



Feasibility study: environmental and run-off attenuation reservoir at Roxhill Manor Farm, Cranfield

INTRODUCTION

Background: Roxhill Manor Farm is an agri-business located in Cranfield, on a raised elevated site with sloping land. On the farm, there is a large number of agricultural buildings and concrete hardstanding areas used for haulage and agricultural plant machinery. Rainfall run-off from the site is channelled into an existing small pond which frequently exceeds maximum capacity, thus increasing localised flood risk. Therefore, an alternative flood attenuation storage solution was needed.

Aim: to provide the Client with a detailed feasibility study of the site to support reservoir engineering design considerations and construction. The reservoir will be for environmental enhancement and flood attenuation/runoff mitigation purposes but it will also need to be carefully sited and designed to provide a safe engineered structure taking into account local topography, soils and hydrological characteristics, geotechnical aspects and compliance with regulations regarding land planning, impoundment of water (Reservoirs Act), Construction, Design and Management (CDM) regulations and Health and Safety.

METHODOLOGY

- A topographical survey was conducted using an RTK-GPS, from which the field data was used to create a GIS based Digital Elevation Model (DEM).
- A detailed study of published Geological information was combined with in-field soil survey and laboratory analysis to assess the suitability of local soil for clay-lined reservoir construction.
- A long-term daily meteorological record was collected and used to:
 - Develop a hydrological runoff model to estimate the annual water balance in the reservoir and to predict water level fluctuations over a 30 year period.
 - Calculate the intensity of a 1 in a 100 year rainfall event for the design of the emergency spillway.
- Engineering options for reservoir design were developed considering:
 - Environmental features such as curved edges, gentle slopes and shallow shelves to promote flora and fauna biodiversity.
 - Relevant planning and environmental legislation and industry guidance.
- Capital investment costs together with an annual operational and maintenance costs were estimated for the reservoir.
- Guidance for the future operation and maintenance of the reservoir were developed.



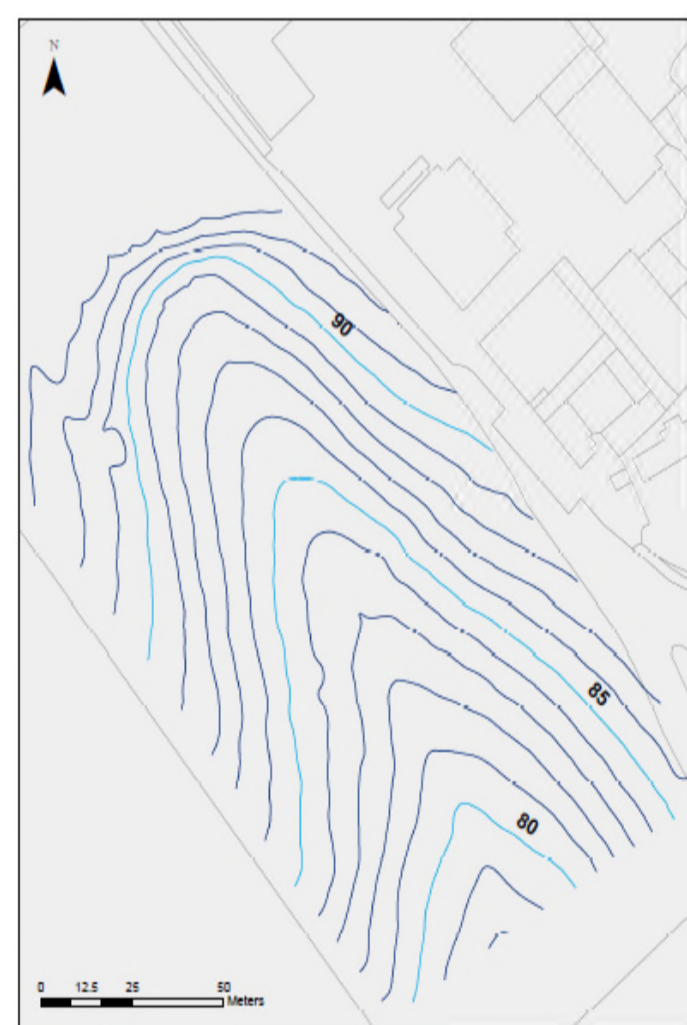
Images showing on-site soil sampling activities; (left) soil sample augering; (right) collecting soil samples for different augered depths



Particle size distribution analyses using sedimentation and pipette method in the laboratory

RESULTS

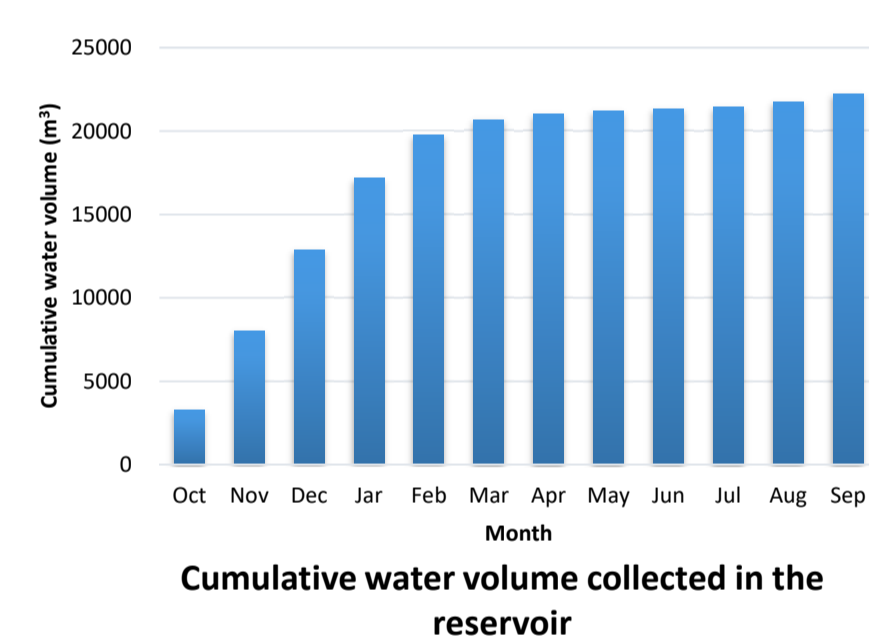
Topographical survey: a high resolution DEM was obtained from the survey. This product allowed careful design of the reservoir using CAD software.



Contour map of the proposed reservoir obtained from the DEM showing a U-shaped valley.

Soil survey: on-site soil properties were found to be ideal for a clay-lined reservoir (>40% clay content).

Hydrological model: the reservoir will collect an annual water volume of 21,500 m³.



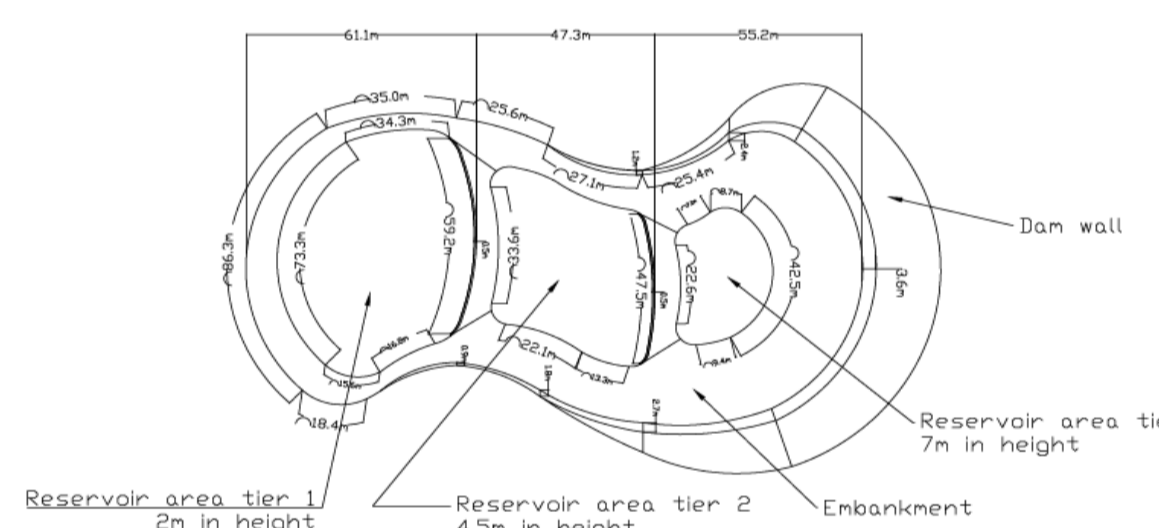
Reservoir design: a three-tiered reservoir with curved edges, gentle slopes and zoned embankments was designed.

- **Total capacity:** 36,350 m³
- **Flood capacity:** 7,500 m³

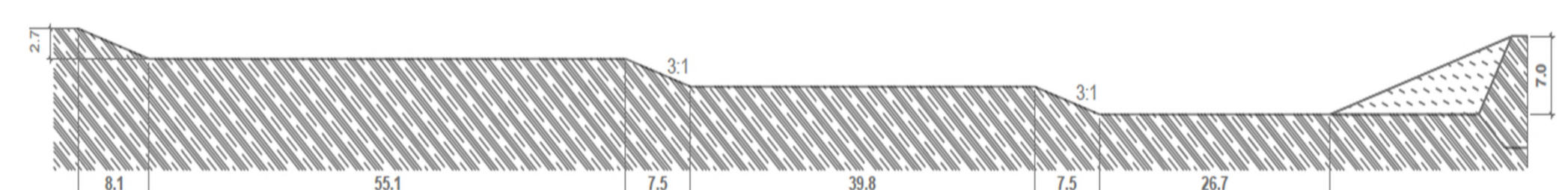
This design offers the possibility of creating a wetland habitat in the shallower tier. This environmental feature will support **great crested newt** population, which is a protected and rare species.

Spillway design: the emergency spillway was designed to remove 3 m³/s from the reservoir. An additional submerged spillway has also been designed for water level control.

Reservoir blueprint: reservoir plant-section. **Reservoir blueprint:** dam cross-section.



Reservoir blueprint: reservoir cross-section.



Final design: 3D effect picture with farm house.



CONCLUSION

Based on the results from the site investigations, it was deduced that both the local topography and parent soil material and geology were ideal for the construction of a clay-lined reservoir. Taking environmental considerations as well as conventional engineering reservoir design specifications into account, a design based on a three-tiered reservoir was proposed. This will be capable of controlling excess runoff from the farm building rooftops and reducing local flooding risk, whilst also creating a new aquatic habitat that will result in a significant environmental improvement of the site.

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The group would like to acknowledge the kind support and feedback from the Client (Robert and Julia Barnes), particularly for their valuable guidance, and use of facilities whilst we conducted our fieldwork.

This Group Project was supervised by Prof Jerry Knox and Dr David Haro – Monteagudo. The support from Dr Mike Hann and Prof Keith Weatherhead is also acknowledged.

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