

SIMULATION OF OIL CONTAMINATION MIGRATION IN AREA OF SEWAGE WATER TREATMENT PLANT OF VENTSPILS SEAPORT

Aivars Spalvins¹⁾, Janis Slangens¹⁾, Romans Janbickis¹⁾, Inta Lace¹⁾,
Olgerts Aleksans²⁾ and Peteris Snitko²⁾

¹⁾ Riga Technical University
1 Meza Street, Riga, LV-1058
Latvia
E-mail: emc@egle.cs.rtu.lv

²⁾ VentEko Ltd.
49 Matisa Street, Riga, LV-1009
Latvia
E-mail: arta.ba@parks.lv

KEYWORDS

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ABSTRACT

This paper discusses modelling of seaward migrating oil contamination in the shallow water aquifer adjacent to the Ventspils sewage water treatment plant (SWTP) where underground pipeline ruptures have resulted in extensive groundwater contamination.

INTRODUCTION

Ventspils is a major seaport of Latvia. Large volumes of crude oil and oil products by a pipeline are transshipped from Russia through Ventspils. In the past, accidental oil spills have resulted in extensive soil and groundwater contamination (Spalvins et al. 1998).

The groundwater simulations have focused on the following two issues:

- the groundwater flow within the SWTP area has been heavily contaminated by the migrating oil plume; the treatment process of sewage waste water has been seriously endangered, because oil has

penetrated into the pump station from where clean water is carried through pipes directly to the Baltic sea;

- the oil contaminated groundwater flow may pass the SWTP area and impact the Baltic Sea.

MODELLING TASKS

The following tasks were undertaken in order to evaluate the current SWTP situation (Spalvins et al. 1998):

- a hydrogeological model (HM) of the SWTP area was created;
- volumes of free and residual oil were evaluated;
- a protective hydraulic barrier was proposed and simulated in order to prevent oil intrusions into the SWTP area in the event of major oil pipeline leakages (see Figure 1 and Figure 2).

This proposed barrier would also hasten natural oil degradation processes in the soil due to the following factors:

- by applying the barrier, the velocity of the groundwater flow will double and free oil will migrate away from the SWTP area more rapidly;

- oil biodegradation processes may be considerably accelerated if the barrier is supplied with oxygen and nutrient enriched water, taken from appropriate reservoirs of the SWTP.

Simulations indicate that migrating oil would not reach the Baltic Sea because the contaminants are being collected by a local sewage system of SWTP.

USED SOFTWARE

The following special groundwater modelling software tools were applied:

- the GDI program (Spalvins and Slangens 1995) for building the SWTP HM;
- the REMO program (Janbickis and Lace 1996) for running the SWTP HM;
- the VOF program (Spalvins and Lace 1997) for evaluating free and residual oil volumes;
- the ARMOS code (ARMOS 1996) for simulating free oil migration processes in the area of the protecting barrier. This program cannot be applied for investigation the oil contamination - transportation along the various pipelines of SWTP because it cannot account for heterogeneities of the soil there.

PROJECT IMPLEMENTATION

On the basis technical considerations it was decided to substitute infiltration ditches (drains) with a line of boreholes. The length of the infiltration borehole line was shortened in order to better control the migration of the central part of the contamination. A total of 7 infiltration boreholes were drilled and connected.

In the next stage of the project additional information will be obtained regarding the hydraulic conductivity of the saturated zone for input into the hydrogeological model. Refinement of the model will facilitate optimization of the performance of the

remediation system and increase the rate of remediation.

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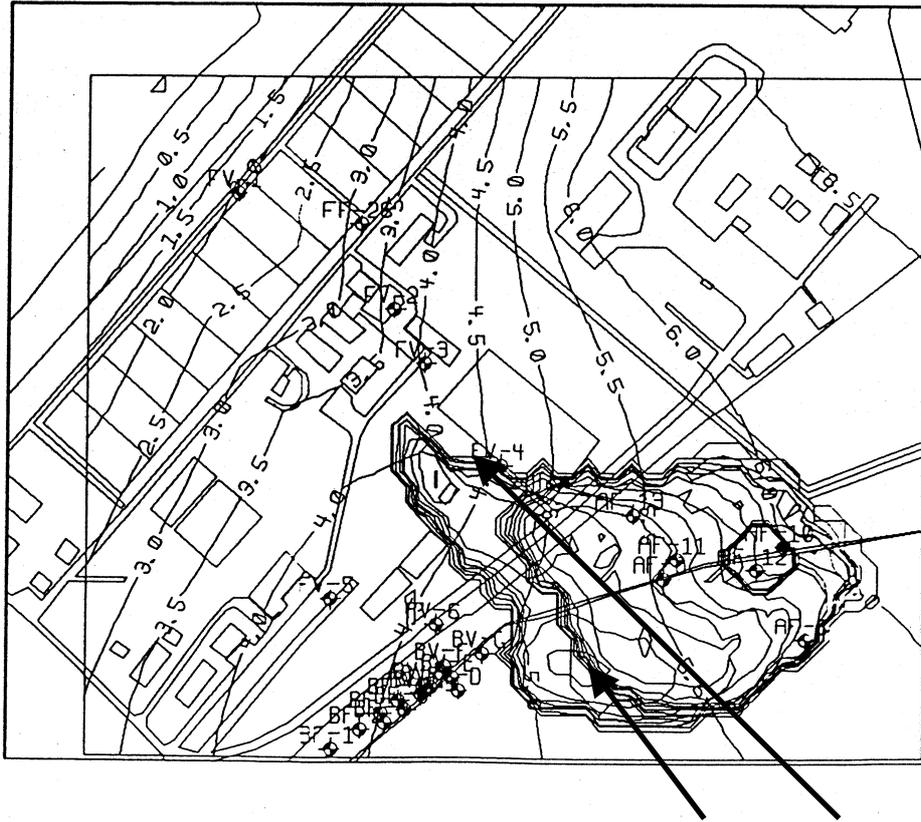


Figure 1. The oil thickness distribution in area of SWTP after 2500 and 5000 days if the oil spill of volume about 2000 m³ has happened (no protective barrier exists)

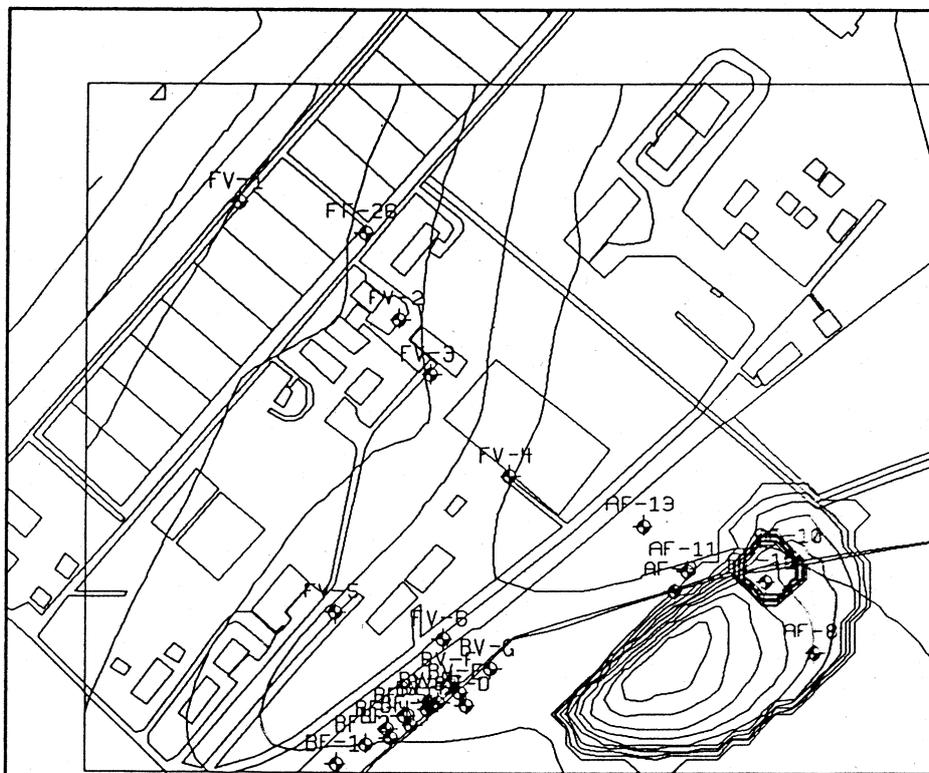


Figure 2. The oil thickness distribution in area of SWTP after 2500 days if the oil spill of volume about 2000 m³ has happened and the protective barrier is applied