Sample Application of Visual MODFLOW Flex: Mine Dewatering at Open Pit Mine

Keywords

MODFLOW-NWT, Mine Dewatering

Background

Open pits are developed in the mining industry for the extraction of minerals, raw materials, and aggregate. In many circumstances, these pits are excavated below the water table. Depending on the geologic environment and proximity of streams, rivers, ponds and lakes, significant groundwater inflows may occur. The magnitude of these inflows must be estimated so that pumping systems can be designed to collect and dispose of the water. In addition, these inflows can result in significant drawdown of the water table in the surrounding countryside. This drawdown can impact on water supply wells and baseflow in streams.

Because groundwater flow systems are heterogeneous and subject to a variety of influences such as recharge, rivers and wells, analytical techniques are often insufficient for identifying the critical parameters in these types of analyses. This example demonstrates some techniques for estimating pit inflows and their impacts on the surrounding flow system. The flow system in this hypothetical exercise includes a shallow regime, which is locally recharged, and a regional sub-system, which is reasonably isolated below a confining layer. The topography slopes gently toward the west. The western hydrologic boundary consists of a river.

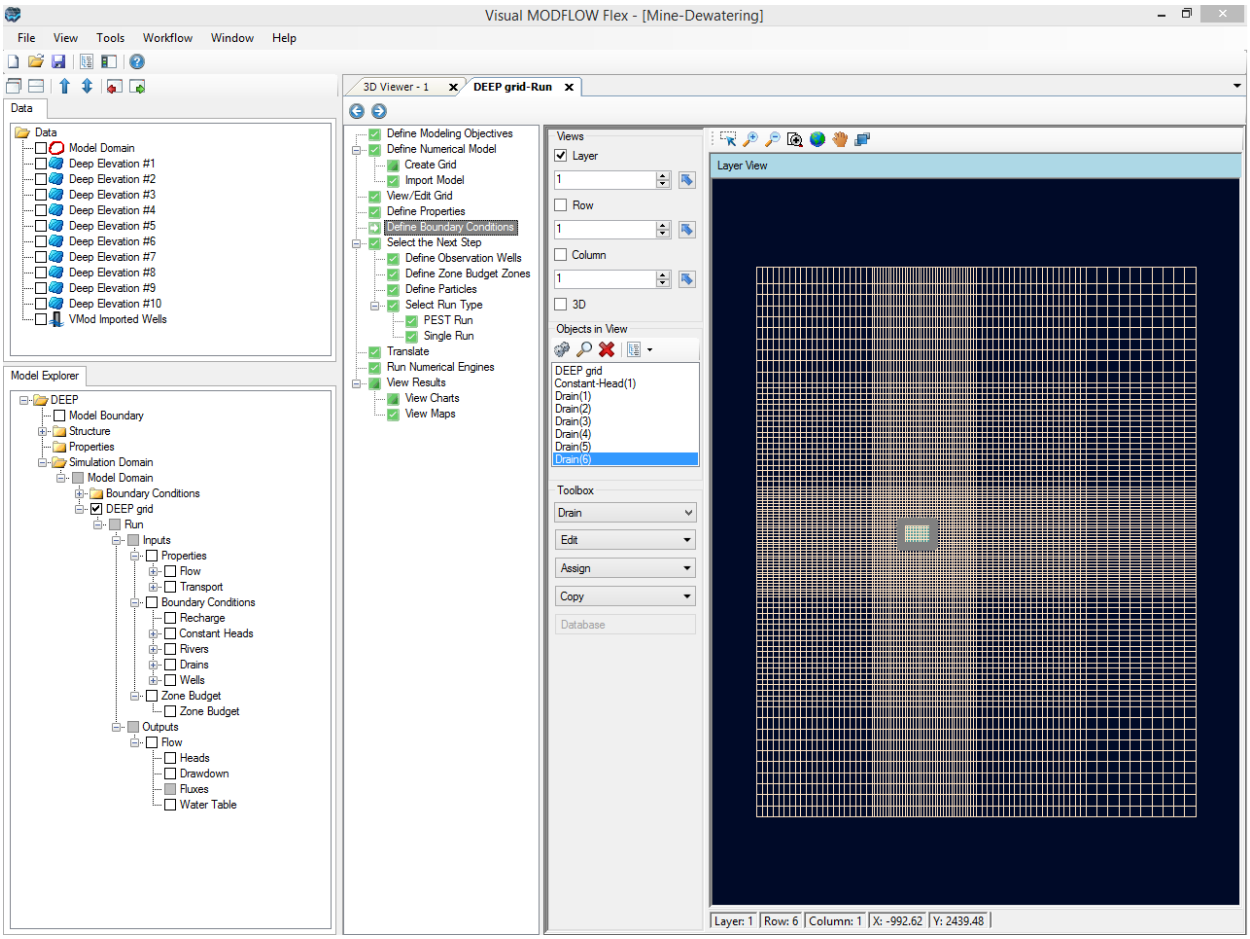

Figure 1: Drains around open pit

Objectives

The scenarios that we're going to analyze include the impacts of the first stage of pit construction (shallow pit), then the impacts of a deeper pit. A model of the ambient flow system has been provided for you. It will serve as the basis for future sections of the exercise where we will be simulating the impacts of an open pit.

Modeling Approach

The pit seepage face requires special consideration because the head along this face is not known in advance. However, the boundary can be specified with the knowledge that the pressure head at the seepage exit face is zero. Therefore, the piezometric head is equal to the elevation head. To simulate this condition, MODFLOW drains can be assigned along the seepage face with drain elevations equal to ground surface elevation. The ground surface elevation of a given model layer can be approximated as the elevation of the centre of the cell. These drains surround the area that represents the pit and their geometry will be defined by the shape of the pit contours. With this formulation, the pit face is modeled at the centre of the cell. Drain boundaries are also assigned to the bottom of the pit. It is a bottom seepage face.

Note, that there are inactive cells within the area of the pit, as indicated by the turquoise green cells. If we were to leave these cells as active MODFLOW would try to determine the groundwater head in them. The Drain cells represent the boundary of the MODFLOW model, and therefore these cells are outside of the model boundary.

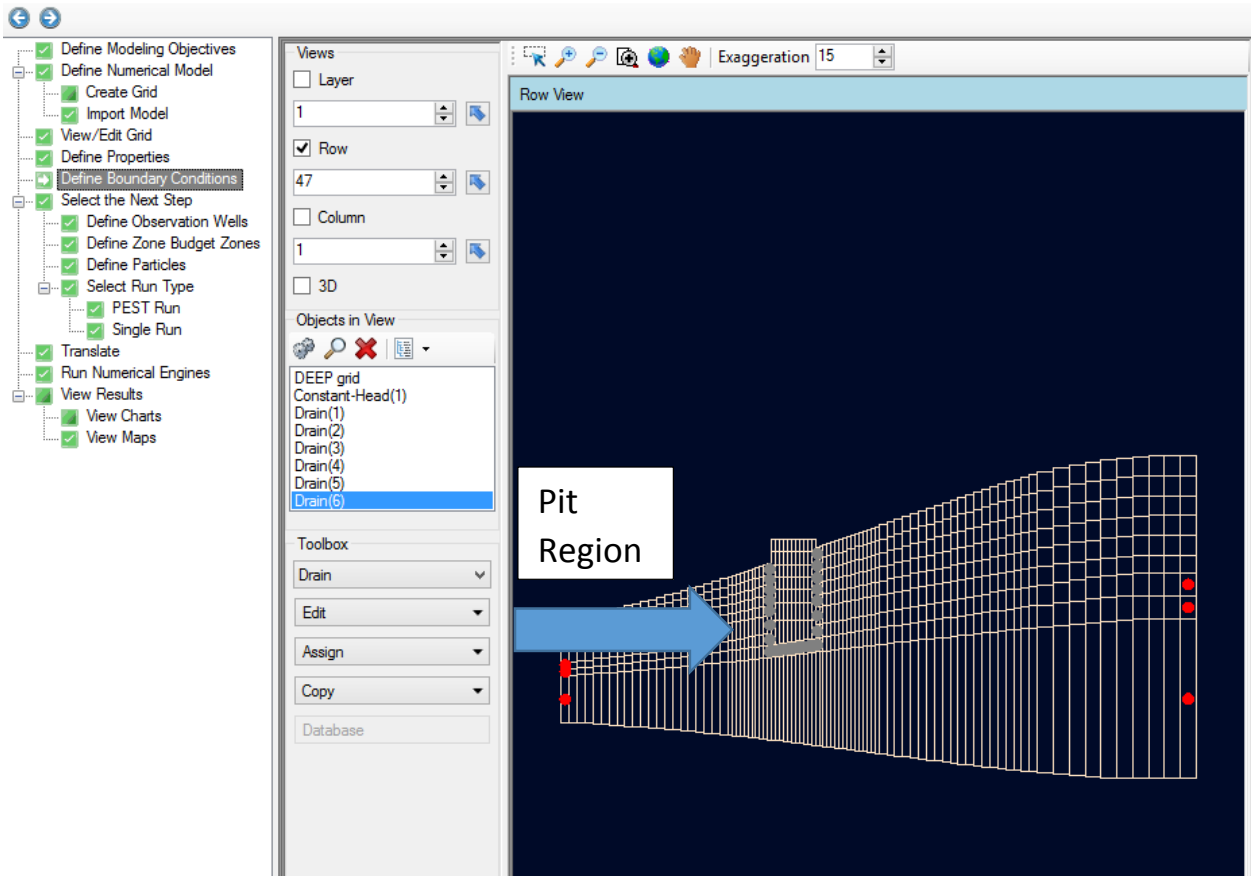

Figure 2: Cross-section view of pit region

Results

An analysis of the water table near the vicinity of the private well shows that during pit operations, the water table is still located in the well screen location.

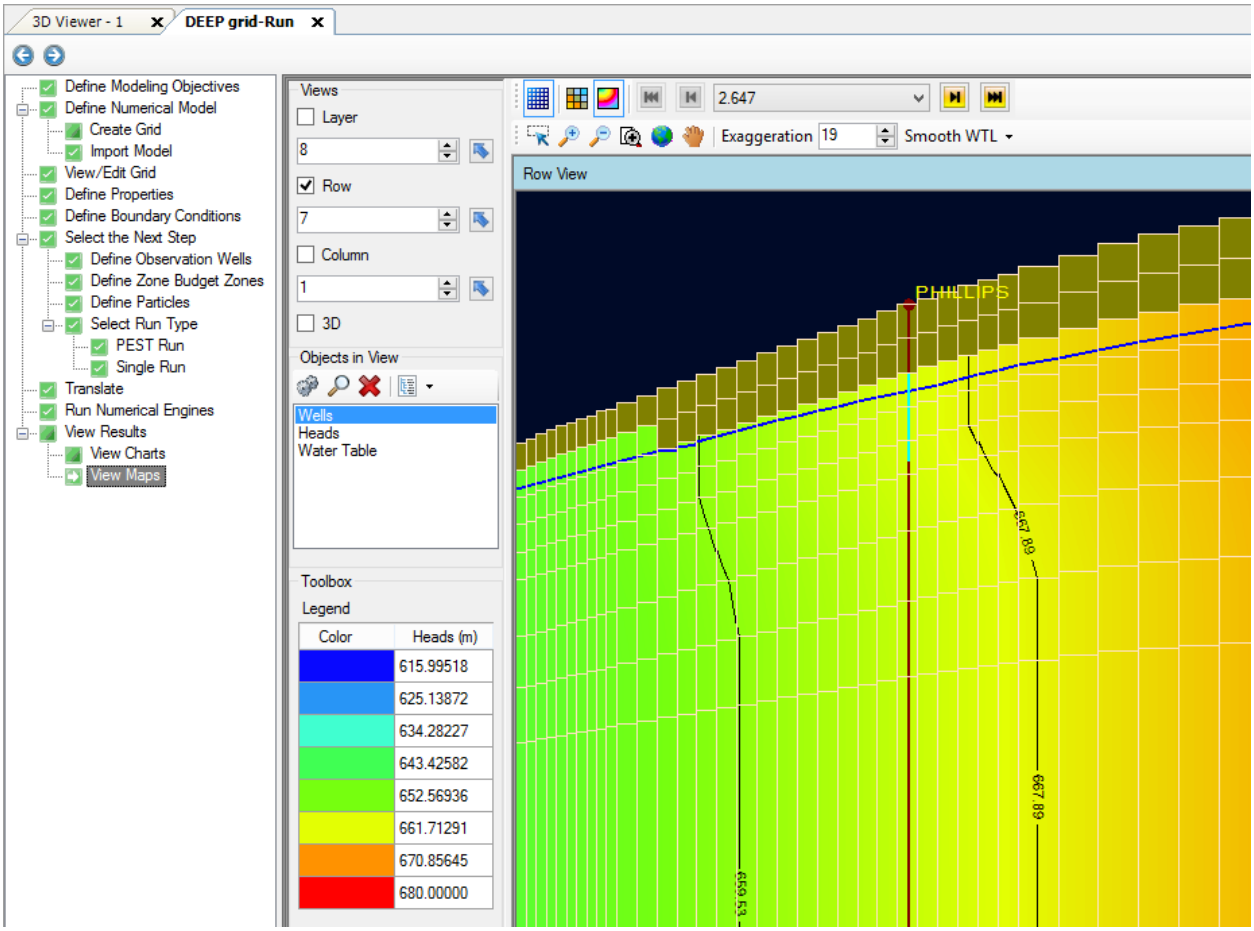

Figure 3 Water table in cross-section, over the well screen

The drawdown in the pit region is shown below:

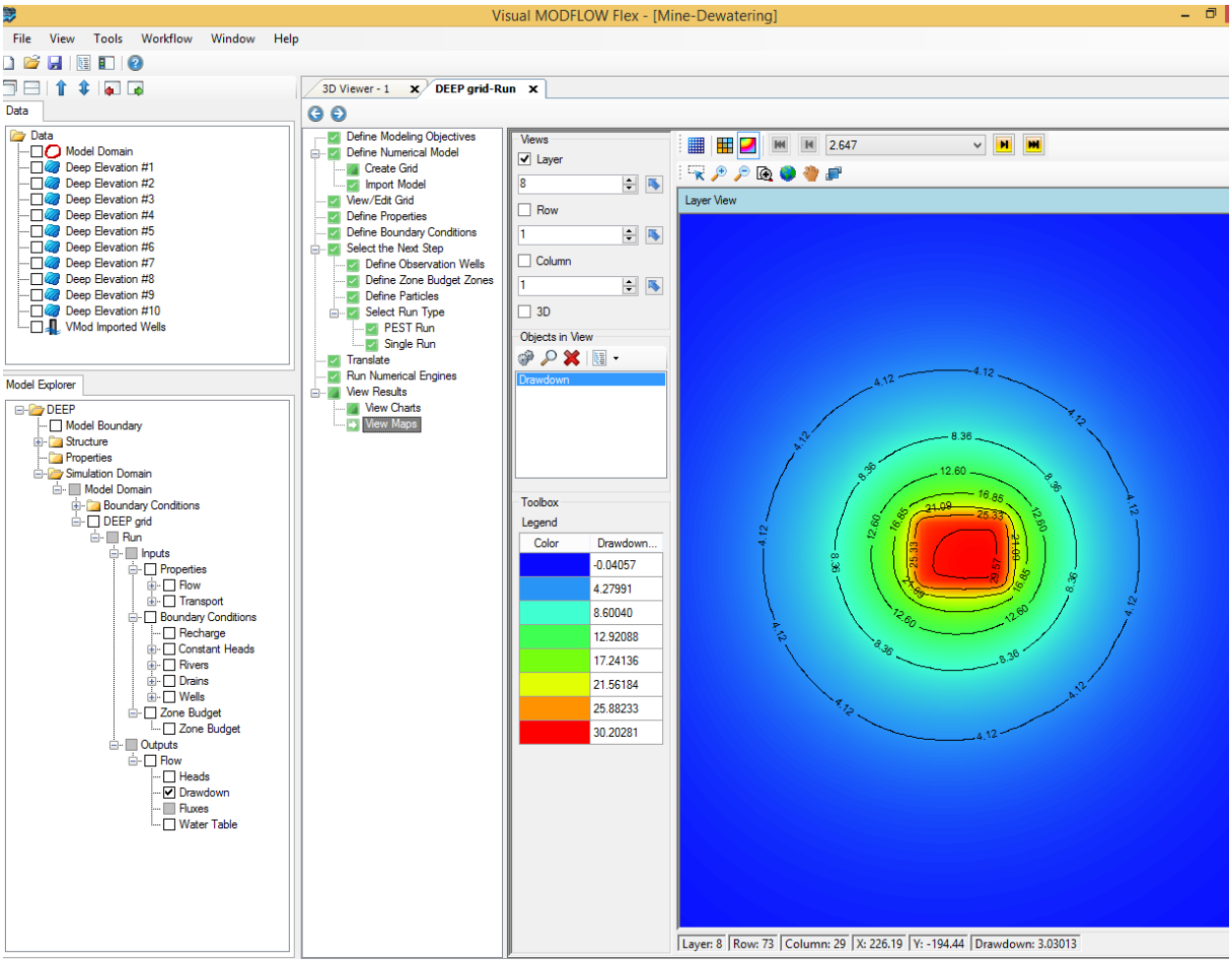

Figure 4: Drawdown layer 8, in the region of the pit

Waterloo HYDROGEOLOGIC

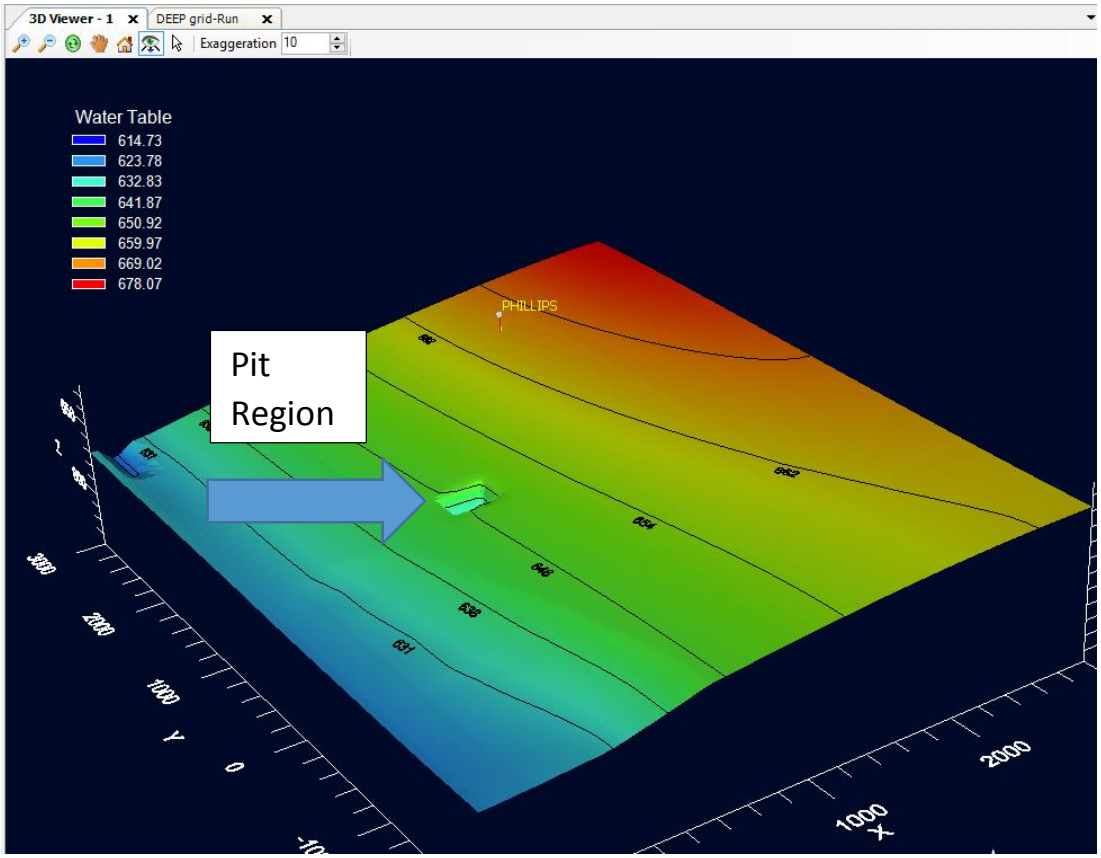

Figure 5: Water Table in 3D view; note the depression in the region of the pit

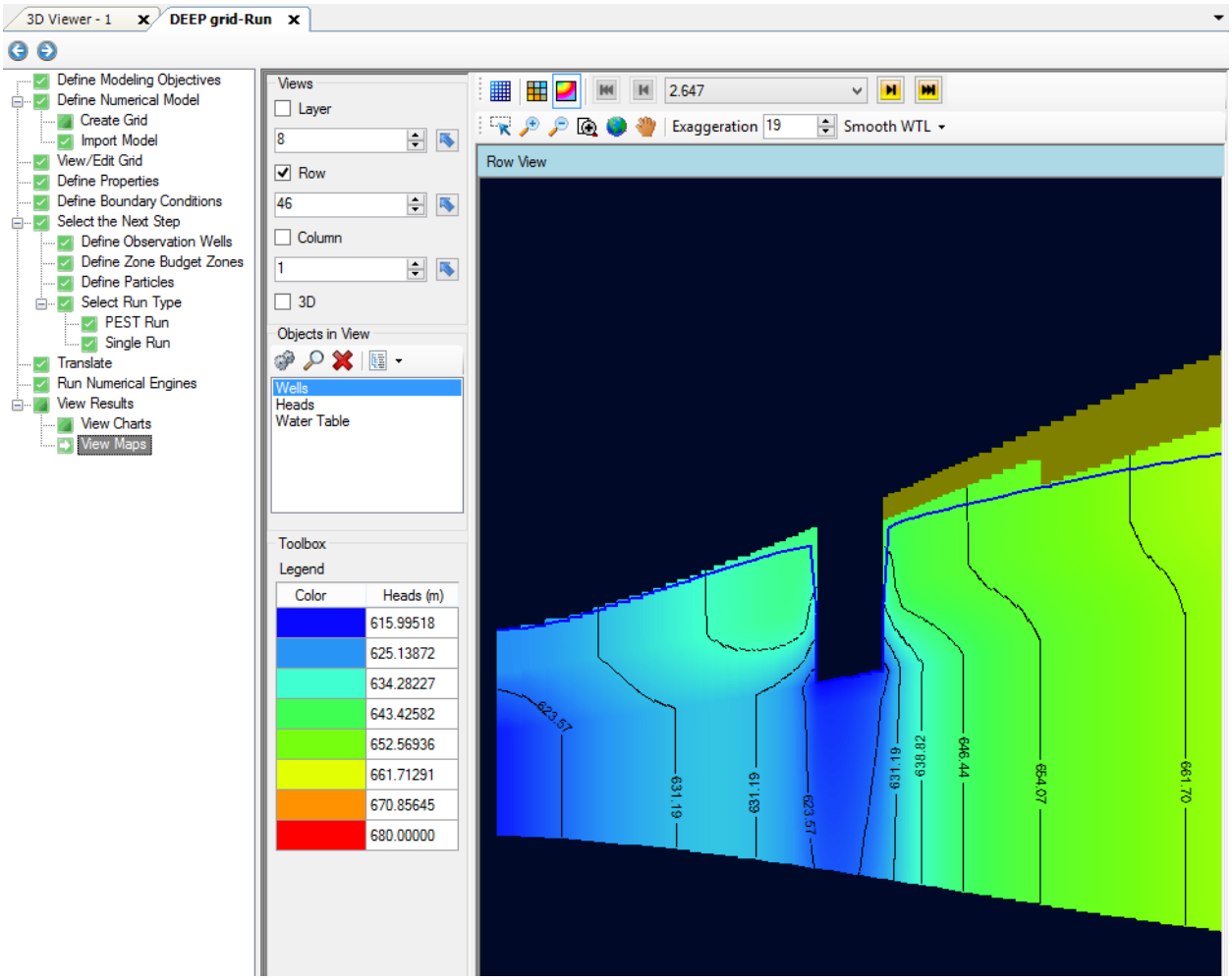

Figure 6: Cross-section through pit region showing water table