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Evaluation of geophysical techniques to characterize depth to shallow groundwater in the agriculturally important Northern Adelaide Plains, South Australia

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The arid plains north of Adelaide, South Australia (~450 mm of rainfall per year) have historically been an important food growing area in Australia, presently supplying the city of Adelaide with much of its fresh produce. Recent proposals to extend the quantity of food produced by increasing the amount of irrigation water available to growers in the area (sourced from treated sewage plant effluent) needs to be evaluated closely so that this new water source is used appropriately. Importantly, depth to groundwater and groundwater quality over the area are variable and not well known. While a large-scale airborne electromagnetics survey may ultimately be useful, understanding the local soil conditions and how they interact with local conditions and farming practice means that understanding this variability is necessary.

Underlying groundwater quality ranges from fair to poor. Salinities approaching ocean water have been found in some areas. Depth to shallow/perched groundwater is variable as well, ranging from <2 m to >15 m. High risk areas are likely to be associated with zones where the groundwater is shallower than 3 to 4 m. In these areas even slight over-irrigation will result in bringing groundwater to the surface; additionally, limited available data suggest that these are often the zones with the highest groundwater salinities as well. To assist with water-use planning it is necessary to be able to evaluate which parts of the plain are suitable for extensive irrigation and which are more suited for more intensive/expensive farming methods, such as hydroponic farming of tomatoes, where potential for water loss to the shallow aquifer is less.

Starting in 2017, we have collected geophysical data sets at three study sites within the Northern Adelaide Plains (NAP) area. Techniques evaluated include: a frequency domain, shallow terrain conductivity meter; a fast-sampling time domain electromagnetics system; a resistivity system; and a shallow reflection seismic system where first arrival times and surface waves were processed together to estimate depth to groundwater. Additionally, to provide background information and further information on soil variability, as well as groundwater depth and quality, 47 geoprobe boreholes were drilled and geologically logged. These bores were drilled to 6 to 8 m depth. If water was encountered these holes were extended and then logged using a shallow borehole NMR system.

Evaluation of these results suggest that: a) while much of the study area is flat, subtle features in the landscape (predominantly ephemeral streams) appear to be important conduits to supply water to shallow and perched water tables; b) the seismic survey appeared to provide useful information about depth to groundwater; and c) all of the electrical techniques provided information about depth to groundwater – when there was sufficient contrast between the soil host and the groundwater.