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 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.

RESULTS

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

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: 36,330 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.

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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