

CONTAMINATED EARTH REMEDIATION COSTS BY STOCKPILING

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Stockpiling is widely usable for remediation, by war disaster, contaminated earth (Fig 2). Many international organizations, in environmental area, as FOCUS- Humanitarian Relief Operation, recommended it for application, and Swiss Disaster Relief Unit (SDR) financed Program Contaminated earth removing and stockpiling, in case primary remediation problem by war disaster in Yugoslavia.

This method is usable for prevention contamination spreading and inactivation (for instance Hg) (Type A), for prevention of contamination and temporary stocking (PCB and even radioactive material), and for permanent earth remediation from pollutant with decomposition time is shorter than isolation PVC foil live time (Oil) (Type B).

In paper are presented fundamentals of supplemented tender, which MEGA-Project prepared for FOCUS, on concrete : job description, accounts specific points and work description, for both type of using. Also itemized shares and total prices were calculated, on the bases of available works prices in FRY.

SPECIFIC POINTS

- a) All given prices must include all expenses and all local, federal and other taxes.
- b) Unit prices will be applied regardless of the actual quantities.
- c) Invoicing can be made by the contractors only on the basis of the actual amount of work being done and quantity surveying by project management.
- d) Contractor has to conclude every insurance requested by this kind of work.
- e) Cost of protection equipment hiring which is necessary for work with Hg is not included..
- f) Immobilization chemicals cost are not included
- g) Contractor is obligated to submit for waterproofing sheet: Brand and Type of PVC material, technical characteristics, end delivery time

DESCRIPTION OF THE JOB

Principle: see attached schematic drawing (Fig. 1).

- a) Preparation of a receiving stocking area by digging out the necessary surface.
Hole (Pos.1. Fig 1):Depth: 1 m (A,B₁,B₂), Width : 20 m (A,B₁), 7m (B₂); Length:
According to work description; inside slope : h/l= 2/3(A,B₁);1/1(B₂)
Bottom (Pos.5.Fig1): Protection and waterproofness with a synthetic foil, thickness 2.5 mm, assembly of foils by thermal binding.

Dike around stocking area (Pos.3.Fig1): truncated pyramid : Upper side slope = 10% (A,B₁,B₂); Height in middle 0,5 m(A,B₁),1 m (A₂); Base : Width 2,5 m (A,B₁,B₂); Length: According to work description; Slope : h/l= 2/3(A,B₁); 1/1(B₂).

- b) Digging out of the contaminated area and transferring of the excavated material to the stocking area.
Depth :up to 0.5 meter according to the location; Quantities: According to work description.
Pile: Height from the bottom= 2,5 m (A,B₁,B₂), Upper side slope = 10% (A,B₁,B₂).
- c) Covering of the excavated materiel for waterproofing by a synthetic foil and a layer of earth.
- d) Restoring of the excavated place in condition before contamination.

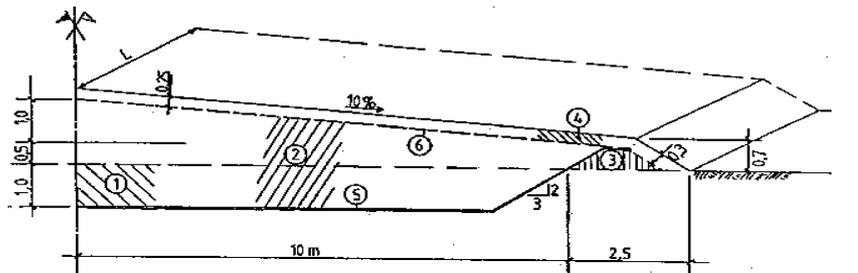


Fig. 1: Schematic drawing of stockpiling (A,B₁ measure)

WORK DESCRIPTION

- 1) Building site preparation including:
 - a) access roads, working places, barriers, signalization and necessary protections
 - b) barracks, toilets
 - c) transport and installation of all the necessary equipment
 - d) electricity and water connections (including electricity and water consumption bills)
 - e) evacuation of the wastes
 - f) disassembling and removing of all the equipment et the end of the work
- 2) Collecting spilled oil
Pumping remaining oil in damaged tank and bomb crater and transportation of the oil in a nearby tank up to a distance of 500 meters.
- 3) Excavation work for stocking area
Excavation work in all kinds of soil (humus, gravel clay ...) for receiving

- stocking area, depth up to 2 meters, loading on trucks, transportation up to 200 meters, unloading on the receiving area, included embankments with a $h/l = 2/3(A, B_1); 1/1(B_2)$ slope. (see position 1 of the fig. 1),
- 4) Additional work on stocking area
Providing and installing PVC drainage pipes on the bottom of the stocking pit
 - 5) Dike around the stocking area
Execution with excavated material of position N^o3 of a dyke all around the receiving area, height 0.5 meter(A, B₁), 1m(B₂), slope $2/3(A, B_1); 1/1(B_2)$, packed all 0.3 meter.(see position 3 of fig.1)
 - 6) Sand layer at the bottom
Providing and putting into place, at the bottom of the pit, of a sand layer (thickness 3-5 cm), ready for receiving the plastic sheet for waterproofing
 - 7) Waterproofing protection (bottom) Providing and careful installation according to the producer specifications of a synthetic waterproofing sheet (Type PVC, thickness 2.5 mm, rolls of 2 meters width, withstanding to hydrocarbons and UV rays), on the bottom and the embankments of the pit plus the border dyke.
Assembling by thermal binding and all necessary protection are included.
 - 8) Excavation work of polluted area Excavation work with machines of the contaminated ground, depth up to 0.5 meter(A, B₁); 1 meter(B₂), loading on trucks, transportation up to 500 meters and stockpiling in layers into the pit with machine or vehicle equipped with caterpillars, including manual work for removing all stones larger than 80 mm and (only A) manual spreading of elemental sulfur for fixing mercury.
 - 9) Overcost for longer transportation
Overcost on article N^o 8 for transportation distances up to 2 km
 - 10) Overcost for concrete blocks
Overcost on article 8 for concrete blocks
 - 11) Aeration of contaminated material (case B, oil)
Providing and setting up horizontal aeration pipes (drainage type), PVC, diameter 120 mm, length 20 m, in 2(B₁); 1(B₂) layers.
 - 12) Waterproofing protection (top)
Providing and careful installation according to the producer specifications of a synthetic waterproofing sheet (Type PVC, thickness 1.5 mm, rolls of 2 meters width, withstanding to hydrocarbons and UV rays), on the top and the embankments of the border dyke. Assembling by thermal binding and all - necessary protection are included. (see position 6 of the attached drawing)
 - 13) Protective cover layer
Manual execution of an earth protective covering layer above the synthetic sheet of article 8, thickness 20 to 30 cm, with excavated earth from art. 3, including transportation and all necessary protections. (see position 4 of the attached drawing)
 - 14) Unpolluted soil transport
Excavation and loading on truck (difference between article 3,5,8), transportation from distance max 200 m (A, B₁); 5 km(B₂), uncontaminated loose soil (without stones) for the dumps covering and refill the excavated area.

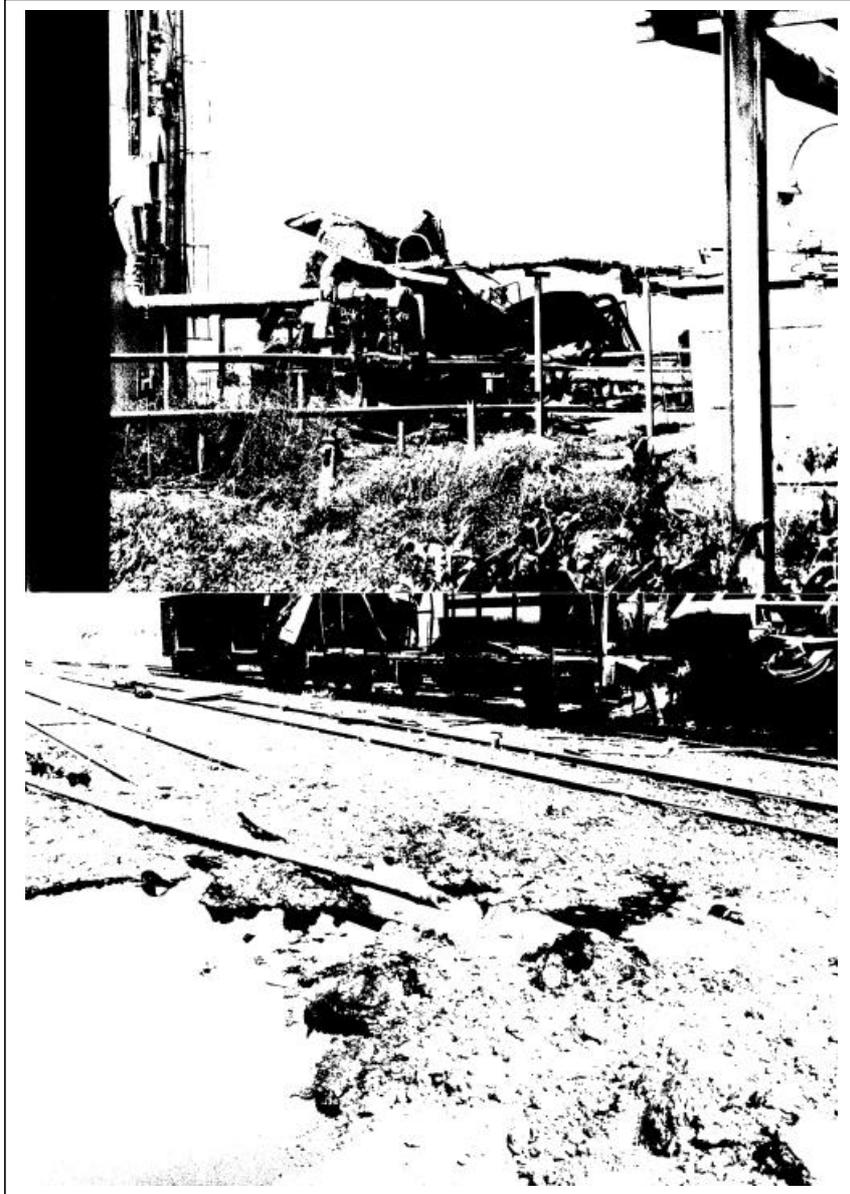


Fig.2. War damage and oil pollution in HIP Azotara Panëevo

- 15) Additional work for concrete for returning condition before contamination
Providing concrete and iron net with in building on the place.
- 16) Removal of destroyed rails (4x30m) and equipment
Disassembling and evacuation of the destroyed equipments in the area of excavation. Total weight of steel 55 tons, and ballast removal 60 m³.
- 17) And 18) Reconstruction of 2 rail tracks basement and area between

RECAPITULATION

Table 1: Work price shares and total prices of works

Location/ Type of use	A	B ₁	B ₂
Work description	% in price	% in price	% in price
1) Building site preparation .	6,28	8,13	11,40
2) Collecting spilled oil (B type)	0,00	7,48	0,00
3) Excavation work for stocking area	4,84	4,37	1,67
4) Additional work on stocking area	3,35	0,00	0,00
5) Dike around the stocking area	0,22	0,19	1,85
6) Sand layer at the bottom	1,78	1,71	0,85
7) Waterproofing protection (bottom)	13,85	11,98	19,26
8) Excavation work of polluted area	27,93	24,15	14,92
9) Overcost for longer transportation	2,65	2,30	0,00
10) Overcost for concrete blocks	4,90	3,05	0,00
11) Aeration of contaminated material	0,00	1,57	0,63
12) Waterproofing protection (top)	13,42	11,73	14,81
13) Protective cover layer	4,43	3,90	4,70
14) Unpolluted soil transport	5,88	13,41	3,67
15) Additional work for concrete	10,46	6,04	0,00
16) Removal of destroyed rails, equipment, and ballast	0,00	0,00	20,17
17) Reconstruction of 2 rail tracks basement (2x30m)	0,00	0,00	4,05
18) Reconstruction of the area between the rail tracks (30m)	0,00	0,00	2,02
Total price; DEM	459032	132466	88738

Art. 2: B₁ for 515 m³; Art. 5: A for 125 m³, B₁ for 30 m³, B₂ for 160 m³; Art. 8: A for 3950 m³, B₁ for 990 m³, B₂ for 580 m³; Art. 10 i 15: A for 300 m³, B₁ for 50 m³ concrete; Art 11: B₁=120m, B₂=70m; Art. 13: A for 630 m³, B₁ for 160 m³, B₂ for 125 m³, soil; Art. 14: A for 2250 m³, B₁ for 550 m³, B₂ for 120 m³, soil), and with 16,4 DEM/m² thermal welded PVC sheet(A= 4640 m², B₁=1170 m², B₂=1150m²).

So contaminated earth (Fig.2) remediation costs by stockpiling are:

For price PVC sheet	DEM/m²	16,4	26
A	DEM/ excavated poll. m³	116	127
B₁	DEM/ excavated poll. m³	134	145
B₂	DEM/ excavated poll. m³	153	172

CONCLUSION

1) Contaminated earth remediation costs by stockpiling, for m³ excavated contaminated ground, are around 116-153 DEM , with 16,4 DEM/m² welded PVC sheet, and are very sensitive on price of sheet.

2) Empty place restoring cost, without rebuilding new objects, are 16,3-29,9 % of total price, in until now treated cases.

3) Exposed calculation technique, for this prices, aloud quite good remediation cost estimation for other situations, as well as comparison with other remediation method prices.