

AN ENGINEER'S PROFESSIONAL LIABILITY “HORROR-STORY”

By

John L. Seychuk, P.Eng.
Geo-Engineering Consultant



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INTRODUCTION

- This talk is a summary account of a case history involving a young geotechnical consulting engineer
- who responded, on a “rescue mission”, to an urgent request to visit an active construction site

where the Constructor encountered groundwater related excavation problems.



Introduction (continued)

- The Geo-Engineer's expeditious participation in a satisfactory resolution of the problem unfortunately became a "Horror Story"
- which eventually ended up in a full scale litigation scenario
- with major professional liability implications for the Geo-Consultant.



Introduction (continued)

- There are significant lessons to be learned by Practitioners (particularly the younger ones)
- from the Geo-Consultant's involvement as a "fireman-to-the-rescue" on this project.



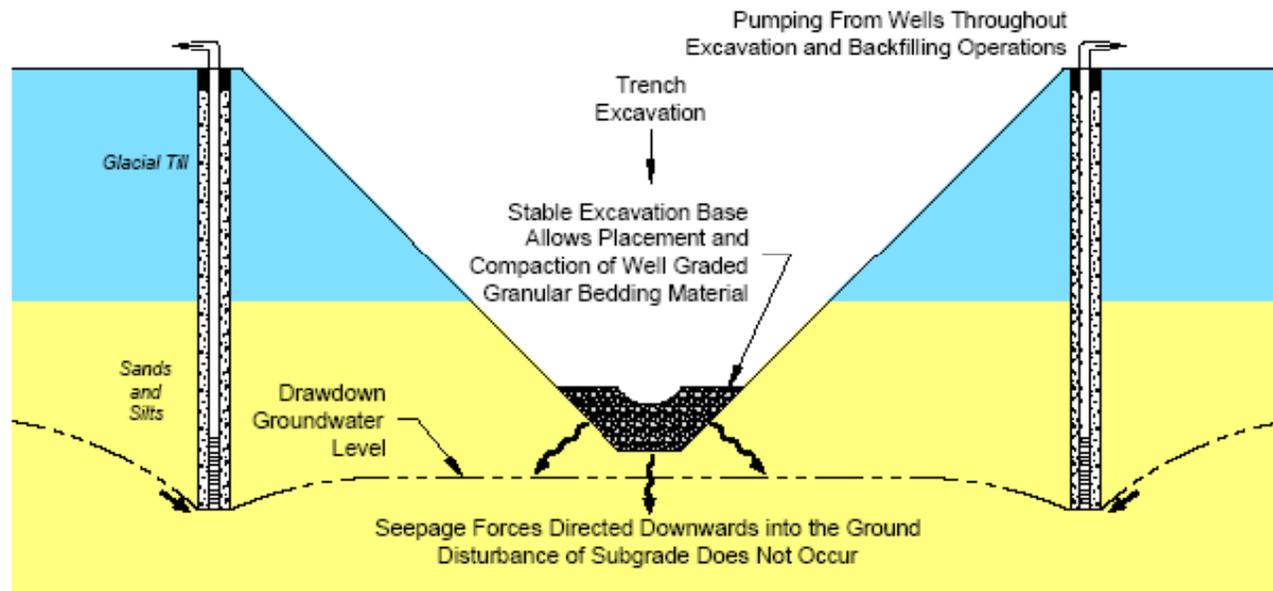
The Project

- The project under consideration involves the construction of a sewer system beneath a roadway in Canada.
- A preliminary site investigation along the route found a thin layer of glacial till underlain by water bearing sands and silts.
- Open cut trench excavation by the Contractor proceeded without any “prior” dewatering
- (i.e., the groundwater level in the sands and silts was not lowered to below invert level prior to excavation activities as illustrated in Figure 1).



Illustration of "Prior" Dewatering Excavation Conditions

Figure 1



An Engineer's Professional Liability "Horror Story"



PROJECT No. 90-1110-1000

DATE May 31, 2006

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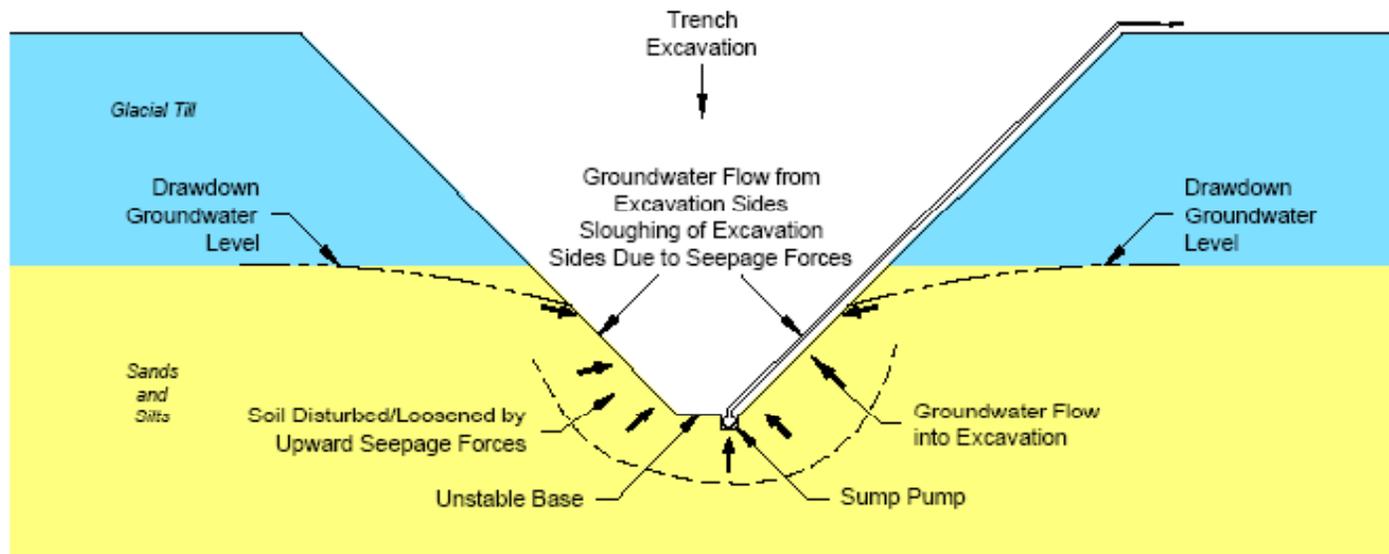


The Project (continued)

- Needless to say, without “prior” dewatering, water inundated the trench before the excavation reached sewer invert level, and
- groundwater inflow could not be controlled by sump pumping alone.
- The negative effects of sump pumping (which is referred to as “post” dewatering) on the
- stability of the excavation sides and bottom are shown in the “Engineering Cartoon” in Figure 2.

Illustration of "Post" Dewatering Excavation Conditions

Figure 2



An Engineer's Professional Liability "Horror Story"



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The Project (continued)

- It was at this stage (quagmire-like basal trench instability conditions) that the Geo-Consultant was contacted by the Prime Consultant on the project
- and asked to come out to the “rescue”.
- The Geo-Consultant, ***without any prior involvement in the project*** - put on his “fireman’s” hat and charged out to the site.



Site Meeting

- After a brief review of the design drawings, the Geo-Consultant found that the sewer - invert was located below the bottom of the preliminary borings.
- Accordingly, he concluded that there was insufficient subsurface
- (soil and groundwater) information at and below the sewer invert level.



Site Meeting (continued)

- Additional deeper borings and piezometer installations were recommended.
- The Contractor objected to the delay in getting a drillrig on site.
- Instead he attempted to dig a test pit to invert level, without success due to caving conditions.
- There were therefore no soil samples available for laboratory gradation testing from the critical lower excavation and sewer founding zone.



Initial Recommendations

- Without any further meaningful investigation, the Geo-Consultant recommended lowering of the groundwater level (i.e., “prior” dewatering)
- by the use of wellpoints, and the placement of concrete for the sewer pipe(s) bedding in the problem area.
- Elsewhere, along the remainder of the route, a recommendation was also made to continue
- “prior” dewatering to provide a stable and - undisturbed trench excavation base on which a
- well-graded granular “A” material could be used for the bedding of the sewer pipe(s).

Compromise Solution

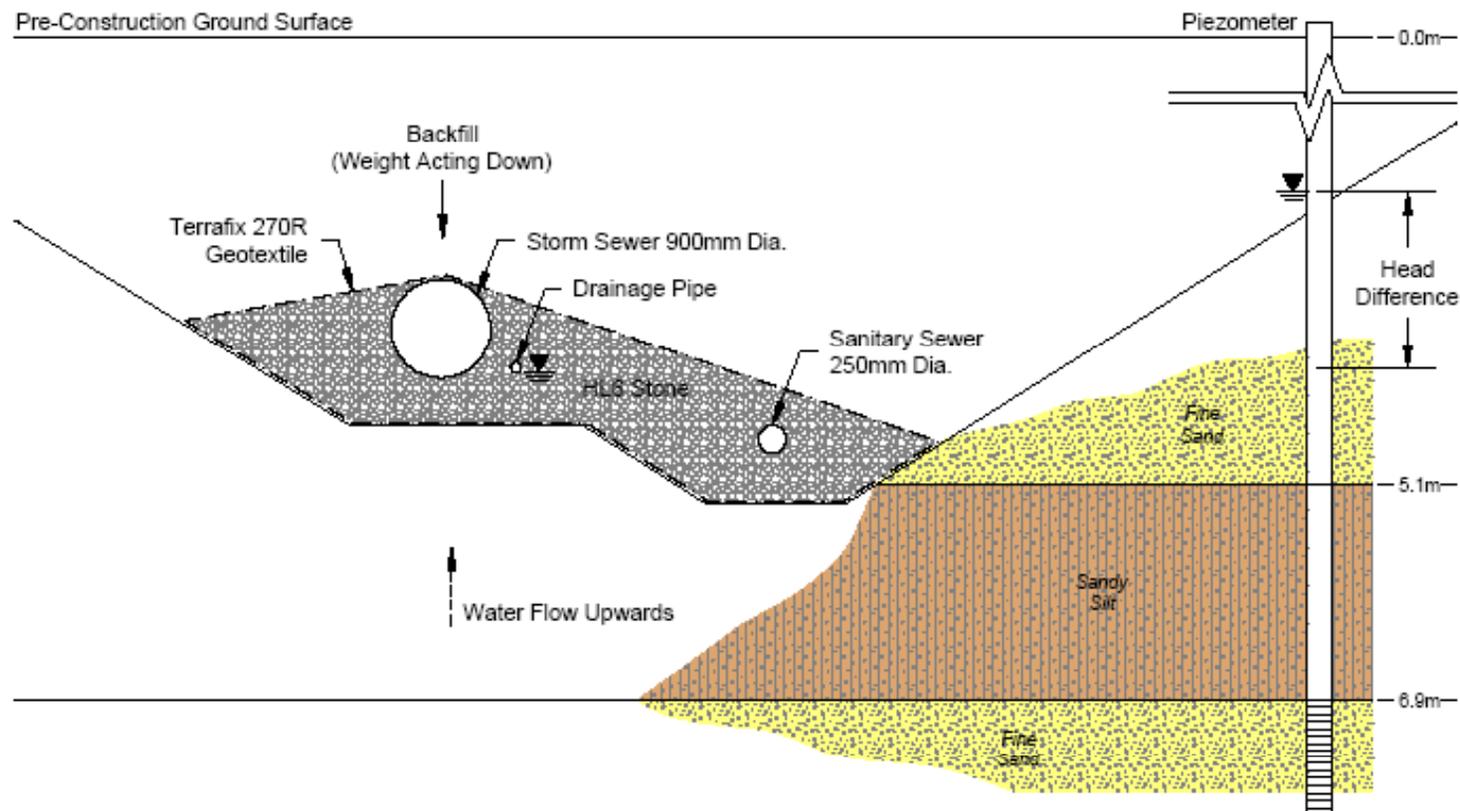
- The Contractor objected to the use of granular “A” on the basis of cost and workability issues and insisted on using clear stone.
- The Geo-Consultant recognized this approach to be a “recipe for disaster” because of the potential of a “piping failure” – (i.e., ingress of the fine grained soil into the clear stone void spaces)
- resulting in settlement of the surrounding ground and consequent deformation of the sewer pipes.

Compromise Solution (continued)

- Based on a suggestion by the Prime Consultant, a compromise solution was reached
 - with the use of a geotextile wrapped around the clear stone bedding,
 - to act as a protective filter median (as per the design arrangement shown on Figure 3).

Schematic Cross-Section of Compromise Sewer Design System Clear Stone Bedding with Filter Fabric Surround

Figure 3



An Engineer's Professional Liability "Horror Story"



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Continuing Involvement

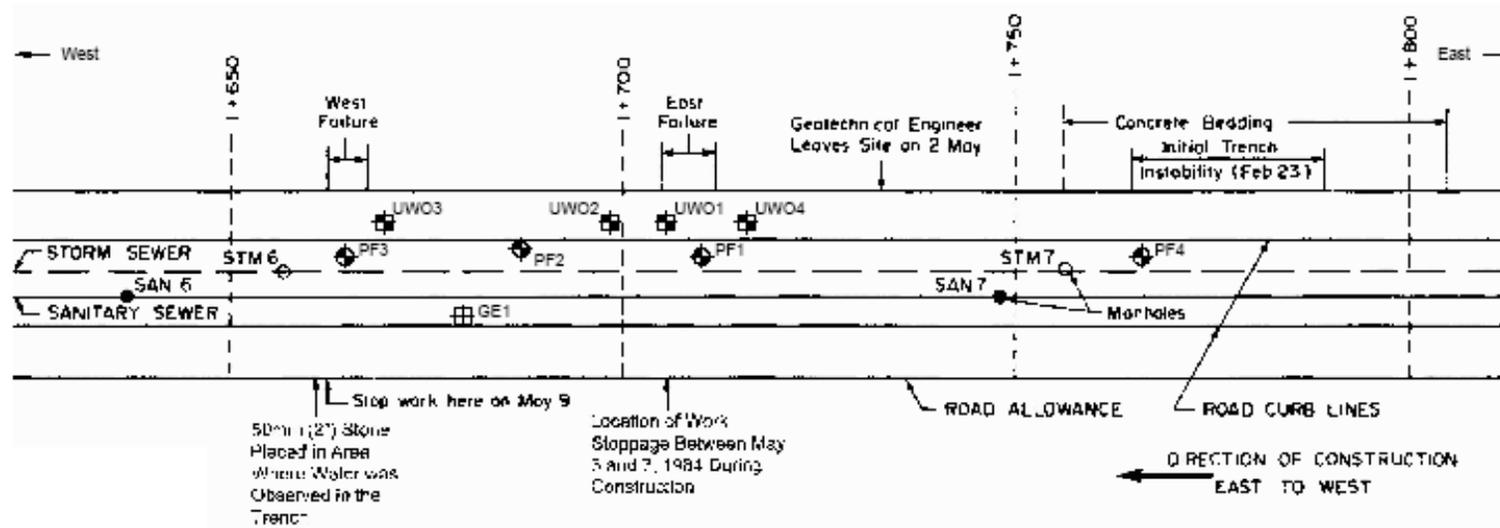
- The Geo-Consultant observed the initial placement of the geo-textile “wrap-around” for a short distance
 - beyond the problem area.
- However, his site involvement was curtailed shortly thereafter,
 - and the Prime Consultant took on total responsibility for construction monitoring activities.

The Failures

- One year following completion of sewer construction, two (2) separate shallow cave-in failures of the roadway surface occurred
 - along the section of sewer where clear stone with geotextile wrapping was used.
- Significantly, these failures took place in the area where the Geo-Consultant
 - was not involved in installation monitoring activities (Figure 4).

Site Plan Showing Failure Areas and Borehole Locations

Figure 4



LEGEND:

-  1984 Geotechnical (GE) Test Pit
-  1985 Post-Failure (PF) Investigation Borehole
-  1991 UWO Investigation Borehole

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Post Failure Situation

- The various parties involved in the project were served with legal papers informing them that the Developer was suing for damages resulting from the failures.
- The Geo-Consultant proceeded to review his notes in connection with the project.
- Unfortunately, to his dismay he had almost no written records of his involvement.



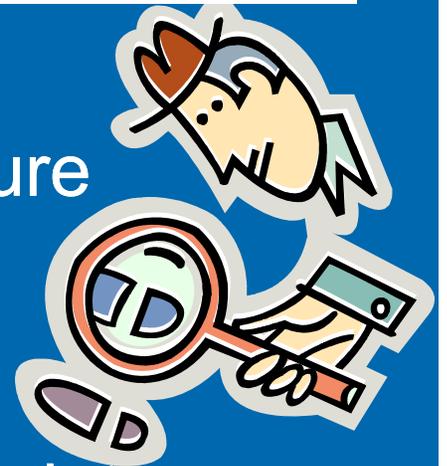
Post Failure Situation (continued)

- Specifically, there was no record of phone conversations or of recommendations that had been made - at site meetings pertaining to decisions to use the clear stone and geotextile combination.



Post Failure Investigation (For Developer)

- The Developer hired an independent investigator (PFI) to conduct a post failure “forensic-type” investigation at the site
 - to determine the cause of the failures.
- Unfortunately, due to the lack of appropriate groundwater level lowering at this post-construction stage,
 - it was not possible to adequately examine the geometric pattern and condition of the geotextile “wrap-around”.



Post Failure Investigation (For Developer) [continued]

- In particular, to determine whether there was sufficient overlapping, or any tears, in the geotextile surround.
- Visual inspection within the storm sewer at the failure locations showed that the pipes - had sheared in some places and silty water was flowing in some others.



Post Failure Investigation (For Developer) [continued]

- The three boreholes put down at, and between, the failure areas - encountered silty fine sand at and below pipe invert level.
- At the first (easterly) failure location - the minimum d_{85} of the soil at invert level was found to be 145 microns.

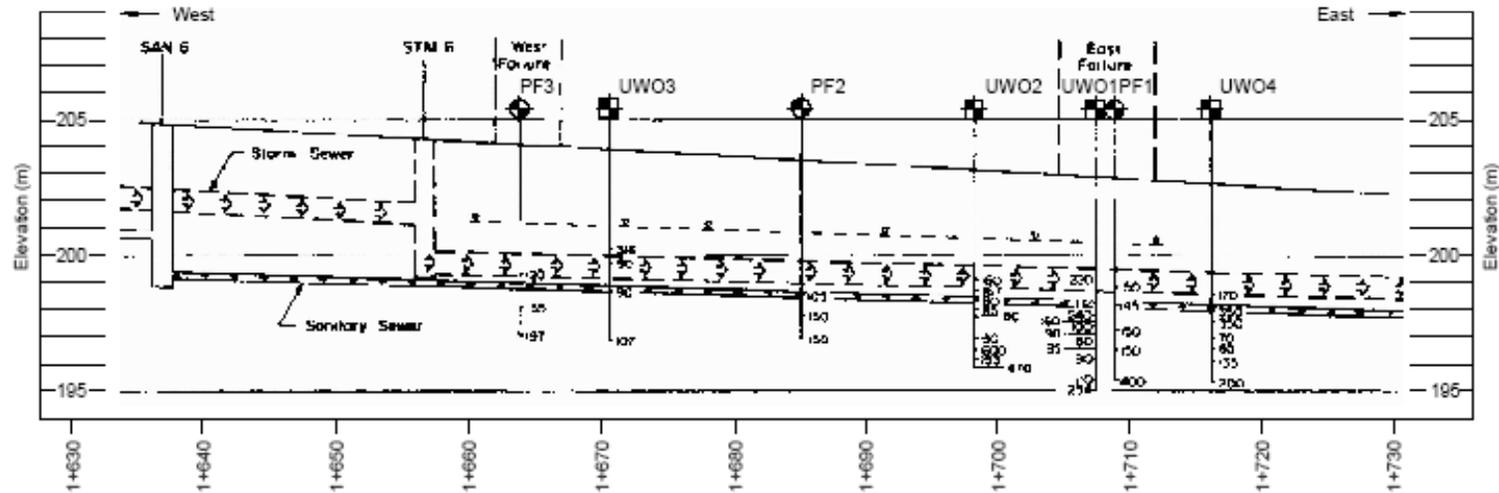
Post Failure Investigation (For Developer) [continued]

- A minimum d_{85} (grain size) of 120 microns was found at the second (westerly) failure location.
- Significantly, at the third borehole located in a non-failure area, the d_{85} of the soil was 105 microns – i.e., the soil was finer grained here than at both failure locations (Figure 5).

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Longitudinal Section Along Sewers Showing the Post-Failure Borehole Locations and D85 Laboratory Gradation Test Results

Figure 5



LEGEND:

- ◆ PF - By Developer's Investigator (1985)
- UWO - By Consultant's Experts (1991)

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Post Failure Investigation (For Geo-Consultant)

- A University based Laboratory Testing Group was retained by Counsel for the - Geo-Consultant to provide a separate independent assessment of the situation.
- Sampled borings were put down including a comprehensive laboratory testing programme - to simulate field ground conditions.



Post Failure Investigation (For Geo-Consultant) [continued]

- It was found that the geotextile used on site (GEOFAB→EOS = 130 microns)
 - met all the established (State of the Art) design criteria
 - for the gradation characteristics of the subgrade soil at the failure locations.

Post Failure Investigation (For Geo-Consultant) [continued]

- Furthermore, the laboratory simulation tests conducted with the finest soil encountered at the site ($d_{85} = 60$ microns)
- indicated that, provided the geotextile was placed in intimate contact with the subgrade soil, the geotextile used on site
- did not permit the passage of any significant quantity of fines through it, at
- hydraulic heads well exceeding site conditions.



Post Failure Investigation (For Geo-Consultant) [continued]

- Another important observation worthy of consideration,
 - in any assessment of the cause of failure,
 - is the location of the failures.
- The detailed post failure sampling and testing programme identified
- a more critical zone of soil gradation
- (i.e., **finer material**) near, or at, sewer pipe invert levels
- **where no failures occurred.**

Post Failure Investigation (For Geo-Consultant) [continued]

- This, taken in conjunction with the laboratory simulation tests, leads one to reasonably conclude that,
- if there were no failures due to direct soil migration through the geotextile itself
- **in areas of finest grained soil at the site,**
- then logically no failure should be expected as a result of the use of the same geotextile
- **at the coarser-grained failure locations.**

The Lawsuit

- Adversarial court proceedings took place.
- There was eventual general agreement that the failures occurred due to infiltration - of the fine grained soil into the clear stone surrounding the pipes
- with consequent loss of subgrade ground support
- causing differential settlement and cracking of the sewer pipe(s).



The Lawsuit (continued)

- The basic issue in this dispute therefore “boiled” down to:
 - (a) whether the failures occurred due to migration of soil fines directly through the filter cloth (geotextile); or
 - (b) If the failures occurred due to construction related factors causing movement of the subgrade soil through tears or gaps due to
 - inadequate placement procedures.

The Lawsuit (continued)

- The Experts for the Contractor and Prime Consultant took position
 - (a) – migration through the geotextile.
- While the Geo-Consultant and his Team argued position
 - (b) – direct access of soil through tears or gaps in the filter fabric surround.

The Judgement

➤ The Judge found that the failures were due to inadequate selection of the geotextile.

➤ Specifically, the Judge concluded that:

- The geotextile, which permitted migration of the natural soil through it,
 - should not have been used;
- There was no evidence presented to establish inadequate overlapping,
 - or the presence of gaps or tears in the geotextile, as a cause of the failures;



The Judgement (continued)

- The Geo-Consultant gave opinions based on inadequate information and did not insist on, or stress the importance - of borehole investigations, but relied on a shallow test pit which did not go down to at least sewer pipe invert level;
 - If the Geo-Consultant was pressed to proceed without adequate subsurface information, he should have either - refused to do so, or written a qualification report stating that his opinion was provided on insufficient information;
- and
- The Geo-Consultant did not give adequate instructions to the Prime Consultant, or the Constructor, - in good practice procedures for geotextile installation.



The Judgement (continued)

- The Judge ruled that:
 - ❖ There was no evidence that neither the Contractor or the Prime Consultant was negligent.
 - ❖ The Geo-Consultant was **solely liable** for all the costs in conjunction with the damages incurred - **including all associated legal and expert witness costs.**



Lessons Learned

- The **lessons learned** from the Geo-Consultant's project involvement can be summarized as follows:
 - If you are called to resolve a “rescue” problem on a construction project in which
 - you had no previous involvement,
 - try to obtain (at the outset) a “white Knight” indemnification letter providing immunity for your services.



Lessons Learned (continued)

- Alternatively, as a minimum, get your professional liability limited to a quantum
 - not to exceed your fees on the assignment;
- Do not provide an opinion or solution based on inadequate base information.
 - Insist on obtaining enough data to enable a proper evaluation of the problem;
- If in doubt, provide a safe conservative solution, such as the use of concrete (“unshrinkable fill”)
- for the bedding instead of clear stone surround;

Lessons Learned (continued)

- If you are forced to accept a compromise or expeditious solution, which in your opinion cannot be technically substantiated,
 - clearly state this in your report,
 - together with the risks involved;
- Document major points of discussion and opinions provided at meetings and during telephone conversations;
- The Geo-Consultant should have insisted on being allowed to continue the monitoring of the geotextile installation operations
- throughout the length of the sewer;

Lessons Learned (continued)

- If not permitted to do so, the Geo-Consultant should have provided written detailed instructions to the Prime Consultant regarding proper geotextile “wrap-around” installation procedures,
 - together with the provision of a departing “non-involvement” statement clearly absolving himself of any liability;
- Based on experience on this project, and others,
 - overlapping of the geotextile should be avoided and
 - replaced by sewn seams, in applications where formation of gaps could cause failure;

Lessons Learned (continued)

- Post-failure forensic investigations should not be conducted under “sloppy” conditions which do not permit proper in situ observations;
- Although the laboratory tests demonstrated that geotextile filtering works,
 - it is important for the geotextile to be in intimate contact with the soil it protects; and
- The “wrap-around” configuration (Figure 3), as designed by the Prime Consultant,
 - is impractical to construct due to the difficulty of ensuring intimate contact of the soil with the geotextile throughout its “circumference”.

Lessons Learned (continued)

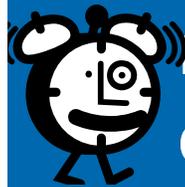
- Last, but not least, it is significant to note (particularly for young Practitioners) that the Geo-Consultant's representative on site
 - was a young engineer, with a lack of experience in construction related problems involving
 - decisive and assertive interaction
 - with a Constructor whose main objective is concentrated solely on completion of the work on a timely basis and at minimum cost.

Lessons Learned (continued)

- The young engineer on this assignment should have sought the guidance and direction of a more senior colleague
 - with “battle-hardened” previous experience
 - in dealing with “Fireman-to-the Rescue” situations involving “hard-nosed” Constructors.



Closing Comments



- Of necessity, due to time restrictions, my talk is essentially a capsule summary of this case history, focusing primarily on “lessons learned” by the Geo-Consultant.
- A detailed technically oriented paper can be found in the hard copy Proceedings of the (Xth) PAN AM Conference held in Guadalajara, Mexico in 1995, as follows:

Closing Comments (continued)

- Volume 3, Theme VI (Forensic Engineering) – Paper entitled “Alleged Non-Performance of a Geotextile Filter” by R.K. Kerry Rowe and John L. Seychuk;
and
- Volume 4, Theme VI (Forensic Engineering) – General Report by John L. Seychuk and Tomas Shuk-Erdos.

Closing Comments (continued)

- The above referenced Guadalajara paper was written by an Academic
 - with background information provided
 - by a Senior Geo-Consultant who had post failure geo-forensic investigation involvement in the project.

Closing Comments (continued)

- This collaborative effort is consistent with the main objective of the ISSMGE Professional Practice Task Force which encourages the publication of papers that provide lessons learned from “real street” case histories (aka “Horror Stories”).

Closing Comments (continued)

- Accordingly, a cooperative “team effort” initiative is encouraged,
where Academics could write and publish
 - appropriate case histories
 - utilizing the resources of Practitioners who have valuable information in their files
 - but don’t have the same incentive or need, to publish, as Academics have.

Closing Comments (continued)

- Muchas gracias por su atención.

Chichén Itzá, Mexico

