Australian Government
Cotton Research and Development Corporation

FINAL REPORT 2019

For Public Release

Part 1 - Summary Details

Please use your TAB key to complete Parts 1 & 2.

CRDC Project Number: UNSW1601 (UNSW ID RG151699)

Project Title: Baselining Lower Namoi Groundwater and Evaluating Pilliga CSG impacts

Project Commencement Date: 1/07/2016 **Project Completion Date:** 30/12/2018

CRDC Research Program:

Industry: 2.2.4 Researching the connectivity between cotton farms and natural systems.

Part 2 – Contact Details

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Date Submitted: ____________

Part 4 – Final Report Executive Summary

Provide a one-page Summary of your research that is not commercial in confidence, and that can be published on the World Wide Web. Explain the main outcomes of the research and provide contact details for more information. It is important that the Executive Summary highlights concisely the key outputs from the project and, when they are adopted, what this will mean to the cotton industry.

Hydrochemical and isotopic results reveal that there are distinct differences in the groundwater chemistry with depth throughout the Lower Namoi Alluvium (LNA). This is due to varying recharge processes, as well as the evolution of the groundwater chemistry through the system. Na-HCO3 -type groundwater is dominant throughout the study area, increasing in concentration with depth. Locally, in areas where the alluvial sediments have a higher proportion of clay, the groundwater is more saline because of evapotranspiration processes and is classified as Na-Cl-type groundwater. Groundwater residence time (an indicator of age) is correlated with distance from the river channel for near surface samples, and with depth due to increased proportional input for the Great Artesian Basin (GAB). Where the groundwater is enriched in Na^+, it is most likely the result of mixing between the Na^+-rich GAB groundwater and surface-sourced water (river leakage, floodwater recharge, and areal recharge (including irrigation deep drainage)). The weathering of silicate minerals and cation exchange processes in the shallow alluvium with a higher clay content may also contribute to the enrichment of Na^+ in the LNA.

High activities of tritium (^3H) in the shallow aquifer close to the river corridor highlight the importance of river leakage and flood associated recharge to total aquifer recharge. Modelling the mixing of various water types using a box model mixing approach shows that large floods are the biggest contributor to the renewal of the near-river shallow groundwater. Our calculations also show that minor recharge occurs into the shallow groundwater proximal to Namoi River in years when the region experiences average rainfall. Isotopic data ($^{36}Cl/Cl$, ^{14}C and ^3H) indicate that the residence time of the groundwater is highly dependent on the proportion of groundwater sourced from surface recharge and input from the GAB in each location. The Lower Namoi alluvial groundwater in the study area is a mixture of groundwater of different origin mainly: a) a young component with residence times of < 70 years associated with periodic flooding and; b) groundwater that is potentially hundreds of thousands of years old, mostly derived from outflow from the GAB units.

Methane is ubiquitous throughout the alluvium, with the concentration increasing significantly with depth. The CH_4 isotope data suggest that the CH_4 in the LNA is biologically produced, with varying degrees of microbial oxidation occurring. Our results, coupled with CH_4 data collected from formations underlying the GAB (primarily the Hokissons coal seam) by Eastern Star Gas (ESG 2008-2011) suggest that mixing of groundwater in the LNA with water from the GAB has influenced both the occurrence of CH_4 in the alluvium (hence the increased concentration and lighter isotopic signature with depth), and the processes acting on the CH_4 once it has reached the LNA. Microbial community analyses of the alluvial groundwater show 3 distinct changes in composition with depth. These changes with depth are related to the changing geochemical environment through the vertical profile of the LNA, because of multiple recharge inputs. There are significantly less methanogens in the groundwater than suggested by the CH_4 concentration, indicating that in situ production is not the primary source of CH_4 to the alluvium.

Comprehensive details on the biogeochemical results from this project are published in:

Iverach C.P; Cendón D.I.; Meredith K.T.; Wilcken K.M.; Hankin S.I.; Andersen M.S.; Kelly B.F.J, (2017) A multi-tracer approach to constraining artesian groundwater discharge into an alluvial aquifer, Hydrology and Earth System Sciences, vol. 21, pp. 5953 - 5969, http://dx.doi.org/10.5194/hess-21-5953-2017