CIV5881-6881 Ground water hydraulics

Week 1 Practical: Groundwater head and flow lines

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Introduction

In this practical we're using real field data from the Defence Explosive Factory in Maribyrnong (Melbourne, circa $\sim$ 1890 - 1990s) to map the groundwater flow direction and then use the results to locate the water table and identify the aquifer types.

Figures 1 to 3 show cross sections of the geology stratigraphy and groundwater piezometers. At each piezometer (location shown in inset) the screen length and depth is shown and adjacent to it is the measured groundwater total head (estimated by measuring the depth to the water level). Importantly, because this prac. is using real field data, measurement errors exist. For example, the piezometers may not be exactly on the cross-section line, the stratigraphy is estimated from the piezometers drilling logs (and hence uncertain) and the head measurements were not all taken on the same day. Therefore, this in completing this prac. you need to exercise some professional judgement.

Lastly, please complete all of the activities for one cross section before starting the next cross-section. I suggest starting with Figure 1 because it is the easiest.

The learning outcomes for this practical class are:

- Identify vertical flow in groundwater at bores and water bodies.
- Draw groundwater flow lines that fit the observations and physical constraints of the groundwater systems.
- interpret groundwater flow lines to understand major aquifer types.

Activity 1: Assess vertical flow directions (30min)

In this activity we're going to use the observed head data to identify if groundwater is likely to be flowing upward or downward.

Many piezometer shown in Figures **??** to 3 actually have multiple observation bores at one location, each measuring a different depth (e.g. MW308 and MW309 in Fig. 1). Some also have another piezometer very nearby but which is measuring a different depth (e.g. MW120 and MW351 in Fig. 2). Use this information to identify if the groundwater is likely to be flowing upward, downward or neither at each available pair of observations.

In completing this activity, annotate each pair with an upward or downward arrow that reflects the estimated groundwater gradient; that is, draw a larger arrow when the gradient is large and a smaller arrow when the gradient is small. You can approximate the groundwater gradient by estimating the difference in head divided by the difference in elevation of the piezometer screens.

Activity 2: Draw cross-sectional groundwater flow (40min)

In this activity we're going to use the observed head data to map the groundwater flow direction throughout the cross section. This activity is difficult and may require a few attempts, so please consider using a pencil. Below are the suggested steps for creating the groundwater flow lines:

1. Mark vertically on each piezometer (and below it) the approximate depth at which a range of head increments are likely to be at; for example, for Figure **??** you could use 2m, 1.5m, 1m and 0.5m. To do this you'll firstly need to look at the observed head of each piezometer and the likely vertical flow direction. If the groundwater is flowing downward, then the head should decline with depth; and vice versa if flowing upward.

2. Join up your 2m head points to create the 2m head contour. Try and approximate where the 2m head contour reaches the land surface. Also, remember that groundwater head often changes slowly across the landscape, so rapid head changes are unlikely.

3. Repeat step 2 for the other head increments, e.g. the 1.5 m, 1m and 0.5m contours. Remember that the head at the river is ∼0m.

4. Add groundwater flow lines going through the highest head contour (e.g.2m) to the 0m contours. Importantly, groundwater flow lines must be perpendicular to head contours. Also groundwater flows parallel to aquitards, not through aquitards.

Activity 3: Identify the water table & the aquifer types (30min)

In this activity we're going to use the head contours to identify the elevation of the water table along the cross section, and then assess if the aquifers are confined or unconfined.

In identifying the top of the water table, remember that the water table is at the depth where the atmospheric pressure equals the head. That is, like in the video from week 1 of a well being dug, if we started drilling a piezometer down to an elevation of 5m and at this point we first hit water and if the water also had an elevation of 5m then we'd be at the water table. So, to identify the top of the water table in your cross section you need to find the point along each contour where the head equals the elevation. By joining up these points you will have mapped the top of the water table!

Next, examine your head contours and the stratigraphy to assess if each stratigraphic layer is an unconfined, confined or semi-confined aquifer. To complete this activity you'll need to understand module 4 from the week 1 lecture slides.

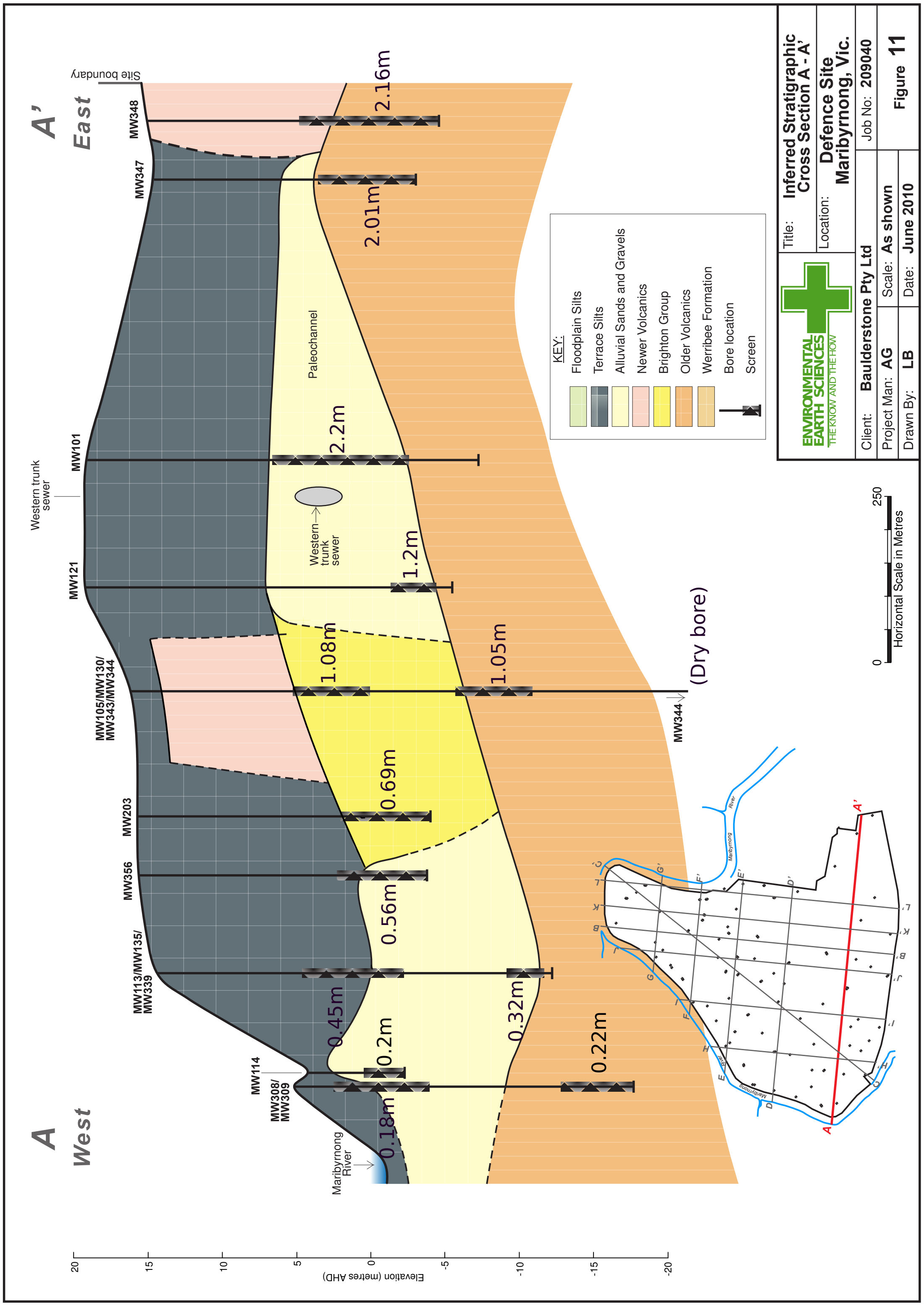

Figure 1: East-west cross section of geology and groundwater observations at the Defence Explosive Factory, Maribyrnong (Melbourne). Source: https://apps.epa.vic.gov.au/EnvAuditFiles/53X/46115-2/46115-2_b.pdf p128

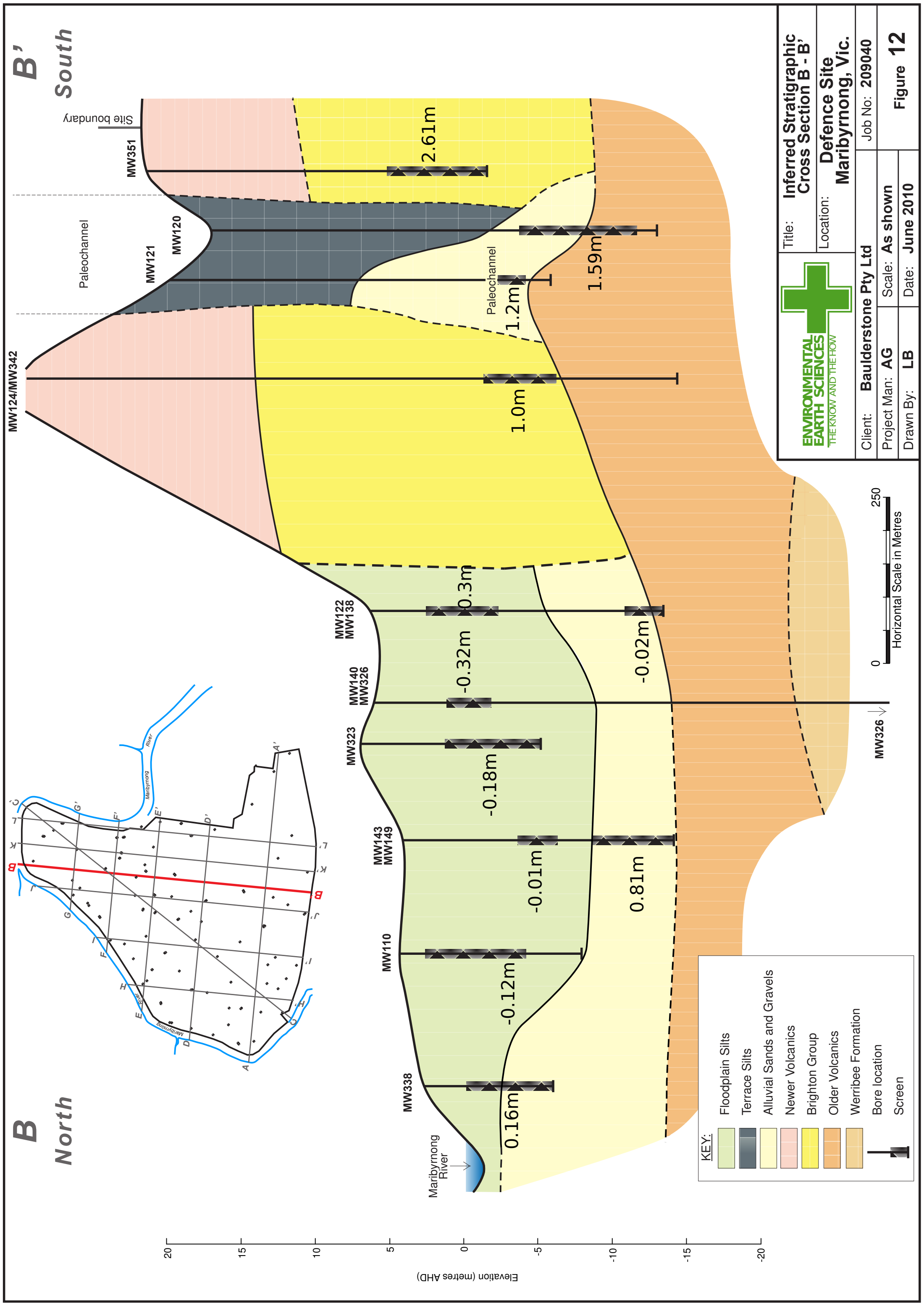

Figure 2: North-south cross section of geology and groundwater observations at the Defence Explosive Factory, Maribyrnong (Melbourne). Source: https://apps.epa.vic.gov.au/EnvAuditFiles/53X/46115-2/46115-2_b_.pdf p129

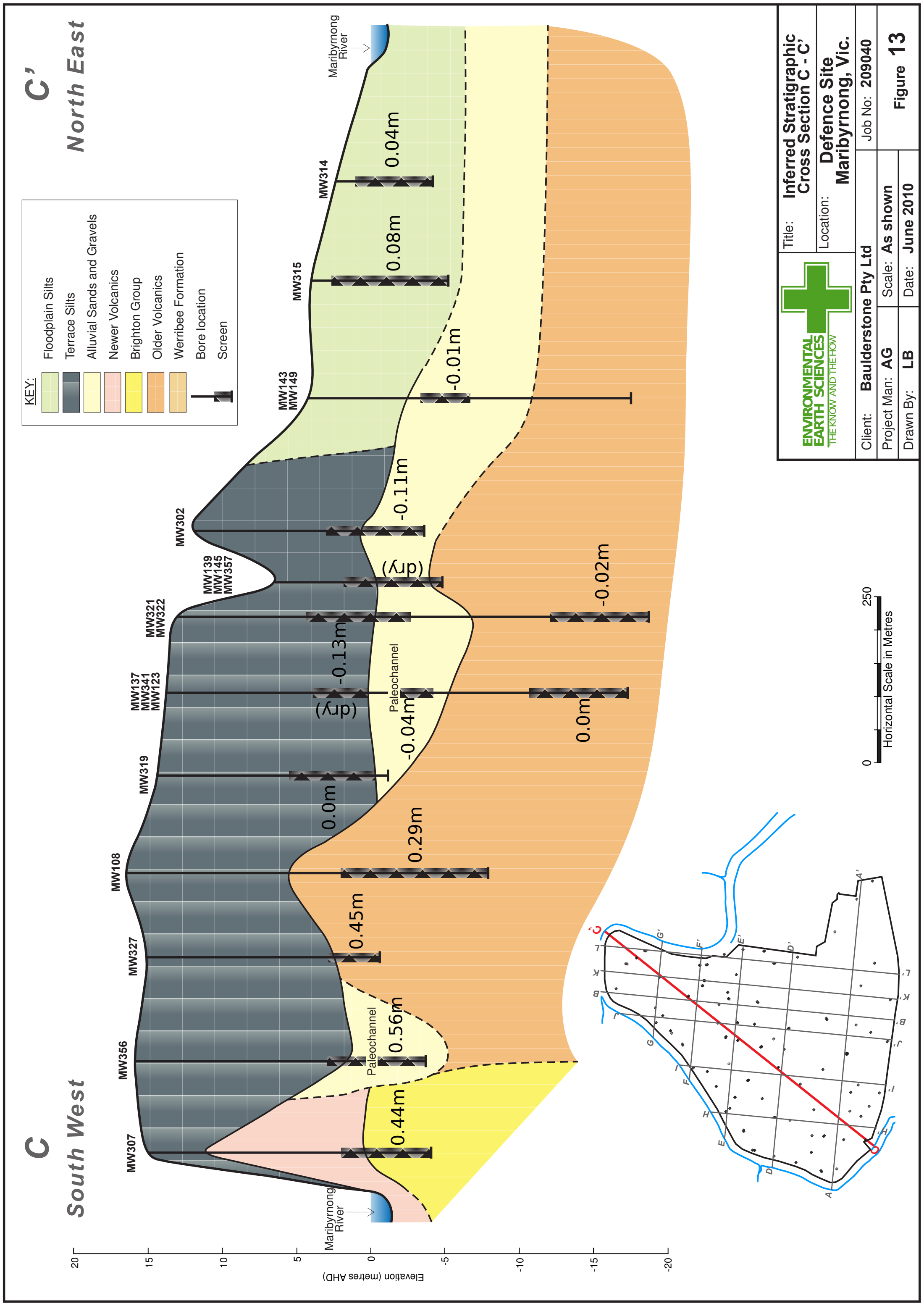

Figure 3: South west-north east cross section of geology and groundwater observations at the Defence Explosive Factory, Maribyrnong (Melbourne). Source: https://apps.epa.vic.gov.au/EnvAuditFiles/53X/46115-2/46115-2_b.pdf p130