First Large-Scale Application of GCL in Highway Foundation

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"ABSTRACT: Groundwater is a valuable resource that we have to protect from all sorts of pollution. In connection to transportation (roads, railways and airports) there is always a risk that contaminants will be released and transported down to the groundwater table. The way to stop that is to use engineered barriers, "impermeable" materials in the ground. Such materials can be natural soils, synthetic materials or a combination of both. This paper describes the first large-scale application of a geosynthetic clay liner constituting a primary containment system for highway runoff water.

1 INTRODUCTION AND BACKGROUND

For the first time in Sweden a bentonite mat has been installed under a road embankment in order to protect a groundwater resource.
It is the Mjölby municipality who on the intercity Highway 32 between Mjölby-Motala performed an installation of a GCL extending over a 2 km of highway length, see Fig. 1.

2. GEOLOGY AND GROUNDWATER

The Scandinavian precambrium bedrock was overburden by an ice-sheet of several thousand meters thickness during the latest iceage, about 10,000 years ago. In connection with the retraction (melting) the formation of glaciofluvial deposits occured e.g. the "Mjölby-Terrace" and the famous eskers. Consequently, the

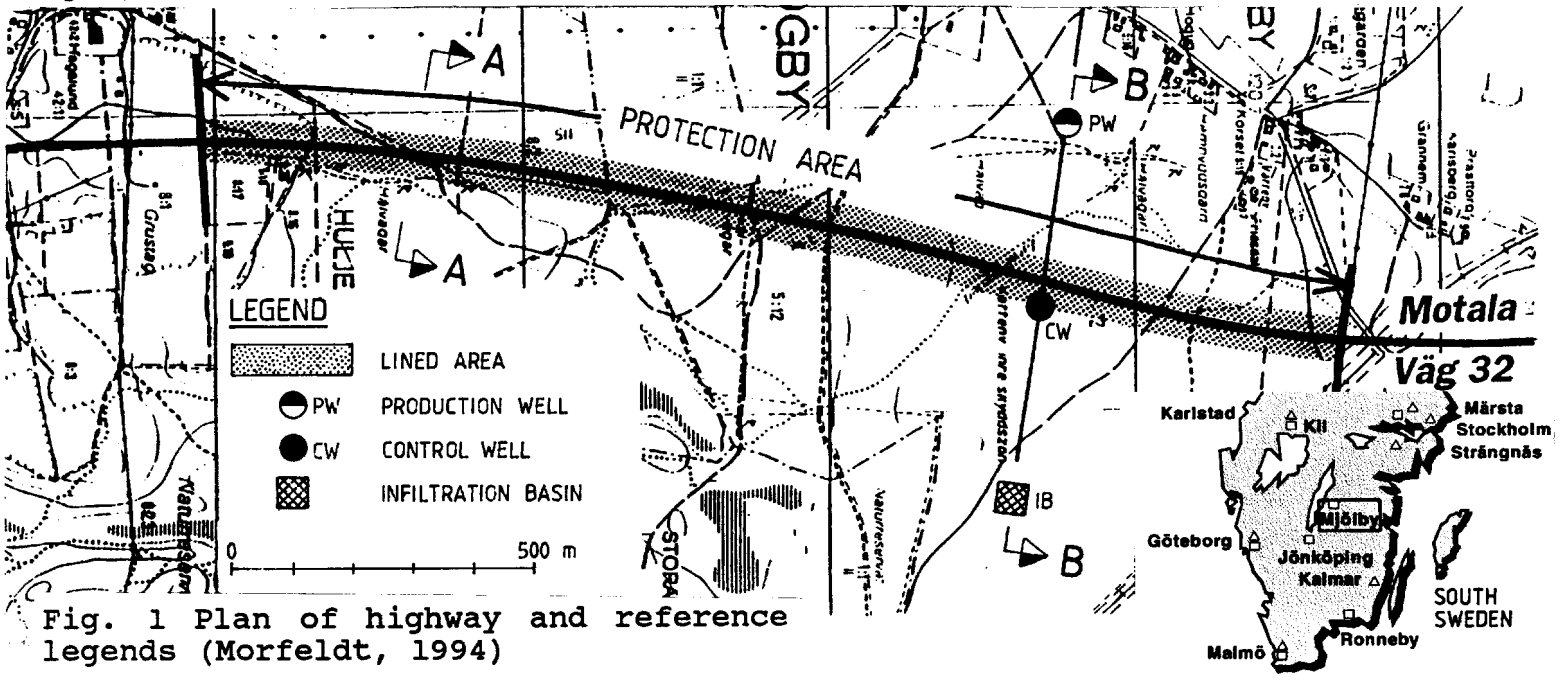

Fig. 1 Plan of highway and reference legends (Morfeldt, 1994)

soil consist of glaciofluvial materials, comprising sand and sand-morain strata of about 30 meters thickness. More in detail, the complexity of this formation or estuary glacial deposit is pertinent deformations by ice thrust at the margin of above mentioned ice-sheet. Geotechnically, this formation represent a dense deposit and due to this fact issues such as bearing capacity, stability and subsidence were not necessary to analyse. Further more the formation is a good example of water-bearing superficial deposits in Sweden. More than 50% of the total water consumption in Sweden is made up of groundwater and of this about half has been provided by artificial replenishment, see Fig. 2.

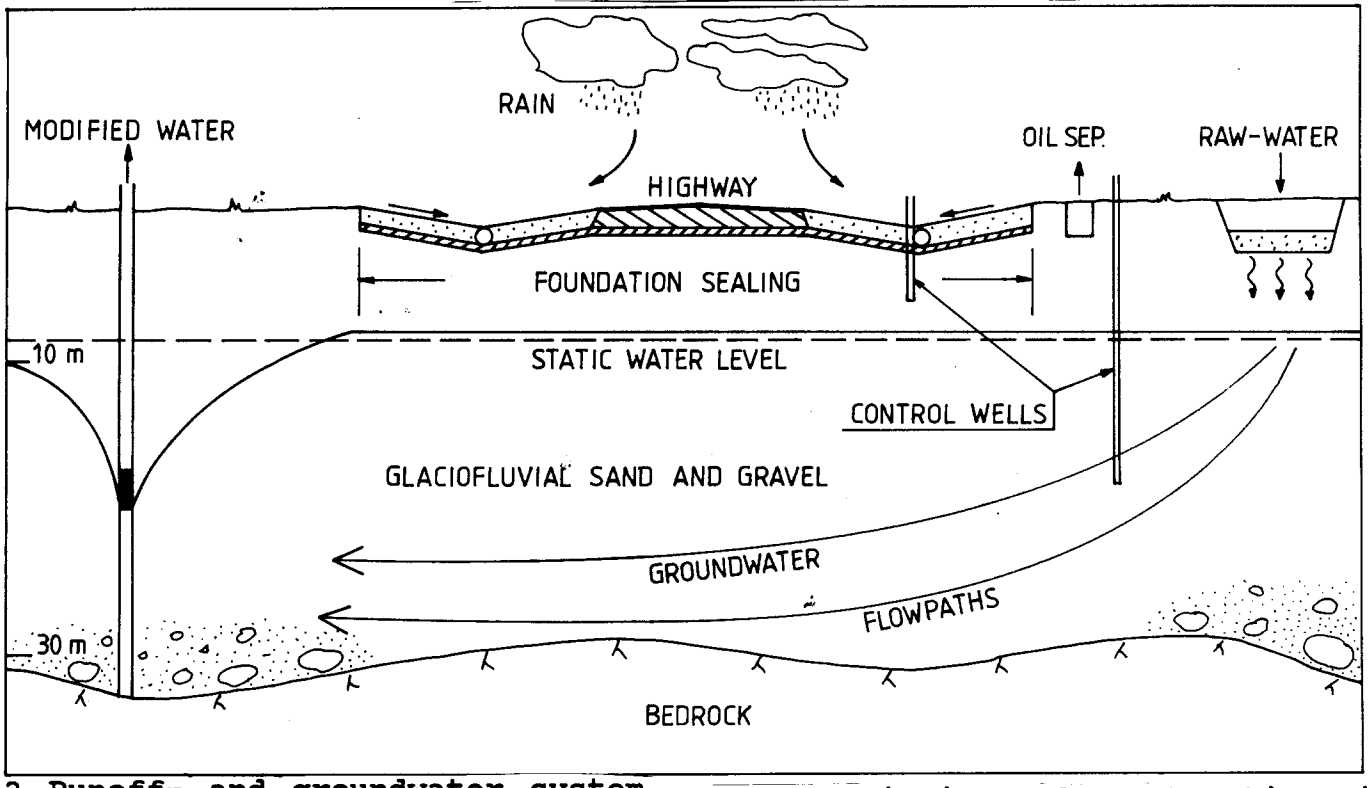

Fig. 2 Runoff- and groundwater system around a highway (C. Morfeldt, 1994) *Correspond to sect. B - B in Fig. 1.

Also, Mjölby is today successfully using their "Terrace-formation" with its valuable hydrogeological features such as water balance, water storage and water chemistry to "host" their infiltration plant. Fig. 2 explains how it intercept under the highway. The raw-water source is the river Svartån, from there an amount of 2 M m annual is pumped to the infiltration basins, located 350 m east of Highway 32. From the basins the water is percolating down through a gravel and sand layer about 10 m thick, before mixing with existing groundwater and constitute a modified raw-water along a flowpath towards the well side. About 250 m west of the highway, a modified water of good quality from a physical-chemical and bacteriological point of view, is piped to the consumers whom together represent a yearly water consumption of 1.7 M m^3.

3. SOCIETY AND LEGISLATION

Considering the importance of groundwater in Sweden, it is obvious that such a society over the years has developed extensive regulations, stipulated with the aim of protecting surface- and groundwater resources but simultaneously make it possible for an development of the infrastructure. Of course the Road Authority and Mjölby municipality had to comply with all regulations/laws etc., when designing and constructing Highway 32 in such an location as in this paper described. Refering to the legal concept "first in time, first in right" and recognizing that the approval of the highway project was obtained before the by law stipulated protection area, Fig. 1, Mjölby and the Road Authority decided to implement the planned project. Undoubtedly, this would lead to public debate in Mjölby, concerning the interpretation of "reasonable precaution" adopted by the Owner, when he proposed protection measures for this project.

4. CONCEPTUAL DESIGN

The Swedish Geotechnical Institute and Hulthéns (J&W), studied the following three groups of sealing system; traditionary clay, geosynthetic clay liners and unreinforced geomembranes. After a comprehensive comparison of merits and demerits of the candidates, all parties including the Mjölby municipality proposed a single lining system by the means of a self seaming bentonite (sodium) mat. Concerning the conceptual layout of the GCL system for the highway, see Fig. 3.

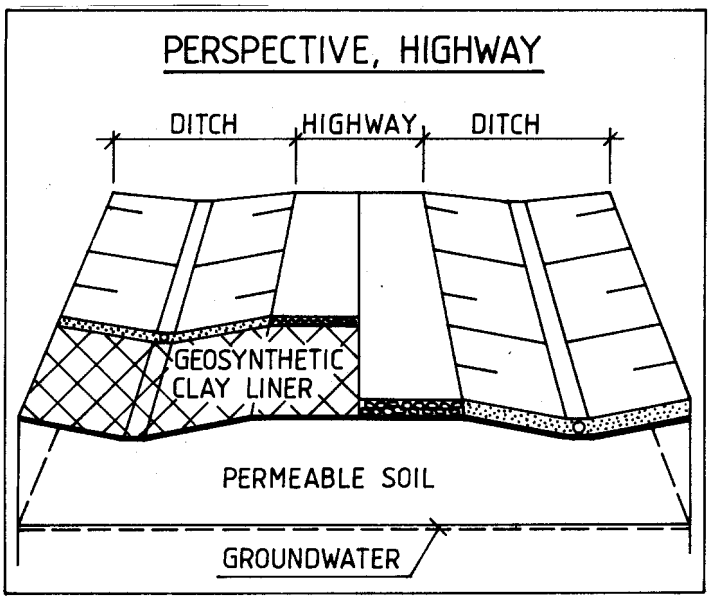

Fig. 3 Perspective, Highway

5. TECHNICAL DATA

The following compilation of technical data, all in accordance with above figure 4 represent a description of the installation in review:

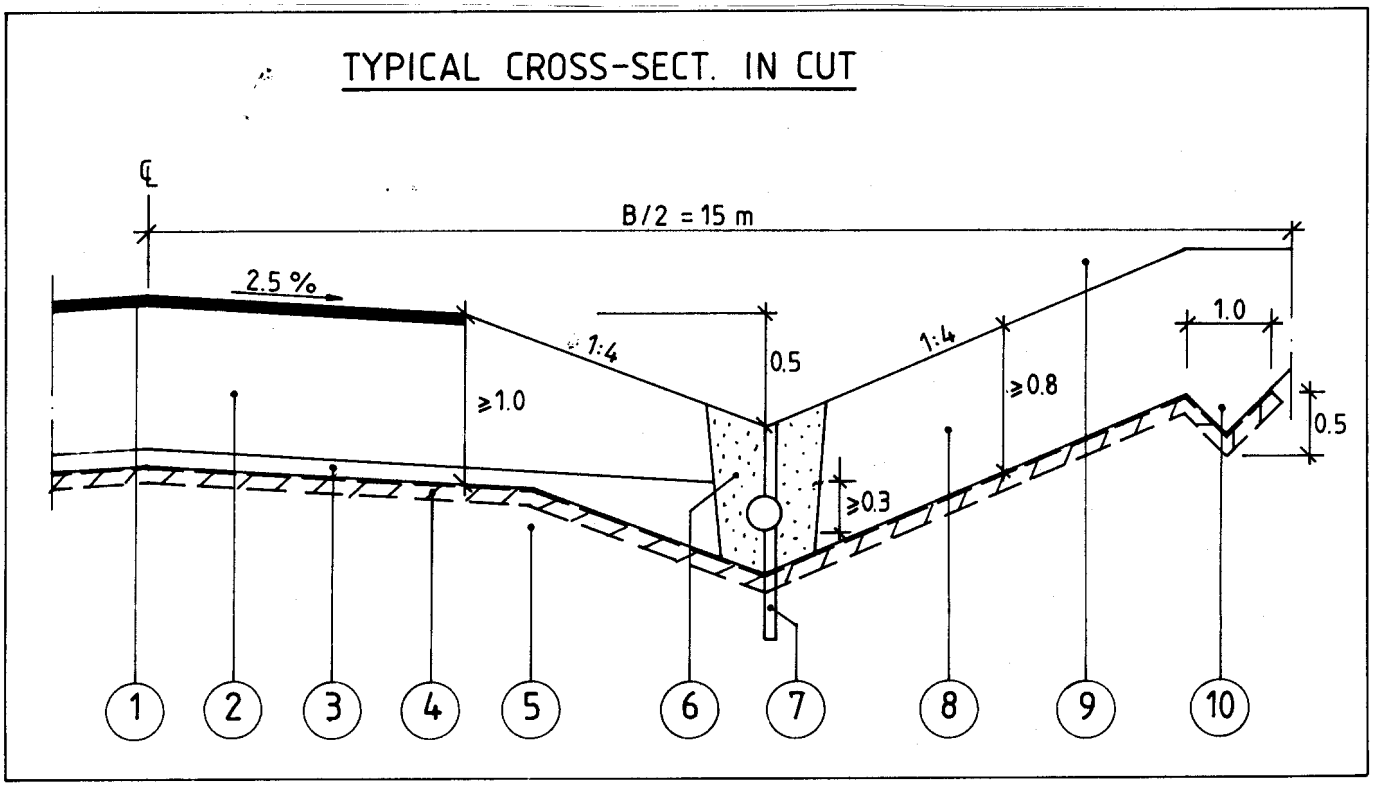

Fig. 4 Typical detail of the lining system, (correspond to Fig. 3)

1. Paved area 18,000 m²
2. Superstructure (incl 1. ≥0.8 m
3. Protection layer of backfilled subbase material 0.2 m
4. Claymax 200R-GCL, in units sized 30 x 4,1 m, to overlay breadth of foundation.
   Specific values; $h \leq 5 \times 10^{-12}$ m/s and bentonite content equal to ≥ 4,88 kg/m².
5. Subbase of sandy soil approx. (0.06 - 0.6) mm
6. Drainage system.
7. Control well monitory of water balance below liner.
8. Excavated sandy material, backfilled to cover the GCL.
9. Excavated material in cut (see 8).
10. Anchor trench in total 3,900 m. Furthermore, an lamell oil-separator, type Skanska Prefab LOA 200 (see Fig. 2)

Finally, a supplementary protection measure is examplified by the photograph in below Fig. 5, which also shows the finished product.

Fig 5. Shows protection measure by means of information board.

6. CONCLUSION

The Swedish Road and Transport Research Institute has on the behalf of the Swedish Road Authority and Mjölby municipality undertaken a long-term technical audit of in this paper discussed engineered barrier and pertinent function. Conclusions, regarding the initial phase of this audit, indicate no noticeable changes in the balance of water in the subbase (0.2 - 2) meter below the bottom of the drainage system. The same result counts for comprehensive water analysis, all in accordance with the by specification in corporated control program.

REFERENCES

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Fletcher G. Dirscoll (1987) Groundwater and wells - quotation from: *Groundwater Law,* Chapter 20, Second Edition.