AN ANALYSIS OF THE TRINITY RAVINE AND THE AFFECTS OF DEPOSITON

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ABSTRACT

North of the Trinity campus at the University of Vermont on Colchester Ave. there is a drainage basin that transports water and sediment towards Riverside Ave. and eventually into the Winooski River. This basin is in the shape of a ravine and on the south side of the ravine there is exposed sediment from a landslide. With further examination of the area three gullies are found. These gullies show how sediment is transported from deposition down into the ravine. On the gullies many old and new landslides can be seen and are the mechanism for erosion in the area. The deposition of the area is post-glacial and Lake Sediments overlie glacial sediments. Above the lake sediments is coarse oceanic sediment from the intrusion of the Champlain Sea. The lake sediments are the reason for the failure because they do not let water permeate down into the groundwater but force the water laterally cause the slopes to fail. A comparison between three gullies and a newer landslide help demonstrate how the sediment was deposited and how it is currently being removed.

1. INTRODUCTION

Behind the Trinity campus, north of the University of Vermont, in Burlington VT, there is a drainage basin that flows from Colchester Ave. to Riverside Ave. where it enters the Winooski River. There are three large gullies on the south side of the ravine. The gullies act as drainage for runoff and are actively failing, creating landslides. The gullies have formed as a result of landslides that have moved upstream from the ravine. On the south side of the ravine a landslide is seen with a scarp of about a meter. The sediment once contained on the ravine wall has failed and is now part of the sediment filling the ravine. The post-glacial depositional history of the area is the results of the formation of Glacial Lake Vermont and then the intrusion of the Champlain Sea (Chapman 1937). The depositional history leads to the formation of clays and sands. The permeability of the sediment results in many failures in the slopes of the ravine. There are 3 gullies that lead into the ravine which are actively being eroded by way of landslides. The gullies show us the erosion capabilities of the area and show us that landslides are not limited to the area of our particular landslide.

2. METHODS

Three soil pits were dug at the location of the landslide. Together they represent a total stratigraphy of three meters of the upper margin of the landslide. They help us hypothesis as to the depositional history directly effecting the landslide. The pits were dug sequentially upward starting with pit 1 at the middle of the cliff. We started in the middle because we believed the bottom portion would be mostly landslide deposit and would not show any difference in sediment.

All three pits on the landslide were dug in such a fashion to expose the top three meters of the landslide. The top of each pit was on a linear plane with the bottom of the next (fig. 4). The stratigraphic columns of the first three pits display vertical relief of the top three meters. Because of this fact the pits are described from bottom to top. The stratigraphy for all soil pits can be found in figure 5.

Visual observations were made and discussed. These observations are do not make up any sort of quantitative analysis, but they do help understand that the failure in the ravine is not reserved to this one landslide.

Research was done to better understand the processes not tested at the site. Research helped to describe the effects of the depositional history of the area's failings. Specifically, research helped to better understand permeability, infiltration, saturation levels and landslide failures. The graphs used in figures 6 and 7 were related to evapotranspiration. This field work was relevant because they represent the amount of water being moved through the ground after they have been absorbed by plants. This data is referenced throughout the paper.

3. DATA

3.1 Pit 1 Pit 1 was 95cm deep. We found brown coarse sand sediment throughout the whole pit. The rocks found were unsorted and unconsolidated with smoothed edges and few facets.

3.2 Pit 2 Pit 2 was a total of 74cm deep. The bottom of the pit was on the same plane as the top of pit 1. In the first 12cm there were many rocks which were sorted, meaning that they got sequentially bigger towards the top of the 12cm section. These rocks all had rounded facets and were deposited in coarse grain sand. On top of them a fine grained silt and clay 27cm thick. The top 35cm of soil is made up of medium grained sand sediment.

3.3 Pit 3   Pit 3 was a total of 70cm deep. Its bottom layer consisted of heavy plastic clay that is the base of our stratigraphic column and is not shown in the layering. On top of the clay 23cm of silt can be seen. The next 3cm, 23- 26cm, was a layer of coarse-grained red sand. Between the 26cm and 30cm mark a sandy silt layer of medium grained red sand was found. Above it, between 30- 32cm, another red sand layer showed slight disturbances. There was a tan segment of medium grained sediment on top of it, which gradually grained upward to coarse as the color became tan. There was no clear layer distinction seen here but it was 14cm thick. The top 24cm, 46-70cm, was at the very top of the scarp and consisted of black muddy topsoil with a few rocks scattered throughout. They were also faceted and rounded. The layers between 23 and 46cm were classified as varve layers. They were angled down slope with the direction of the landslide. There were few rocks found in this section of stratigraphy and they were all unsorted, unconsolidated and faceted. One of the rocks was a piece of calcite infused shale.

3.4 Pit 4   Pit 4 sits directly opposite the landslide on the north bank of the ravine. It contained two sections of medium/ coarse grained to coarse sediments ranging in colors from a rust color, to tan, to gray. The whole pit was 82cm deep and will again be described from the bottom up. In the first 11cm, a clear progression of sorted materials was seen ranging from small, to medium, to large rocks all layered on top of each other. The color of its soil followed the same progression from gray to tan.   On top first 11cm of sorted rocks there is 71cm of consistently coarse grained sand. In these 71cm there were scattered rocks with faceted and rounded sides. These were observed in the pit as having different angles of deposition. They were seen to be angled at randomly, but were seen as lying flat closer to the bottom where the 11cm of sorted rocks were found.

4.1 Soil Pit Analysis

The soil pits help to describe the depositional history of the sediment directly affecting the landslide. The thick layer of sand seen in pit one represents an extended time of moderate-energy deposition. Either from the creation of Coveville Lake Vermont, which would be a moderate-energy episode (Chapman 1937) or from the development of a glacial outwash deposition, which would also be moderate energy episode (Benn and Evans 1998). On top of pit 1 the sections of sorted, consolidated, faceted and rounded rocks, seen in both pits 2 and 4 were at the same height and are used to conclude similar stratigraphy on both sides of the ravine. Above these sorted rock layers was fine- grained silt and clay layers followed by more medium grained sand sediments. With in the clay layers in pit 3, varve layers were seen and represent a change of seasons during deposition of settling Lake Vermont sediment. The varve layers recorded a slight change in disturbance with moderate- energy deposition below the clay and moderate-energy deposition above the clay. The downward slope of the varve layers referred to in section 3.3 matches that of the landslide slope. The slope of the varve layers are the result of the sediments reaction to erosion, much like the angled, rhythmic bedding seen at the mouth of Town Line Brook close to where it flowed into the Winooski River. The top section of sand represents the most recent deposition.

The varve layers are the primary reason for the local soil failing seen in the ravine. Because of their fine to medium grained makeup and low infiltration rate of 0-1mm/hr (table 1, Dunne and Leopold 1978) it is inferred that the layers appear to be forcing excess rainfall along its upper margins. In clay rich soils water is held tightly, supply to roots will not keep up with rates of potential loss and actual evapotraspiration rates will decline with rates of available water (fig. 6, Dunne and Leopold 1978). Its slight permeability and excess water (fig. 7) saturates the overlain sand and topsoil. Water infiltrates sand and organic layers at a rate of 1-4 mm/hr (table 1). In these layers dense root systems can withdraw water close to its potential rate (Dunne and Leopold 1978). However it was inferred that the surrounding trees do not have extensive root systems and therefore the water is saturating these soils. Furthermore the organic topsoil was recorded as being 24 cm thick and is an indicator for poor drainage (Dunne and Leopold, 1978).

SUMMARY

The failures in the area behind Trinity campus are a result of the sediments depositional environment and its permeability and low infiltration rates. This is further antagonized by the high amount of runoff created by development in the Burlington/UVM area. The sand and clay layers result in a saturated surface that is easily eroded away. The three gullies represent different stages of erosion, in the area the furthest east (see fig 3.) is the highly eroded, the next, in the middle, is heavily eroded but not to the extent of gully 1. Gully 3 is the least eroded and located to the west of the other gullies. The 3 different gullies show us how water transport results in the erosion of sediment. The landslide in the ravine is thought to be the start to another gully complex on the south side of the ravine.

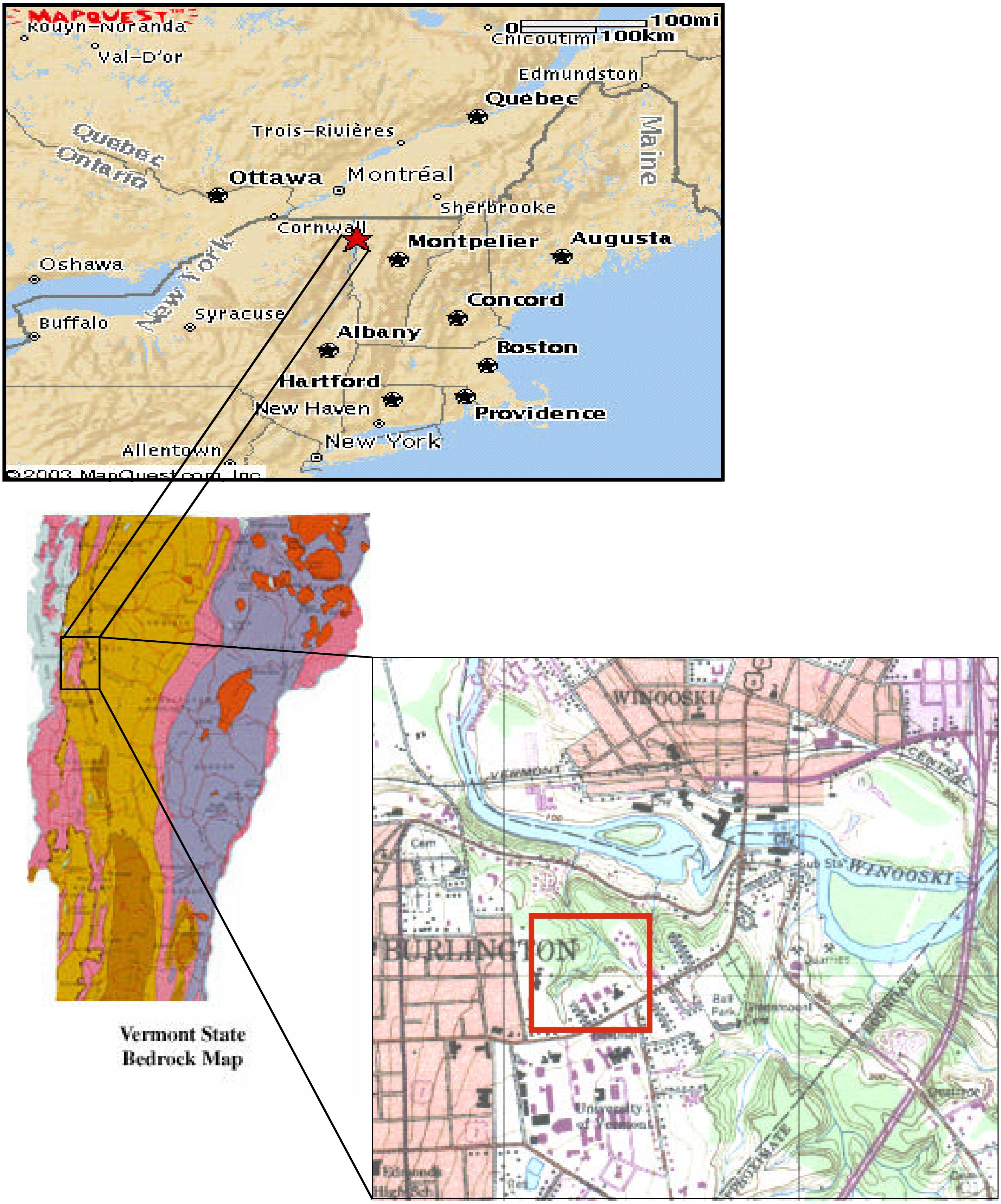

Figure 1. Burlington is located on Lake Champlain in northwest Vermont. It is a major city in Vermont and that has seen many developmental changes in the last 100 years.

Figure 2. This figure is an aerial photograph of Burlington it displays the longitude and latitude of of the area studied. The oulined area corresponds topographically with the basin identified in figure 1.

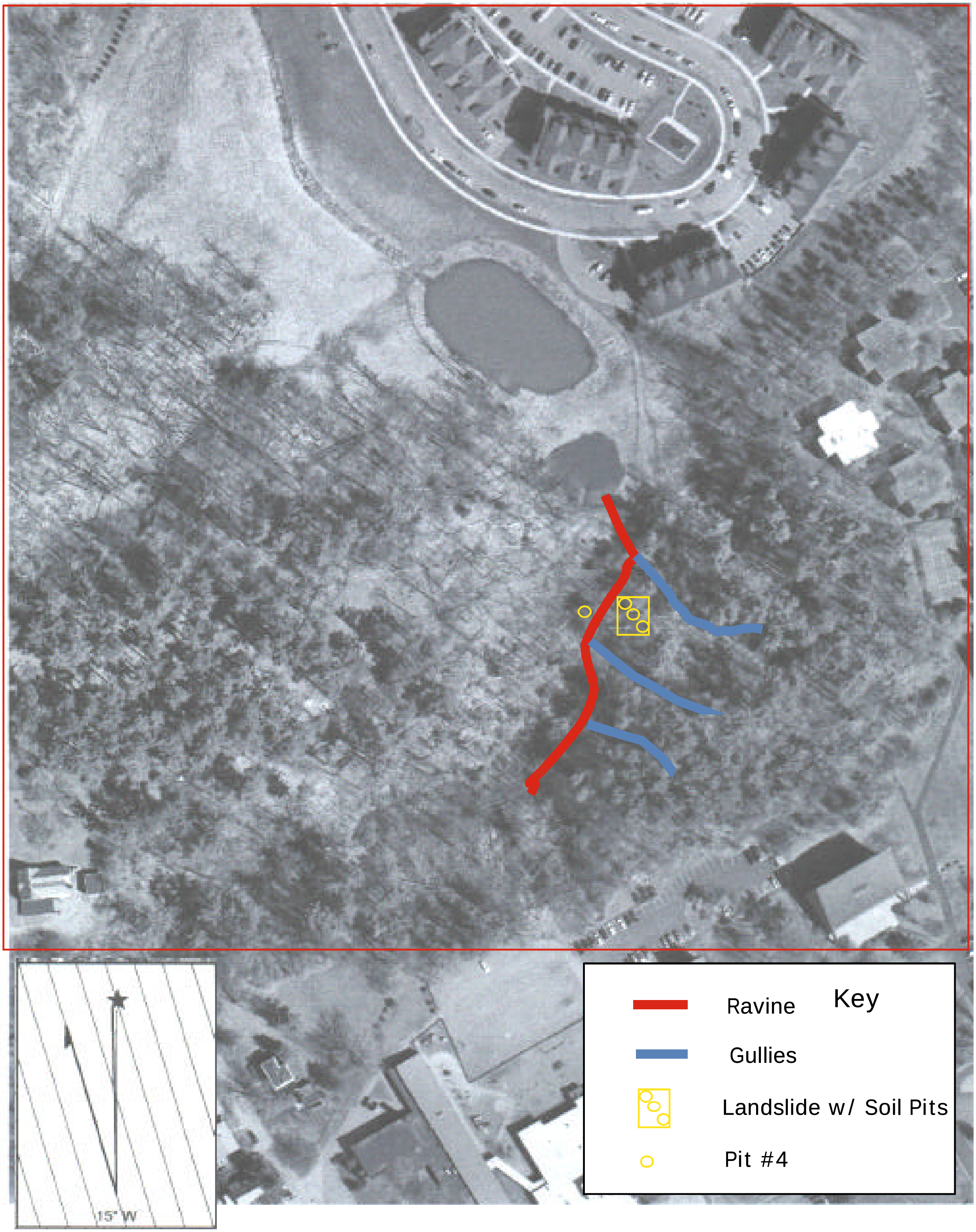

Figure 3. This is a closeup of an aerial photo of the drainage basin. The red square corresponds with the square seen on figure 2. The river and soil pits has been drawn in roughly.

Figure 4. A picture of the Landslide on the South side of the ravine with 3 soil pits dug into the exposed soil

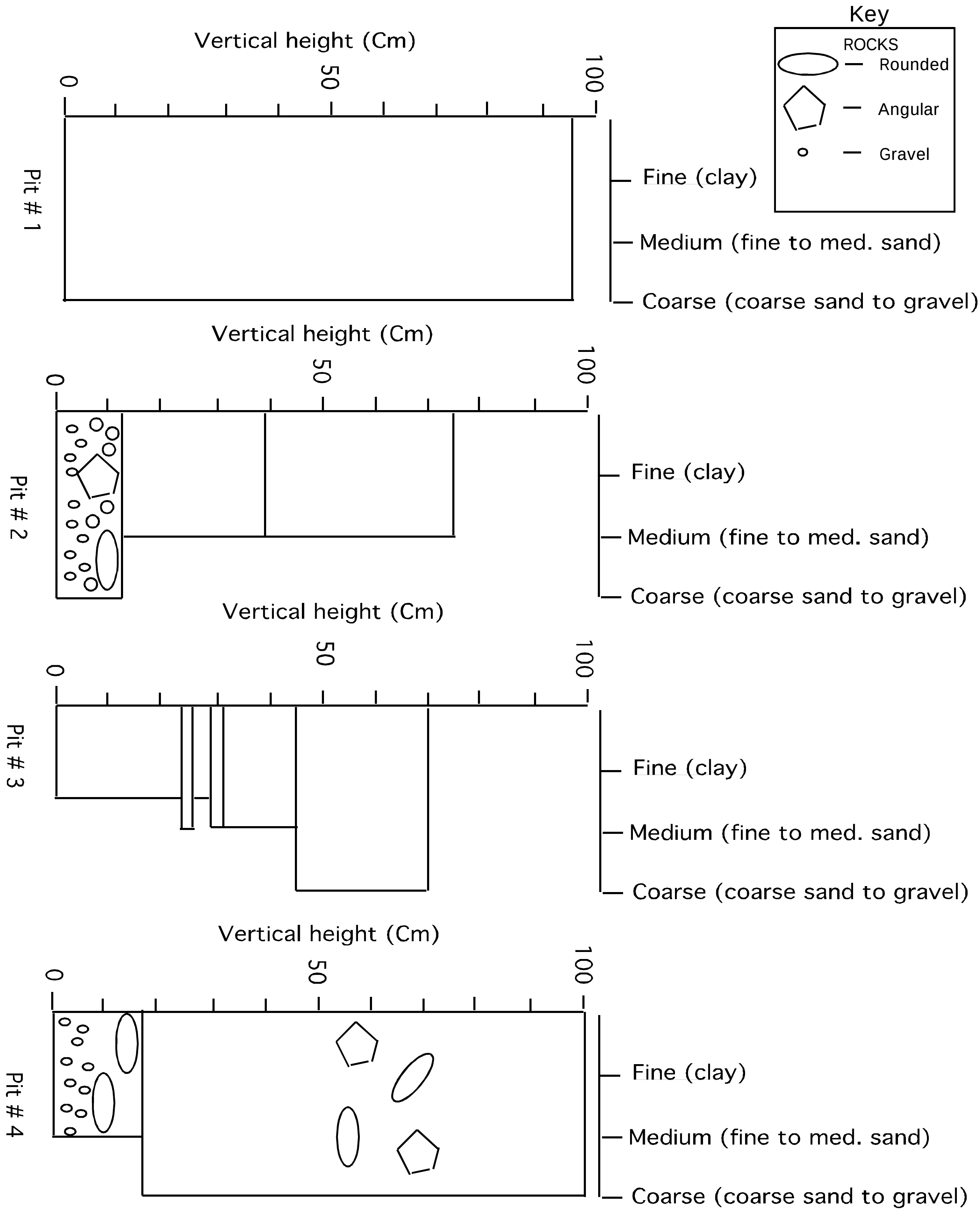

Figure 5. Soil pits 1,2 and 3 are located on the south side of the ravine with in 5 meters of 18T 0643570 UTM 4927188. Pit 4 is located on the north side of the ravine at 18T 0643532 UTM 49272180.

Table 1. Infiltration rates for different soils classified from minimum infiltration rates. The soil types seen in the landslide were, in order from top to bottom of the stratigraphic column, aggregated soils (A), sand loams (B), heavy plastic clays (D), sandy loams (B), followed by sorted rocks (not mentioned here).

GROUP	MINIMUM INFILTRATION RATE (MM/HR)	SOIL CHARACTERISTICS
A	[illegible]	Jeep sands, dee p loesses, aggre gated soils
B	4 to 8	Shallow loess ar id sandy loams
C	1 to 4	Many clay loam s, shallow sand y loams, soils low in or ganic matter, a nd soils
D	0 to 1	Soils of high sw elling percentag e, heavy plastic clays, a nd certain salir ne soils

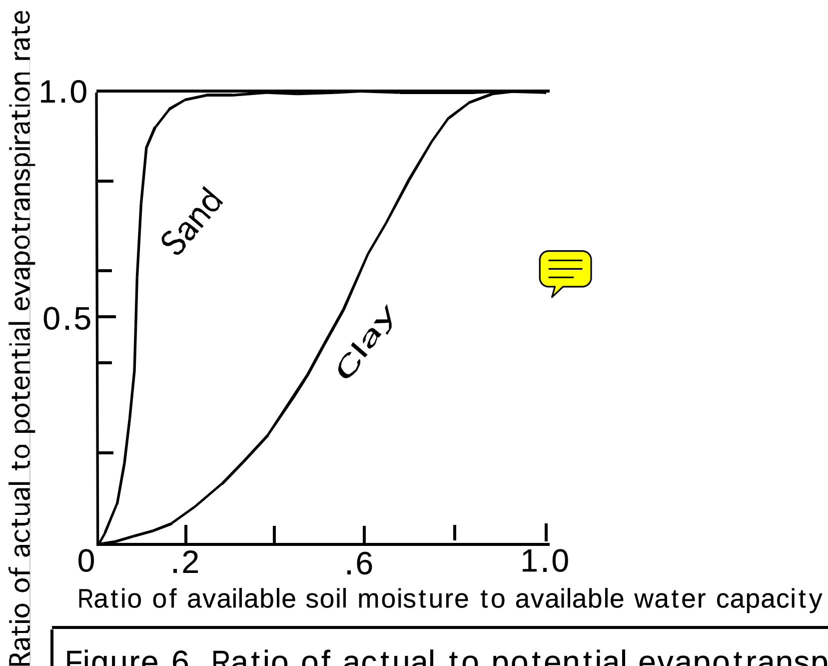

Figure 6. Ratio of actual to potential evapotranspiration as a function of soil moisture in two soil textures. When each soil type reaches its capacity it is saturated. (Dunne and Leopold 1978)

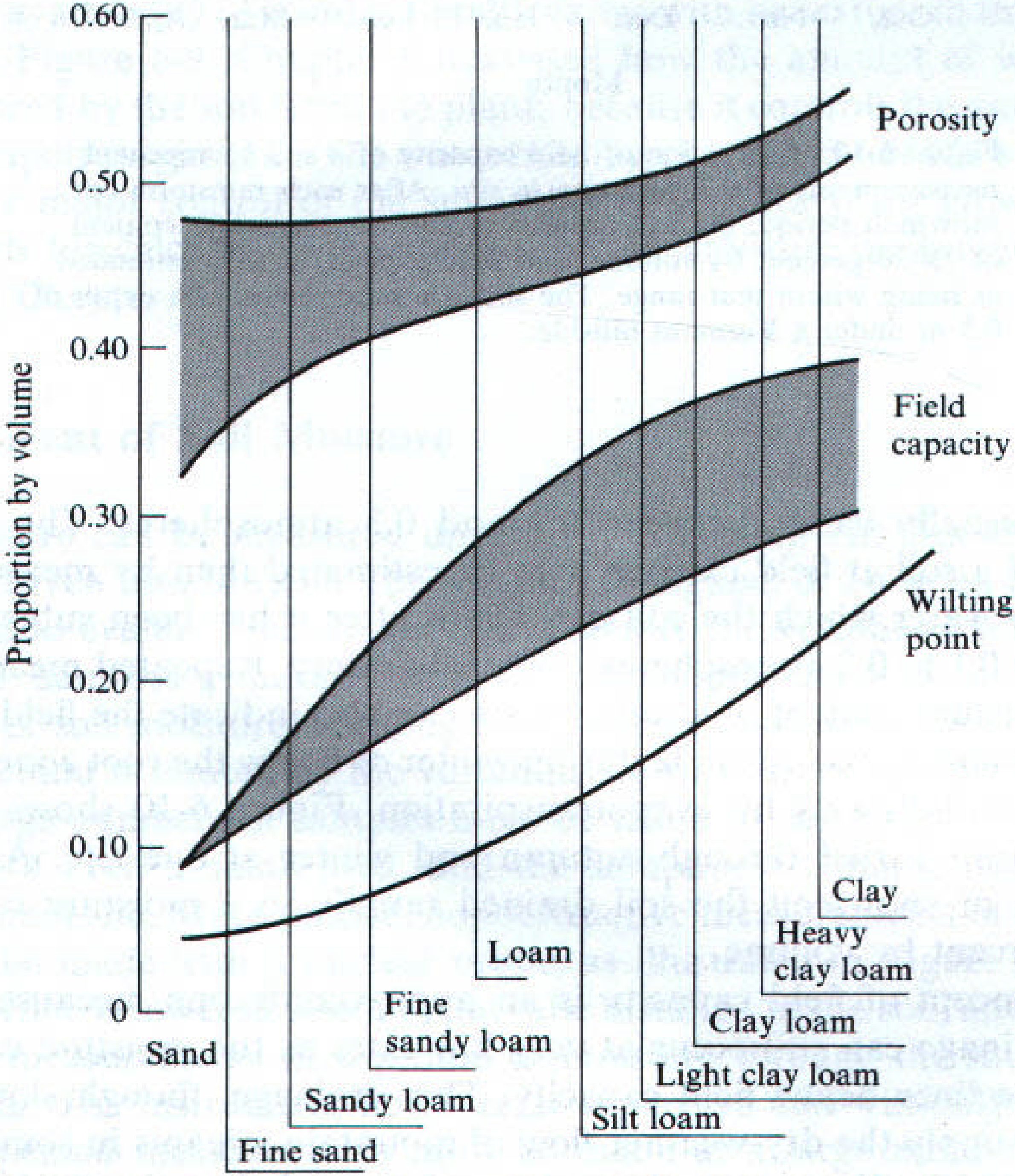

Figure 7. Water- holding properties of various soils classified by texture ranging from coarse to fine grained sediments. This graph predicts the relative difference between porosity and field capacity. For example in sand the porosity is 0.48 and its field capacity is 0.1. The unfilled pore spaces then become 0.38 of the total volume.

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www.mapquest.com 10/25/03 Map on figure 1

Maptech. 2002. Topo. maps and aerial photos.