International Journal of Engineering Research
Volume No.3, Issue No.11, pp : 628-631

ISSN:2319-6890)(online),2347-5013(print)
01 Nov. 2014

Re-circulated lake water: An optimal solution for power, revitalization and inundation - An Overview

By Swapan Ray Chaudhury[1] & Indranil Bhattacharya[2]

1.Chief Manager (Retired), TATA Consulting Engineers Ltd., Bengaluru, swapan_raychaudhury@yahoo.co.in
2. Managing Director, BR Architects & Engineers Pvt. Ltd., Bengaluru, indranil@brae.in

Abstract: This study note is a guideline to set-up a model mini hydro power station (2x500) KW capacity, using re-circulated water from a city lake. In terms of location, terrain, water availability and ease of interconnectivity Kaikondahalli & Agara Lakes in Bengaluru were found to be suitable for this Pilot Study.

Key words: Power channels, Fore Bay, Penstocks and Power Block

I. Introduction

The power scenario of the city is not bright and there are no signs of improvement either. The reason could be attributed to shortage of supply and ever increasing fossil fuel prices. This study reveals that installation of a mini hydro power station to generate electricity using lake water is a viable and sustainable alternative. In the process of power generation, the connection between the lakes is also re-established through the power channels. Further, the proposed interconnection plays an important role in flood control. The excess power may be stored for lean period.

The pilot project concept is adopted with Kaikondahalli and Agara lakes that come under the Varthur Lake Series as identified by the City Development plan for Jawaharlal Nehru National Urban Renewal Mission, Bengaluru.

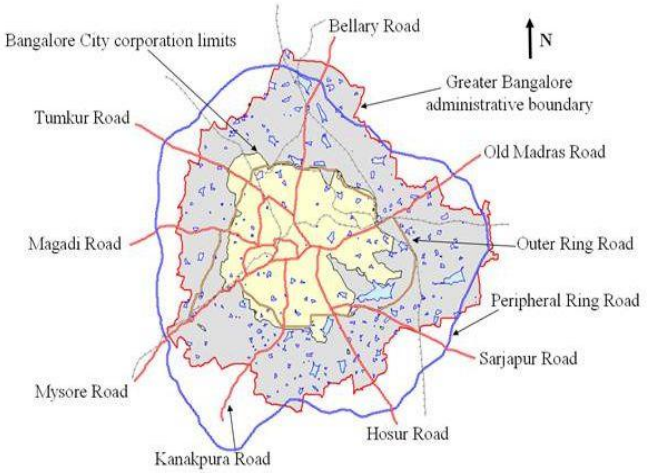


Fig. 1: Location Map of Sarjapur Road, City Development Plan for Bangalore.

II Materials and Methodology: Material for structural elements

Several options were explored to arrive at the most ideal sectional details for the given site conditions including trapezoidal, circular and square. Although a square pre-stressed concrete section was found to be economical (by almost 18 - 20%) than a concrete Hume pipe, the weight was found to be double that of a Hume pipe. Hume pipe joints are more durable in leakage point of view while edge protection of box sections involves extra time, effort and cost. Finally, concrete pipes have better flow rate.

The power house comprises of steel portal structures with standard cladding. The fore bay consists of a RCC Tank on caisson foundation. The RCC Intake pump houses are located on islands created by stone pitching embankment. The turbines sit on mass concrete foundations. The open switchyard comprises of steel structures of gantry and tower types. The paving around transformer foundation is provided with blue metal. The areas are fenced with galvanized barbed wires.

The working methods

The catchment area of Kaikondahalli Lake (the source of water) is 27 Hectares. It is estimated that the water reserve in the lake is adequate for uninterrupted operations of the proposed power plant throughout the year. Kaikondahalli Lake is located at 920M above Mean Sea level (MSL) while Agara Lake, which receives discharge from tailrace water, is located at 892M above MSL. The natural elevation of the lakes facilitates gravity flow thereby reducing transmission losses and energy costs. The power channels, ideally, should be laid along Sarjapur Road, so as to avoid diversion and deviations to minimize both cost and time.

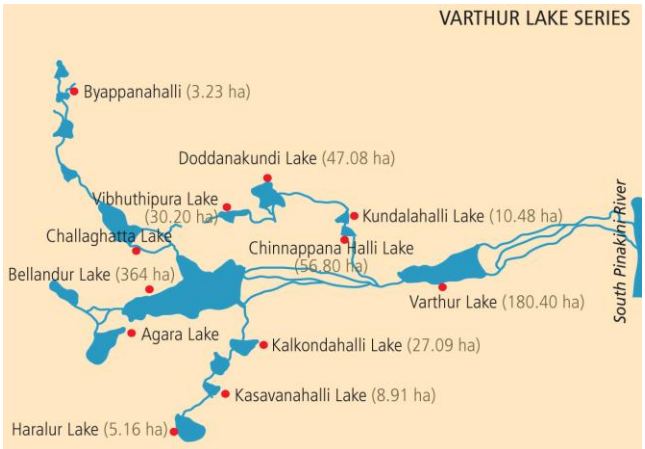


Fig. 2: Varthur Lake Series (Source: Anon 2006, City Development)

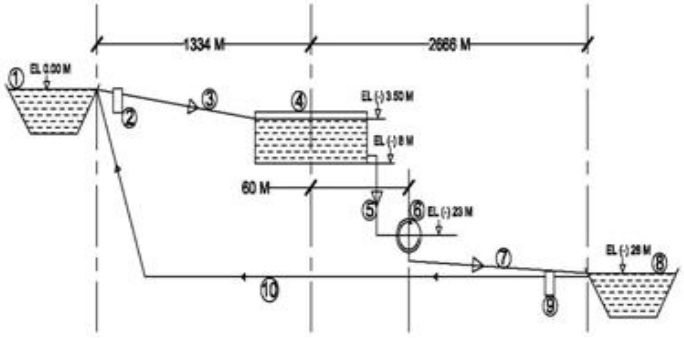
ISSN:2319-6890)(online),2347-5013(print)
01 Nov. 2014

Fig 3: A Bird's eye-view of Kaikondahalli Lake, Agara Lake & the site for the proposed Mini Hydro Power Plant in between (Courtesy Google Earth)

Functional Methods

The Site proposed for the power plant and other ancillary facilities belongs to a Military Establishment, Government of India. The plant area may be acquired by state government on long term lease. The proposed site is bounded by Outer Ring Road on one side and HSR Layout on the other end. It is part of a 'Green Belt' as defined by the Comprehensive Development Plan of Bangalore.

The RCC Hume pipes (for the proposed power channels) shall be laid adopting 'cut and cover' method to save space and time. In preparing the plant layout, an attempt was made to minimize the pumping cost and head loss by optimising the power channel route, locations of fore bay and power block. The tail race length was planned for natural cooling before discharging into Agara Lake. According to the layout of the proposed power plant, the water falls sharply for a height of 15 m out of the total 23m water head available. This head and other parameters are found to be enough to run the turbines at their rated capacities. It is proposed to pump water back to Kaikondahalli Lake, as and when required to maintain a steady water supply to run the power plant throughout the year. The working model of the proposed Mini Hydro Plant is given below under Fig.4



Legend :

1. Kalkondahalli Lake to supply water to turbine
2. Intake pump house #1
3. Head race power channel (1.20 m dia. hume pipe)
4. Forebay Tank (10.50 m x 58.50 m)
5. 0.45 m dia penstocks (2 nos.)
6. 2 x 500 KW Francis Turbines
7. Tail Race power Channel 1.20 m dia.
8. Agara Lake to get discharge of Tail race channel
9. Intake pump house #2
10. Return Power Chanel (1.60 m dia hume pipe)

Fig 4: Working Model of 2 x 500 KW Capacity Mini Hydro Power Plant

Master Planning - Architectural concept

The Master Plan features various structures for their function and services with architectural detail. The detail follows a pattern in harmony with the landscape architecture to provide a sublime environment.

The highlights of the Master Plan are as follows:

A pedestrian pathway and driveway lead to a cable stayed bridge. The cable stayed bridge is provided to carry the power channel and service duct to the fore bay tank. The bridge will be used for maintenance of fore bay tank and public entrance for over viewing the picturesque surrounding. A food court has been planned in the form of a 'castle' adjoining the cable stayed bridge for the public entertainment. It is believed that the terraces could provide for interesting vistas. The castle may be used as watch tower for security reason.

The area around the fore bay tank with its stepped terraces is planned for amphitheatre. The retaining walls of the fore bay tank could act as a backdrop for possible cultural events from time to time. The area around the Power Block shall be fenced off for safety and security reasons.

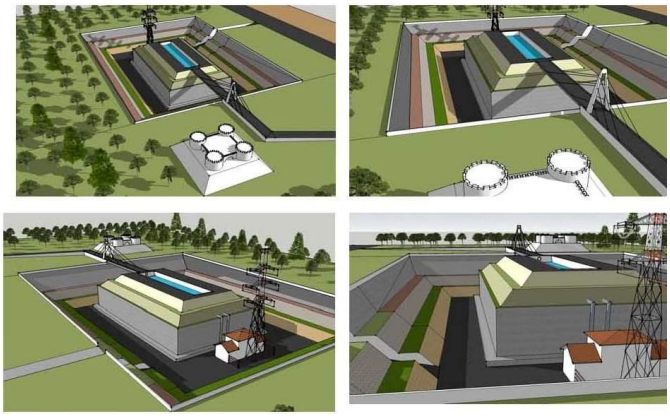


Fig 5: Artists' impression of the Master Plan for the proposed 2 x 500 KW Capacity Mini Hydro Power Plant

The overall layout is given in Fig 6. keeping in mind optimal area requirement for systems and services from functional and serviceability point of view.

ISSN:2319-6890)(online),2347-5013(print)
01 Nov. 2014

III. Conclusion

The merits from the study to set up above plant attributes a clean and green, sustainable and reliable power plant, Connection of lakes is also established through recirculation of lake water for revitalization. It is believed that the mini hydro power station would be a realistic and reliable solution for the future.

References

i. *Google earth map for location and overall view of the power plan , 2014*
ii. *Google map for distance between and elevations of lakes*
iii. *Proceedings of National Seminar on Environmental Pollution for catchment areas of the lakes ,1995*
iv. *Proceedings of the 2014 Industrial & System Engineering Research Conference. Y.Guan & H.Liao*

ISSN:2319-6890)(online),2347-5013(print)
01 Nov. 2014

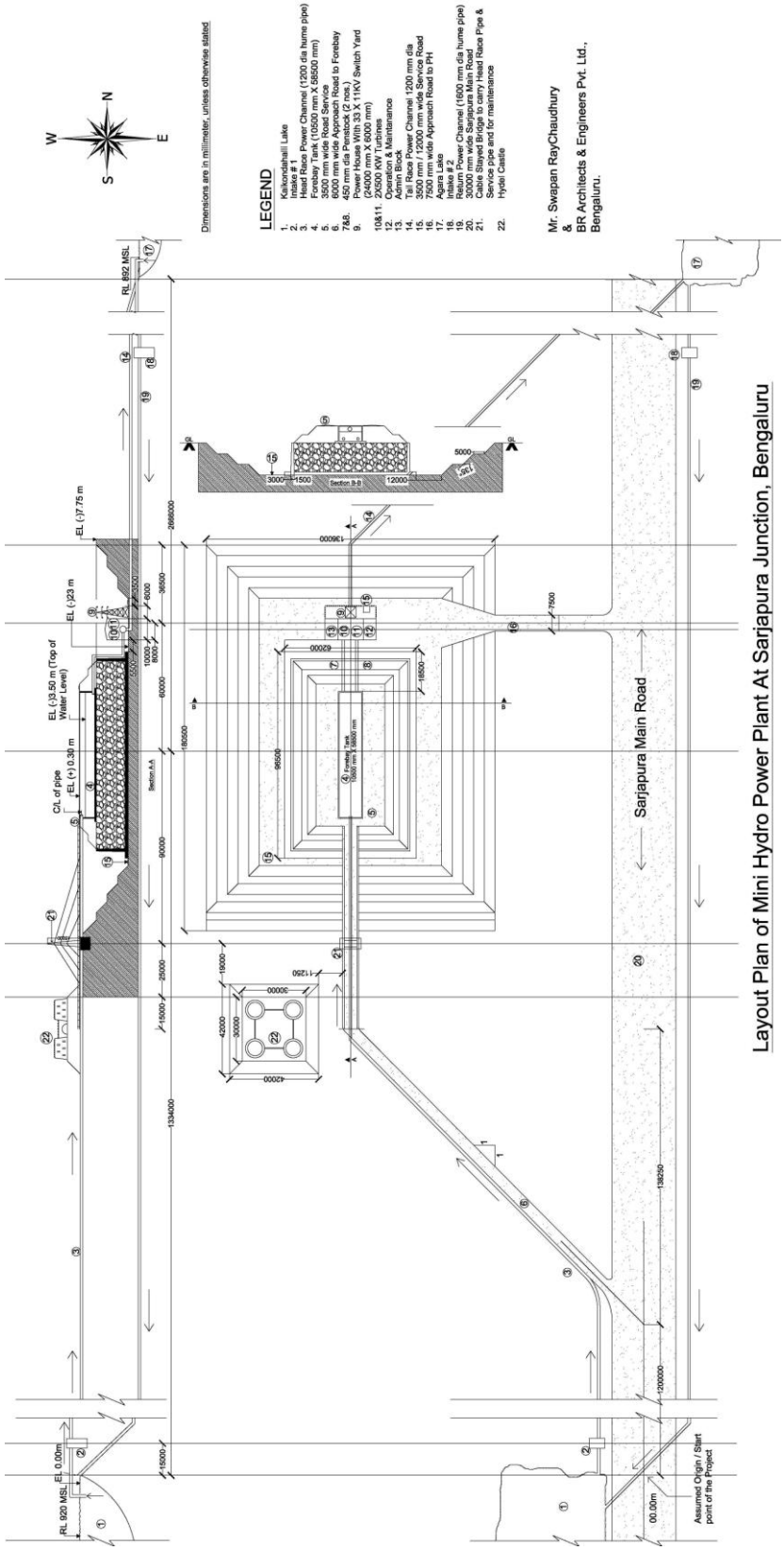


Fig 6: Overall Layout of the proposed Mini Hydro Power Plant