Warsaw University of Technology

FACULTY OF BUILDING SERVICES,
HYDRO AND ENVIRONMENTAL ENGINEERING

Principles of soil Diagnostic Techniques

Development of a field research program to determine the degree of soil pollution in "Laogang" Landfill

Yingqi Fan 309352

Zhiqi Wang 309319

Environmental Engineering

Principles of soil Diagnostic Techniques

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1. Background information about the project

Subject:	**“Laogang” Landfill Site in China**				
Prepared by:	**Zhiqi Wang; Yingqi Fan**				
Group:	**4**	Delivered on:		Grade:	
Module Unit Teacher:		**Prof. Andrzej Kulig, D.Sc., Ph.D. (Eng.)**			

2. DECLATATION OF ORIGINALITY

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1 Introduction

1.1 Purpose and scope of the project

The purpose of the project is to investigate, analyze and possible solutions for the sewage leakage of the “Laogang” landfill site which located in Shanghai, China.

The scope of the report includes the following sections:

1. Survey of local geography, hydrology, weather conditions and population distribution.
2. Identify the sources of soil contamination that the group wants to investigate.
3. Landfill survey, sampling and sample analysis.
4. Identify the source of soil contamination and the cause of the contamination.
5. Give several possible solutions.
6. Give the estimated time and funds for landfill soil restoration

1.2 Basis of the study

Soil pollution refers to the pollutants produced by human activities entering the soil through various channels. The quantity and speed exceed the speed of soil evolution, destroying the dynamic balance of soil, and the accumulation of pollutants leads to the decline of soil quality, harmful to various vegetation, leading to a decline in the yield and quality of crops[1].

The soil pollution of the landfill is mainly caused by the infiltration of landfill leachate into the soil layer, and the pollutants can accumulate in the plant through the soil and water body, and then enter the food chain, affecting human health.
The study is based on the landfill site called “Laogang” landfill site in Shanghai which is really existed. It had a sewage leakage problem and start the closure repair project in 2009.

1.3 Subject of the study

The subject of the study is “Laogang” Landfill Site in Shanghai, China.
The “Laogang” landfill was put into operation in 1989. There were five phases. The earliest completed 1-3 landfills cover an area of 3.26 square kilometers and had a sewage leakage problem after many years of operation, which caused the land to be polluted and affected the living environment of nearby residents. Shanghai started its closure repair project in April 2009. As of 2017, the former abandoned landfill has become a country park, planting more than 30 kinds of plants, and the survival rate of planted seedlings can reach 95.2%.
Currently in use is the fourth phase, covering an area of 5040 acres. The total land area of the Laogang Landfill has been as large as the area of Macau[2]. The “Laogang” Renewable Energy Utilization Center handled about 3,000 tons of garbage per day, accounting for about one-sixth of Shanghai's average daily garbage production. In addition to the energy generated by waste incineration, the “Laogang” base has two 55m × 27m “pit-type” garbage pits, as well as biogas power generation, that is, the generation of biogas generated by landfills, and wind

power generation. A three-dimensional green energy base in the air, ground and underground can transport 400 million kWh per year [3].

1.4 Legal / methodological foundations[4]

《Environmental protection law of the People's Republic of China》(1989, Presidential Decree No. 22)

《Pollution control standards for landfill of domestic garbage》(GB-16889-2008)

《Technical policy on municipal solid waste treatment and pollution prevention and control》 (no. 120 [2000])

《Surface Water Environmental Quality Standard》 (GB3838-2002) Category 4 Category 5 Standard

《Groundwater Environmental Quality Standard》 (GB / T14848-93) Category 5 Standard

《Soil Environmental Quality Standard》(GB15618-1995) Level 3 Standard

《Domestic waste landfill pollution control standard》 (GB16889-1997) in which leachate adopts the first-level discharge standard

1.5 Information sources used

We search the basic information of the “Laogang” landfill from Wikipedia, Baidu Encyclopedia, online forums, etc., learn about his history, future planning from the official website, and browse related papers and publications on google scholar and other websites.

2. Characteristic of the study area

Figure 1 The location of the “Laogang” Landfill Site in China map[5]

Figure 2 Satellite map of “laogang” landfill in Shanghai [6]

2.1 Location of the area

“Laogang” Landfill locates in Pudong New Area, the east of Shanghai which shows in fig.1. If Shanghai is China's economic capital, then Pudong New Area is the epitome of Shanghai's modernization[7].

From the Fig.2, the satellite map shows clearly the coordinates of the “Laogang” landfill and the distance between it and the surrounding landmarks. For example, the distance between “Laogang” and Pudong International Airport is only 12.4km, and it is only 3.3km from the town government to where it is located. Additionally, the “Laogang” is only about 5km away from the "Dazhi" River in the south, and its right side is adjacent to the East China Sea[7].

2.2 Topographic conditions (topography)

The Pudong New Area is on the eastern edge of the Yangtze River Delta, bordered by the Yangtze River estuary in the east. The area where the landfill located is affected by the Yangtze River Delta urban agglomeration, its geomorphological division belongs to the alluvial delta plain of Jiangsu and Zhejiang [7].

The terrain around Laogang is low and the ground elevation is 2.5-4.0 meters above sea level. It consists of sub-clay and silty sand [8].

Because of the geographical features of “Laogang”, it is a typical plain landfill which built on the coastal tidal flats, the characteristics of it are large area and small depth [9]. And there is a 17-meter-thick ash clay water-repellent layer, therefore, surface water, garbage seepage water is not easy to penetrate downwards, and shallow groundwater is no exploitation value because its salty water [8].

2.3 Hydro-geological conditions

The area is located in the plain river network, the river port crosses vertically and horizontally, and the water resources are abundant [8].

Due to the deposition of a large amount of sediment in the Yangtze River, the beach land moves 60-70m to the East China Sea every year, which solves the land-use problem of the project expansion.

As it is close to the East China Sea, the water is brackish water, and the clay layer is 17m thick, so there is no substrate at the bottom of the landfill[9], the absence of the substrate poses a serious threat to groundwater in the surrounding area.

2.4 Climatic conditions

The area which located landfill is belongs to the subtropical maritime monsoon climate, which is mild and humid throughout the year with four distinct seasons. The annual average temperature is 16.6 °C, the annual precipitation is 1202 mm, and the annual rainfall is 120 days.

The most common wind direction in the region is southeast wind (SE), with a frequency of 10%, followed by southeast wind east (ESE) and northwest wind (NW), the wind frequency is 8%, and the static wind frequency is 5%, besides, the average wind speed is 3.6 m/s [8].

Table 1 Annual average temperature and precipitation

Month	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
Day max T(℃)	5	8	13	20	25	28	30	30	26	20	13	7
Day min T(℃)	-5	-2	3	9	14	18	21	20	16	10	3	-2
Precipitation(mm)	21	29	46	70	101	134	156	140	85	49	29	17

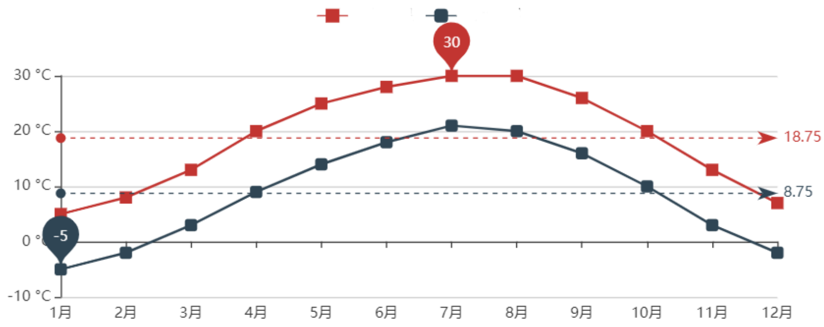

Figure 3 Annual mean temperature change

3. Characteristics of the case studies

3.1 Case report

Figure 4 Pictures of the landfill site

Figure 5 Picture of the landfill site

There are three phases in the early stage of “Laogang” landfill. Because the three phases were completed earlier, shallow landfill was used at that time. Under the high load operation throughout the year, its service cycle was shorter than expected, leachate leakage occurred in 2006, which showed that the irrigation channels around the landfill and surrounding farmland exceeded the normal value concentration of heavy metals and organics.

Our team will make reasonable assumptions about the type of pollution and the source of the pollution in the study area, and then conduct a sample survey and sample analysis to give a reasonable solution after identifying the cause of the pollution.

The total area covered by 44 landfill units in the first three phases of the survey was 2.597 million square meters. The main environmental protection target of this project is Zhonggang Village, about 1km west of the garbage dump. The population density within 1km around the project site is relatively low and there are almost no residential houses.

As can be seen from the figure below, the first three phases of Laogang are on the right side of the entire project, close to residential areas and farming areas; the main rivers around the disposal site are Suitang River, Renmin Pond, Shengli

Pond, and the main The river has Bailonggang and Dazhihe.

Figure 6 The landuse of the landfill site

3.2 Hypotheses of potential pollution

The main environmental problems in the first three phases of the project are: 1. Imperfect anti-seepage system. 2. Failed to meet the requirements of coverage and rainwater diversion. 3. The leachate collection is incomplete, the treatment capacity is insufficient, and the wastewater cannot be discharged to the standard.

1) The Imperfect anti-seepage system may because of: Because the disposal site is located on the tidal flat on the east coast, its elevation is -5 to -22 meters, and there is a 17-meter-thick layer of gray clay aquifer. The groundwater is saltwater and has no exploitation value. Therefore, when the factory was built, its negative impact on the surrounding ecology was less considered.

2) Because there are leaks in the vertical impervious walls around the landfill reservoir area, the leachate in the reservoir area will seep through the leaks in the impervious walls to pollute the surrounding groundwater laterally; as the impervious structure layer was not laid on the bottom of the reservoir in the first three phases of the old port Therefore, the leachate will pollute the surrounding groundwater through the bottom of the reservoir.
Based on the characteristics of the landfill and the pollution sources monitored before the project, we mainly assume that the pollution source leaked by this leachate is COD, BOD, organic matter (NH_3-N, total phosphorus), heavy metals.

3.3 Potentially occurring types of pollution

1. Leachate leakage and non-compliant treatment;
2. Substandard collection and treatment of landfill gas
3. Groundwater pollution;
4. Surface water pollution;
5. Malodor pollution;
6. Poor landscape caused by scattered garbage;
7. Negative impact on the living environment of animals and plants;
8. Noise pollution during construction

4. Description of planned field research

4.1 Scope of tests: soil, groundwater, soil, air …

Impact on surface water:

Due to the inadequate rain and sewage diversion system and surface coverage, the leachate will flow into the surface water with precipitation to pollute the river water quality; the leachate treatment system malfunctions, causing tailwater discharge to exceed standards and polluting sewage water quality[8].

Impact of Leachate on groundwater:

Leakage joints appear in vertical impervious walls around the landfill reservoir area, and the leachate in the reservoir area will seep through the joints of the impervious wall to pollute the surrounding groundwater laterally; as the impervious structure layer was not laid on the bottom of the reservoir in the first three phases of the old port, Therefore, the leachate will pollute the surrounding groundwater through the bottom of the reservoir[8].

Impact of ambient air:

The landfill gas generated from the garbage in the reservoir area after the final field coverage is emitted through the cover layer. The landfill gas contains a small amount of odorous substances such as H_2S and organic pollutants[8].

Impact on soil:

Due to the washing with the leachate, soil could be polluted with the heavy metals (like batterie which don’t be segregated before landfill).

4.2 Methodology of initial and details tests

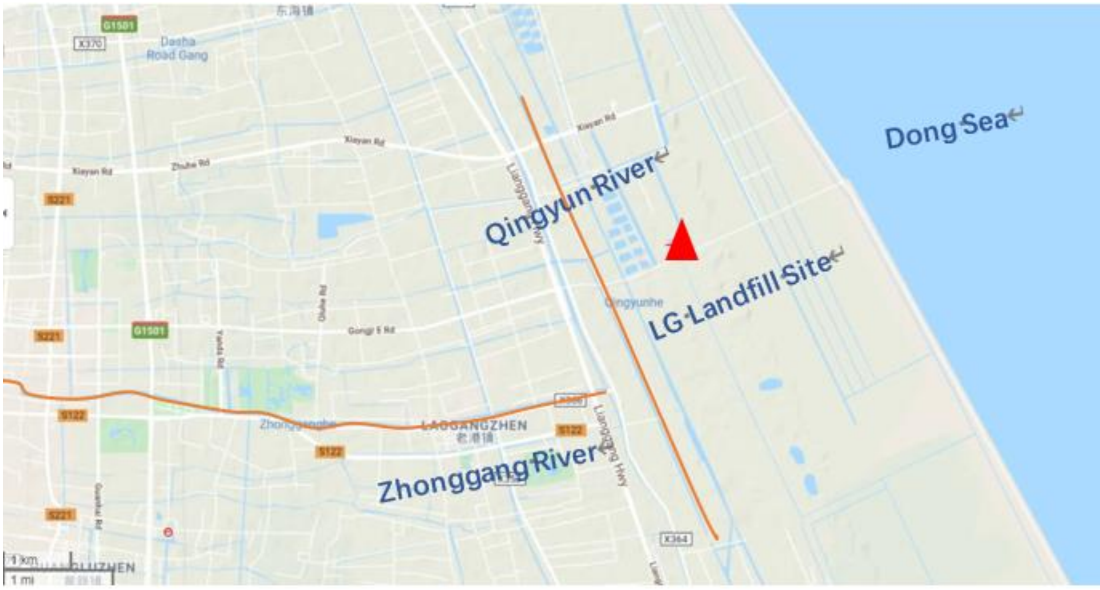

Figure 7 The main water system near the landfill site

Surface water:

Due to the width of the both two river, Qignyun River and Laogang River are below 50m, there will be only one sample point for each river. What's more, for both these two rivers, they are not deeper than 5m, so the sample point is in the top layer (below 0.5m to the surface water and 0.5m above the surface water)[10].

Groundwater:

In areas with low permeability of aquifers, they are spread as point sources of pollution, which can be controlled by laying cross-shaped monitoring lines near the sources of pollution[10].

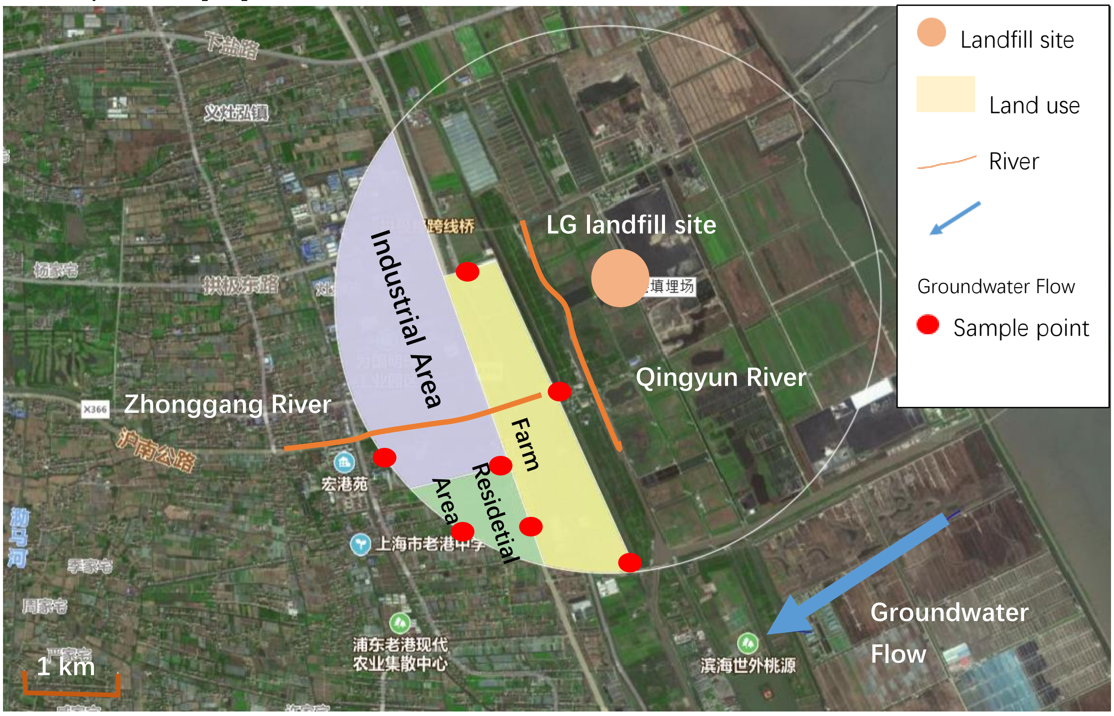

Figure 8 The sampling points of the project

Table 2 The key points of the water sampling for different components[11]:

COMPONENT	BOTTLE	WHAT TO DO	RESERVED TIME	SAMPLING VOLUME
PH	G/P		12h	250
COD	G	Add H_2SO_4, pH≤2	2d	500
BOD_5	Dissolved oxygen bottle		12h	250
TP	G/P	HCl, H_2SO_4, pH≤2	24h	250
NH_3-N	G/P	Add H_2SO_4, pH≤2	24h	250
TN	GP	Add H_2SO_4, pH≤2	7d	250
AS	G/P	HNO_3, add 10ml in the 1L water sample	14d	250
CD	G/P	HNO_3, add 10ml in the 1L water sample	14d	250
CR	G/P	NaOH, pH=8~9	14d	250
CU	P	HNO_3, add 10ml in the 1L water sample	14d	250
PB	G/P	HNO_3, add 10ml in the 1L water sample	14d	250
NI	G/P	HNO_3, add 10ml in the 1L water sample	14d	250
ZN	P	HNO_3, add 10ml in the 1L water sample	14d	250
HG	G/P	HNO_3, add 10ml in the 1L water sample	14d	250

Determination methods for soil:

Because in this report we mainly focus on the soil pollution, and how to sampling, and solve it, So combining the characteristics of this landfill and previous experience, we mainly discuss how to determination the pH, organic matter, and the content of 8 heavy metals in the soil.

Sampling preparation:

The layered sampling method is mainly used to cover the soil layer and the garbage layer. The sampling depth of the garbage layer is 20cm. A total of 4 samples are collected from the soil layer and 3 samples are collected from the garbage layer, which is shown in figure 9. Each sample was a multipoint mixed sample. The collected samples were taken back to the laboratory, and after being air-dried, they were passed through a 2mm sieve for the determination of H and EC. Passed through a 0.16mm sieve for soil organic matter / total N, total P and heavy metals As, Cd, Cr, Cu, Pb, Zn, Ni , Hg Determination[16].

The sampling points which taken outside the landfill site is shown in the figure 8, there are total 7 points and the depth is 20 cm as well.

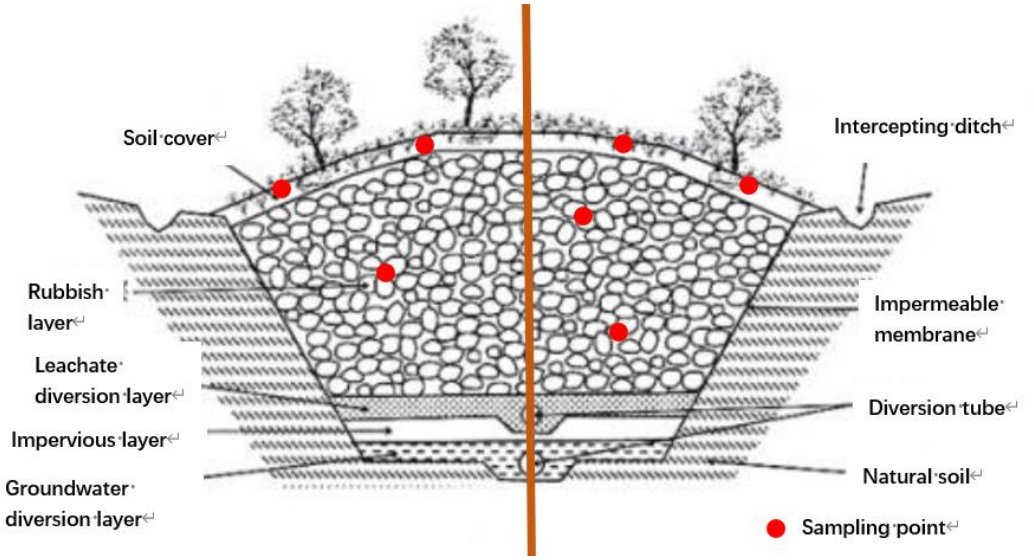

Figure 9 Sampling points of the landfill vertically

Sampling steps:

First remove the surface cover (such as gravel, vegetation) with a sampling shovel, and then dig the topsoil; or use the sampling shovel to directly extract the soil at a certain depth in the section of the soil layer that has been excavated with a machine. If the sample represents a sample in a certain depth range (such as 0 to 15 cm), soil samples obtained at each depth in the range should be mixed as uniformly as possible. After the sampling is completed, if the spoil excavated on the site is not polluting the sampling holes or sampling pits (for example, the spoil contaminated with pollutants cannot be backfilled to the unpolluted layer), the spoil excavated on site should be backfilled and compacted ， sampling personnel should repair or restore the workplace after construction.

Laboratory analysis:

The particle size analysis of the garbage layer uses the sieving method, the pH is measured by the glass electrode method, the EC is measured by the potentiometric method, the total nitrogen is measured by the semi-micro Kelvin method, and the total phosphorus is measured by the sodium hydroxide alkali melting-molybdenum rubidium ratio. Determination of organic matter using potassium dichromate-external heating method, heavy metals using hydrochloric acid-nitric acid-perchloric acid digestion-ICP method [16].

4.3 Estimated cost estimate

This project is the closure and ecological restoration of the first three phases of the Laogang landfill. In view of the main environmental problems in the first three phases of the project, the main contents of the project are:

1. Closing the site: including land cover and leachate. Treatment system reconstruction and new construction, odor treatment, rainwater and sewage diversion, road reconstruction；

2. Ecological restoration: protection forest construction, planting grass and trees in the final field.

In case to estimate the cost of this project, we divided it to two parts: one is the cost of determination of pollution sources, another part is the cost of closing the site and ecological restoration.

<u>The cost of determination of pollution sources</u>

8 points are expected to be used as test points inside the landfill. The test content are: pH, organic matter (total nitrogen, total phosphorus), heavy metals (As, Cd, Cr, Pb, Cu, Ni, Zn). And 7 points were selected in the resident's area, which near to the landfill. If the individual pollution index of each pollutant at each monitoring point is less than 1, and the soil environmental quality in the evaluation area is generally clean.

The testing budget for the 15 points in the soil testing project is as follows:

Table 3 The estimate cost of the substance to be detected in the soil

pH	Total N	Total P	Heavy mental							
			As	Cd	Cr	Pb	Cu	Ni	Zn	Hg

TEAM 4:

Based on Polish Regulations of the Minister of the Environment on the conditions and method of determining control costs and estimating the volume of emissions from installations or aviation operations

The cost of analyzes and measurements, including sample preparation, is set as the ratio of: unit rate, representing 2% of the average monthly salary of a specialist, and factor corresponding to the activities related to the analysis

The average monthly salar estimation:	4863,74 zł
2% of the average monthly salar estimation:	97,27 zł

Soil survey plan:

Measurments of 8 heavy metals concentration
Determination of pH
Measurments of nitrogen concentration
Measurments of phosphorus concentration

Cost assesment:

Biological and physicochemical analyzes:

performed action	*factor value*	*indirect cost*
Single metal determination - spectrometric (times 8)	0,5	389,10 zł
Acid-alkalinity determination	0,3	29,18 zł
Determination of total nitrogen	2,5	243,19 zł
Determination of total phosphorus	1,5	145,91 zł
Calculation of results and preparation of a report on performed analyzes	4	389,10 zł

Sampling:

performed action	*factor value*	*indirect cost*
Taking a soil sample from the surface layer (soil sampling)	1	97,27 zł
Taking a soil sample from a selected subsurface layer	2	194,55 zł
Transport of samples and equipment (for each 20 km started)	0,5	48,64 zł

Summary:

Number of samples:		
top soil	4	
subsurface	10	
Transport distance:	1 · 20 km	
Total cost:		**19,134 zł**

The cost of closing the site and ecological restoration

After the test results are obtained, the three phases of the "laogang" landfill will be closed and start the environmental repair, see the table below for the estimate cost of this project:

Table 4 The cost of closing the site and ecological restoration [18]

ENGINEERING CONTENT	PROJECT	PROJECT QUANTITIES	BUDGET UNIT PRICE	TOTAL ENGINEERING BUDGET
FINAL COVERAGE	Natural soil	1,080,000 m^3	1.5 zl / m^3	1,620,000 zl
	Nutrient soil	70,000 m^3	3.5 zl / m^3	245,000 zl
	Compacted clay	560,000 m^3	10 zl / m^3	5,600,000 zl
	gravel	60,000 m^3	2.2 zl / m^3	132,000 zl
	de 160 horizontal air ducts	62.3 km	15 zl / km	934,500 zl
LEACHATE TREATMENT	Mineralized waste treatment bed + reverse osmosis	2400 m^3/d	45 zl / m^3/d	108,000 zl
ODOR TREATMENT	Covering the area of the sewage treatment system in the landfill area I transformed into a conditioning tank	27,000 m^2	60 zl / m^2	162,000 zl
RAINWATER AND SEWAGE DIVERSION	Rainwater gully repair length	2790 m	20 zl / m	55,800 zl
	Length of new rain gully	2120 m	35 zl / m	74,200 zl
ON-SITE ENVIRONMENT IMPROVEMENT	Road repair length	4200 m	15 zl / m	63,000 zl
	Road clearance area	228,000 m^2	12 zl / m^2	2,736,000 zl
ECOLOGICAL RESTORATION	Greenbelt area	266,000 m^2	3 zl / m^2	798,000 zl
	Planting area	2,331,000 m^2	15 zl / m^2	34,965,000 zl
TOTAL				**48,951,500 zl**

Total cost:

19,134 + 48,951,500 = 48,970,634 zl

Therefore, combining the cost of analysis ＆ measurement of pollution sources and the cost of closing the site and carrying out ecological restoration, it is estimated that a total investment of 49 million will be required for this project.

4.4 Expected duration, test schedule

The project closed the 44 landfill units in the first three phases, added a 2400m^3/d leachate treatment system, rebuilt and capped the adjustment pond, added a total area of 266,000m^2 of green forest belts, repaired or added rainwater drainage systems and leachate. Collection system. The total area covered is 2597000m^2, and the total investment of the project is around 48,000,000 zl.

The project is expected to be one and a half years, the first three months will be used for soil testing and analysis, the next nine months will be used for treatment, and the second half will be used to complete the closure and ecological restoration.

5. Assessment of soil purity / pollution[17]

The portion of the soil layer of the Laogang landfill site with a soil particle size of less than 2mm accounts for a large proportion, reaching more than 50% which is shown in the figure 9. This shows that the soil in the Laogang landfill is well developed, and some of the waste has been decomposed. The reason may be that the old landfill has a long landfill period, and the cover vegetation is already lush.

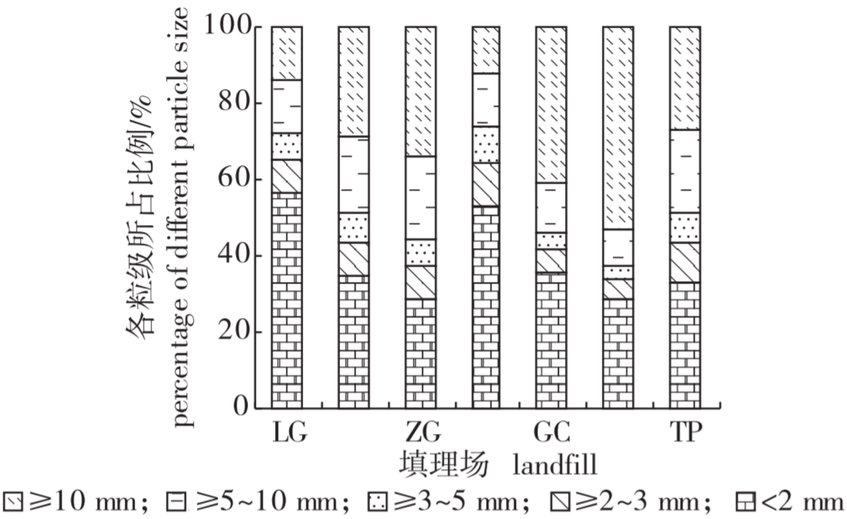

Figure 10 Distribution of soilparticle size of different rubbish landfills

The pH of the soil directly affects the existence, transformation and availability of soil nutrients. The results of this measurement show that the soil pH of the Laogang landfill is less changed, and the soil pH at different depths is also smaller, ranging from 7.43 to 8.42, which is similar to the pH of other soils in Shanghai. The soil is generally alkaline.

The content of soil organic matter, N, P and other nutrients directly affects the plant's nutrient supply. Organic matter in natural soil mainly comes from animal and plant residues and root exudates, while the nutrient content in the soil of the landfill is different. The vertical distribution of organic matter in the soil of Laogang Landfill Site is shown in the figure. The vertical distribution of organic matter in the soil of the landfill is different from that of ordinary soil. The content of organic matter shows a trend of higher content in the lower layer than in the upper layer. The analysis may be due to the special characteristics of the landfill. The lower layer of the landfill is a garbage layer, which contains some other substances with high organic content. Domestic waste in Shanghai is generally composed of food waste + fruits, etc. After years of anaerobic fermentation, these substances can turn some easily degradable substances into a granular substance similar to humus.

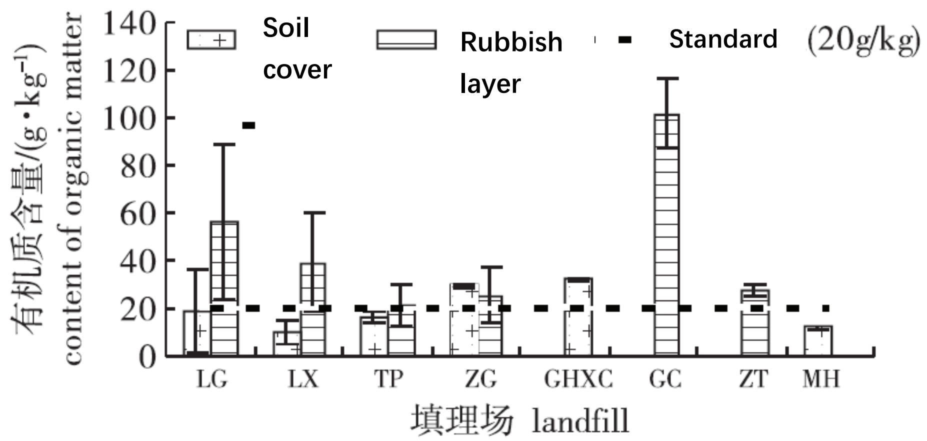

Figure 11 Vertical distribution of soil organic matter of different rubbish landfills

In addition, some differences in the organic matter content of the garbage layers in different landfills may also be related to the type of waste they landfill.

The vertical distribution of total N in soil from different landfills is similar to the change trend of organic matter, that is, the total N content in the waste layer is higher than the total N content in the cover layer, and the total N content in the cover layer is lower than that in China N / standard general level (1g / kg).

Although the vertical distribution of total P in different landfills is different from that of organic matter and total N (Figure), the total P content of the soil is higher in the old landfill, regardless of whether it is covered with soil or landfills. In terms of burial sites, soil P deficiency is less likely.

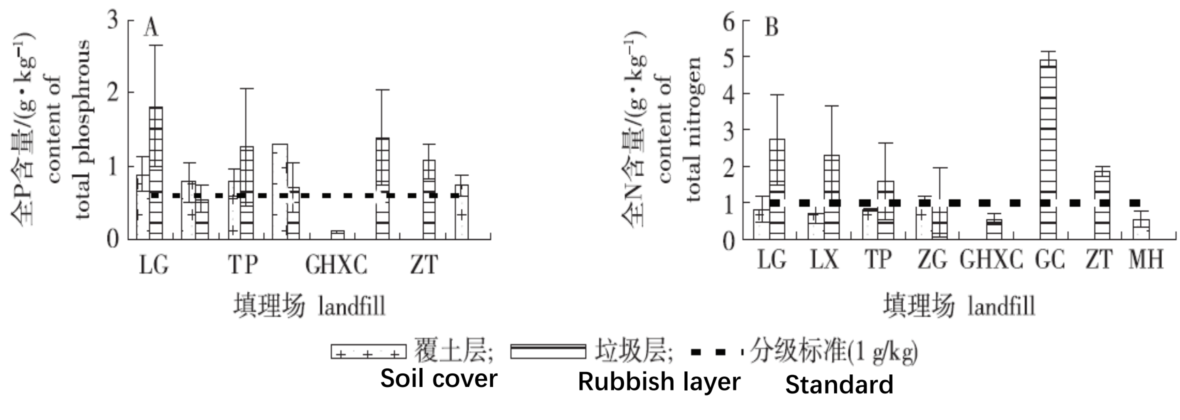

Figure 12 Vertical distribution of the soil total nitrogen and total phosphorus of different rubbish

Table 5 The contents of heavy metal in soil for different municipal rubbish landfills

mg/kg

地点 sites	土壤层次 soil layer	As	Cd	Cr	Cu	Pb	Ni	Zn	Hg
LG	覆土层	356. 7 ± 180. 8	4. 57 ± 2. 53	69. 9 ± 42. 7	68. 1 ± 120. 8	94. 5 ± 220. 9	34. 1 ± 14. 3	1 437. 8 ± 1556. 9	0. 0425 ± 1. 0536
	垃圾层	438. 6 ± 172. 4	3. 13 ± 1. 36	85. 3 ± 32. 8	167. 9 ± 180. 0	140. 2 ± 139. 4	43. 2 ± 13. 6	2 033. 4 ± 837. 5	0. 440 ± 0. 442
LX	覆土层	409. 1 ± 89. 9	1. 80 ± 0. 40	73. 8 ± 2. 83	27. 2 ± 1. 40	18. 4 ± 6. 74	39. 4 ± 1. 26	1 414. 6 ± 497. 4	0. 036 9 ± 0. 025 6
	垃圾层	358. 2 ± 51. 2	2. 04 ± 0. 48	71. 1 ± 7. 42	68. 8 ± 43. 8	57. 0 ± 40. 8	36. 2 ± 5. 98	1 711. 4 ± 433. 3	0. 160 ± 0. 141
TP	覆土层	381. 4 ± 21. 3	1. 99 ± 0. 09	73. 5 ± 25. 6	72. 1 ± 16. 8	35. 8 ± 6. 47	37. 2 ± 2. 93	1 340. 9 ± 355. 8	0. 145 ± 0. 128
	垃圾层	371. 5 ± 32. 1	1. 84 ± 0. 14	71. 9 ± 18. 1	45. 3 ± 13. 9	48. 3 ± 6. 97	33. 5 ± 0. 03	1367. 8 ± 250. 8	0. 096 6 ± 0. 075 3
ZG	覆土层	517. 8 ± 135. 2	3. 84 ± 1. 82	80. 7 ± 5. 81	228. 6 ± 198. 3	169. 4 ± 100. 7	44. 3 ± 1. 53	2393. 8 ± 994. 0	0. 218 ± 0. 069
	垃圾层	214. 0 ± 22. 4	6. 88 ± 2. 04	70. 6 ± 0. 98	66. 9 ± 34. 2	124. 3 ± 98. 8	37. 3 ± 3. 29	436. 3 ± 402. 7	0. 0314 ± 0. 0004
GHXC	垃圾层	371. 7 ± 33. 6	5. 60 ± 1. 21	267. 5 ± 17. 6	84. 6 ± 10. 5	痕迹	88. 5 ± 4. 95	1236. 4 ± 9. 48	0. 461 ± 0. 162
GC	垃圾层	420. 8 ± 12. 8	8. 00 ± 6. 89	338. 1 ± 254. 2	138. 5 ± 22. 4	191. 5 ± 160. 3	54. 0 ± 17. 6	2233. 9 ± 396. 0	0. 467 ± 0. 588
ZT	垃圾层	419. 1 ± 5. 9	1. 75 ± 0. 16	52. 6 ± 1. 31	33. 1 ± 0. 09	33. 1 ± 1. 59	31. 2 ± 0. 13	1553. 6 ± 224. 8	0. 0663 ± 0. 0152
MH	覆土层	416. 3 ± 45. 7	1. 77 ± 0. 13	69. 9 ± 1. 91	24. 3 ± 0. 10	23. 2 ± 2. 60	41. 2 ± 7. 25	1487. 9 ± 220. 1	0. 0465 ± 0. 0267
国家Ⅲ级标准		< 40	< 1. 0	< 300	< 400	< 500	< 200	< 500	< 1. 5

landfills

It can be found from the table that the contents of heavy metals in different landfills are different, but compared with the national soil environmental quality three-level standard (the third-level standard is the soil critical value to ensure agricultural and forestry production and normal plant growth), all show As, Cd and Zn severely exceed the standard. The AS content is 5.35-12.95 times the national soil environmental quality standard, and the Cd content is 1.75-8 times. As far as Zn is concerned, in addition to the waste layer of the Zhenguang landfill In addition, the rest are 2.76 to 4.79 times the national soil environmental quality level standard.The content of heavy metals Zn and As in the landfill is 250% and 300% higher than the local natural soil background value. Cd is a domestic waste can be dumped One of the important pollutants in rot, the analysis of the cause may be related to the source of garbage, and plastics and newspapers contain a large amount of Cd. In addition, a large amount of electronic waste such as batteries entering the dump is also one of the reasons for the high content of heavy metals, such as zinc-carbon batteries containing Zn, Cd, etc., alkaline batteries contain As, etc. High, may also be related to the inclusion of pigments, glass, pesticides, preservatives, pigments and food additives in garbage. However, in terms of different levels, due to the different sources and time of landfills in different landfills, the distribution of heavy metals at each level is also significantly different. Except As, other heavy metals in Laogang landfill have a tendency that the garbage layer is larger than the overburden layer.

What's more, with the determination of the other sampling point outside of the landfill site, the concentration of these pollutants is not exceeded. It means that the Laogang landfill site has not so much leakage to polluted the soil.

6. Summery – conclusions

The first three phases of the landfill are a quasi-hygienic landfill, which uses shallow landfill technology. After years of operation, it has not been suitable for the current situation of the old port landfill. In order to reduce the impact of the first three phases of the project on the surrounding area and reduce further pollution of the leachate, we performed a pollution source detection and integrated its actual conditions to close the site.

In the process of closure, the main consideration is to solve the remaining environmental problems and ecological restoration, and strengthen the pollution control and environmental management after the closure.

The project closed the 44 landfill units in the first three phases, the total area covered is 2597000 m^2, and the total investment of the project is 49 million zl.

This project is a comprehensive environmental improvement project. It is expected that all closures and ecological restoration will be completed within one and a half years.

7. Reference:

7.1 Table List

7.2 Figure list

7.3 Literature

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