh area [2]

No	Industries	Quantity of workers	Tonnage of waste		Quantity of waste water (m ³ /day)
			Suspended matter (kg/day)	BOD (kg/day)	
1	Mechanics	6171	2085		4907
2	Construction materials	640	490	1,59	54
3	Textile- Garment-Shoe leather	772	728	1589	1015
4	Foodstuff-Tobacco	7655	1304	263	22114
5	Other industries	791	259	1,72	95
6	Area tonnage	20729	4596	1855,31	28185

Obtained results of 16 sewage samples at Thuong Dinh factories area during September of 1999 are show in tab.6. Analytical results shows that in most of samples the concentration of Hg and especially As 3 times as high as those set in TCVN-5945-1995. Such factories as Dai Kim plastic enterprise, Asia Dawn Electric Company LTD (ASIA DAWN), Rang Dong Light Source and Vacuum Flask Company (RALACO), Accurate Mechanics Factory (AMF), TLMF, HASO Company, SVRC, Vinashiroki Joint Stock Company (VinaShiroki JSC), Cutting and Measuring Tools Company (CMTC) do not prove to be the source of other heavy metal pollution.

Bohemia Crystal Hanoi Company LTD (Bohemia Company), Lighting and Urban Equipment Company (HAPULICO) and especially. Glass Research Institute are deeply polluted by heavy metals. At Bohemia Company, Pb concentration in waste water outside the factory overcomes 64 times as per standardized by TCVN-5945-1995. Part of waste water at Embryo Polishing shop flows through Hanoi Glass factory, raising lead concentration in waste water 3.5 times as high as the standard one. At Glass Research Institute, this figure exposes 45.7 higher than the standard.

At HAPULICO, zinc concentration in waste water is at a very high level (75.2 mg/l), 75 times higher than the said standard. Zinc in solution with a very high concentration exists only at a complex form (xianua form). Waste water at polishing shop is not well treated which then flows into urban sewage water. This causes a very serious environmental pollution. At Glass Research Institute, Pb and Zn are not the only reasons for pollution

but Cd. Concentration of Cd in waste water here passes the standard 10 times. At Hanoi Shoes JSC, Cd pollution is evinced 5 times higher than standard. This is a very toxic element and a research on source of pollution should be performed for proper treatment; restriction on elimination into city waste water system supposed to be introduced.

Table 5: Composition, characteristic of waste water at drainage sewer from Thuong Dinh area flowing into To Lich river [2]

No	Criterion	HASO company	Dinh Vong	RALACO	HaDinh Water Plant
1.	Water current output discharge (m ³ /day)	9000	4700	500	7000
2.	Temperature of waste water (°C)	22-27	22-26	25-30	22-27
3.	pH	7,4-7,6	7,4-7,8	6,8-7,2	7,0-7,8
4.	Suspended matters (mg/l)	60-750		120-180	120-300
5.	DO (mg/l)	2,2-3,3	80-290	4-7,5	1,5-5,0
6.	Oxidation degree (after MnO ₄ ⁻) (mg/l)	65-750	15-60	8-15	7-12
7.	COD (mg/l)	800-2080	0,2	150-180	175-290
8.	BOD ₅ (mg/l)	30-155	15-60	50-100	15-72
9.	NH ₄ ⁺ (mg/l)	2-6	0,2	3-5	0,5-5,0
10.	NO ₃ ⁻ (mg/l)	1-7	3,5-7,5	0	0,1-0,4
11.	PO ₄ ³⁻ (mg/l)	1,7-8	0,7-10	0,1-0,3	0,4-0,9
12.	Cl ⁻ (mg/l)	70-1800	10-45	15-36	15-35
13.	Conductivity (µs/cm)	300-900	500-550		
14.	Cr ⁺⁶ (mg/l)	0,01	0,01-0,06		
15.	Volume of solution substances (mg/l)	200-2000	200-500	1250	810
16.	SO ₄ ²⁻ (mg/l)	20-200	3-9		

Table 6. Analytical results of waste water at the some factories at Thuong Dinh area

No	Sample place	Concentration (in ppb)							
		Fe	Mn	Pb	Zn	Cu	Cd	As	Hg
1.	Dai kim Plastic Entp	180	80	1	2	3	0		
2.	Asia Dawn.	180	40	14	3	10	0,6	3,5	1
3.	RALACO	110	60	0,6	50	25	0	145	6,6
4.	Accurate Mechanics Factory	1260	160	1	5	2	2		
5.	TLCF	310	60	1	4	2	4	123	5
6.	HASO Company	1080	40	12	50	20	0	138	2,7
7.	SV Rubber Cmpany	740	80	127	270	20	0	101	0,8
8.	VinaShiroki JSC	40	10	16	140	170	0	92	3,5
9.	HAPULICO	850	60	12	75200	60	14	68	6,3
10.	Hanoi Shoe JSC	230	90	1	80	40	50		
11.	Mua Dong Knitwear Company	341	80	9	270	38	16	74	4,8
12.	Hanoi Glass	320	160	350	280	7			
13.	Bohemia Company	340	160	6397	2160	40		127	6,8
14.	Cutting and Measuring Tools Company	270	80	2	50	20	0		
15.	Hanoi Mechanics Company	100	40	50	120	19	0	92	3,5
16.	Glass Research Institute	2300	180	4570	2240	80	100		
17.	TCVN - 5945-1995	1000	200	100	1000	200	10	50	5

Conclusion

Much more regular attention should be spent on heavy metal pollution in of water sources at Thuong Dinh industrial area in particular and Hanoi in general. This problem at Thuong Dinh area is concentrated in some enterprises and research centers, namely, Hanoi Bohemia Crystal Hanoi Company LTD (pollution of Pb), HAPULICO (pollution of Zn), Glass Research Institute (pollution of Pb, Zn and Cd). Concentration of heavy metals including Pb, Cd and Zn in such above-mentioned enterprises all cross the said standard. There are very dangerous source for both human beings and environment not only at this location but also for Hanoi as a whole unless is carried out well treatment. Currently, surface water and underground water pollution should be considered as a single issue. Since waterproof layer providing protection for underground water is destroying by thousands of big and small drill wells, pit for discharge wastes at Me Tri, Tay Mo, by thousands of big and small burial grounds catering around the city, by high building

construction sites, by brick-kiln using kaolin for construction materials, and by heavily-polluted rivers within the city. Apart from said heavy metals, the unique water source system is penetrated by other toxic organic compounds. Arsenic pollution is the most important issue which draws attention on untreated underground water at Thuong Dinh area (and Hanoi area also). Therefore, dissemination of intelligence for everybody to avoid direct usage of underground water for life, especially for drinking and eating.

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TẠP CHÍ KHOA HỌC ĐHQGHN, KHTN, t.XVII, n^o2 - 2001

Ô NHIỄM NƯỚC BỞI KIM LOẠI NẶNG Ở KHU VỰC CÔNG NGHIỆP THƯỢNG ĐÌNH

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Thượng Đình là khu công nghiệp đầu tiên của miền Bắc Việt Nam. Diện tích của khu vực là 26 ha và dân số hiện nay là khoảng 200.000 người. Đây là khu vực dùng nước ngầm làm nguồn nước duy nhất cho sinh hoạt và sản xuất. Công nghệ lạc hậu, sự phát triển không đồng đều chấp vá của nhiều nhà máy, xí nghiệp, dân số tăng nhanh làm nhu cầu sử dụng nước đồng thời lượng nước thải ngày càng lớn. Việc khai thác quá mức nước ngầm dẫn đến cạn kiệt nguồn nước, gây sụt lún bề mặt và nước mặt, nước thải bằng nhiều cách thâm nhập vào nguồn nước gây ô nhiễm. Bài báo này nghiên cứu sự ô nhiễm các loại kim loại nặng như: Cu, Pb, Zn, Fe, Mn, Cd, As và Hg trong nước ngầm, nước thải ở khu công nghiệp Thượng Đình.