CASE STUDY

Revolutionizing Irrigation Pipeline Design using ArcGIS

Client
L&T Construction's Water & Effluent Treatment IC

Industry
AEC

Organization Profile
L&T Construction's Water & Effluent Treatment business vertical provides state-of-the-art design, detailed engineering, procurement, project management, project execution, commissioning and operation & maintenance for: Water Transmission, Treatment; Distribution and Management; Municipal Used Water Collection Treatment and Reuse; Industrial Water Treatment to achieve Ultra-Pure Water; Industrial Effluent Treatment and Zero Liquid Discharge / Recycle; Desalination Plants - Sea Water / Brackish Water; "Unaccounted for Water" Projects to Monitor the Water Loss; Lift Irrigation Projects; Refurbishments of Treatment Plants; Canal Relining projects. With a fiscally sound approach to projects, proven project management skills, country wide operational presence, and an experience & expertise that spans over 40 years, L&T is recognized as the leader in developing and providing water infrastructure in the country.

Solution
Irrigation Pipeline Design

Website
www.lntecc.com

Project Summary

In recent times, lift irrigation projects have emerged as a popular solution for supplying water to agricultural lands at elevations higher than the source of water. The integration of GIS into irrigation projects has revolutionized the way these projects are planned, designed, and managed in India. The technology can also be used to automate various processes and tasks in the lift irrigation project lifecycle. The successful implementation of ArcGIS products in the Lower Suktel Irrigation project serves as a case study showcasing the potential of GIS in such endeavors. The case study highlights how GIS facilitated the design and execution of the project, offering insights into how this technology streamlined the process and contributed to the project's success. By leveraging GIS technology, the project was able to achieve a more streamlined and effective execution, ensuring that the irrigation system is not only well-designed but also optimized for cost savings and operational efficiency. The ability to cater to a large cultivable area and incorporate micro irrigation compatibility underscores the scalability and versatility of GIS in irrigation projects.

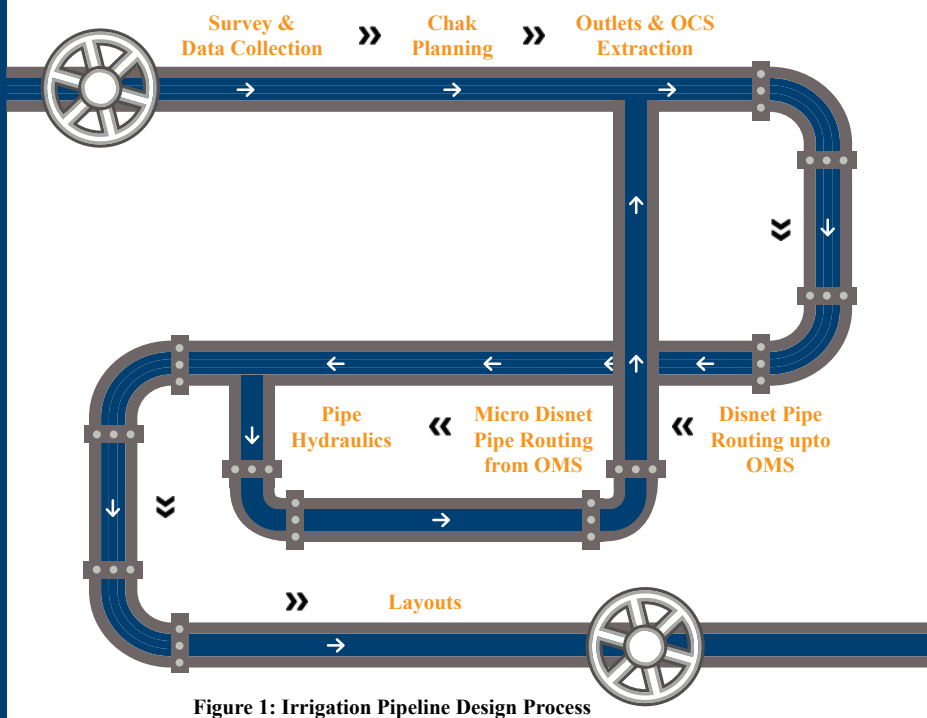


Figure 1: Irrigation Pipeline Design Process

The Lower Suktel Irrigation project in Odisha, with a distribution network of up to 1 ha sub chak compatible with micro irrigation for 27000 hectares of cultivable area, is the subject of this case study, which describes the use of GIS in irrigation pipeline design.

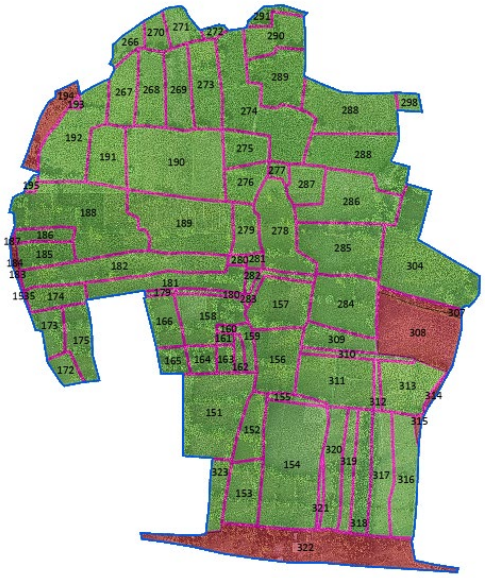
Achieving Optimum Efficiency with GIS

Chak Planning

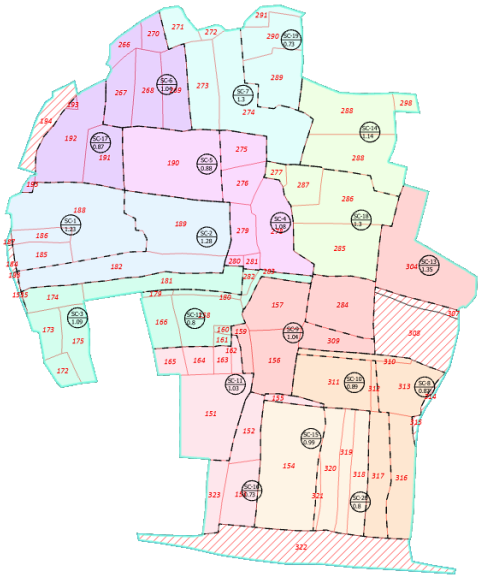
The process of chak planning in irrigation management is undeniably foundational and traditionally labor-intensive. The establishment of layouts for chaks, which serve as basic units within the command of a channel, has conventionally involved significant manual effort using tools like AutoCAD and Excel. This process typically requires merging land records manually, which can be time-consuming and prone to human errors.

The adoption of GIS, particularly through customized tools developed using ArcGIS Model Builder, has proven to be a game-changer in this aspect of irrigation planning. **About 50% of time saving is attained in chak planning process using ArcGIS with minimal manual errors.**

Land Records (ROR) Overlay



Cultivable & Non - Cultivable Making



Sub - Chak Plan
Figure 2: Chak Planning

Distribution Network routing

Assured and timely irrigation water supply is indeed crucial for maximizing agricultural production within a command area. The efficiency of a water delivery system significantly impacts the ability to meet these needs. Designing and constructing a well-planned water delivery system is essential to ensure the efficient functioning of the irrigation network. The implementation of the least cost path analysis (LCPA) as an automated tool for generating a preliminary distribution pipeline network is a significant advancement in the field of pipeline distribution design. LCPA allows for the creation of an optimized distribution pipeline network, ensuring that water is delivered using the most efficient and cost-effective routes. The toolset based on LCPA aids in identifying the least costly path for laying down pipelines, minimizing construction expenses while ensuring a well-connected network. The use of an automated tool for this purpose streamlines the pipeline network design process, reducing manual effort and time while also potentially reducing errors.

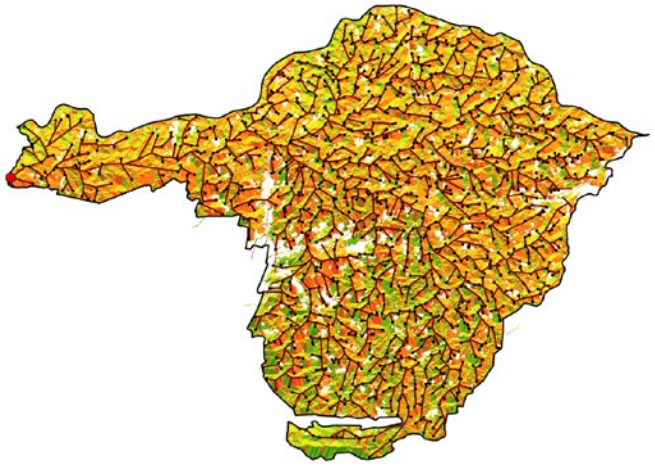


Figure 3: Distribution Network

OCS and Outlet Locations

The utilization of the zonal statistics tool within ArcGIS Pro to develop an in-house automated toolset is a smart approach for irrigation planning and management. This process not only optimizes the placement of sub-chak outlets but also aids in efficiently locating the Outlet Management System (OMS) or Outlet Control System (OCS). By using the zonal statistics tool, the toolset can identify the highest elevation point within a chak. Placing sub-chak outlets at this point ensures efficient water distribution, leveraging gravity to distribute water effectively.

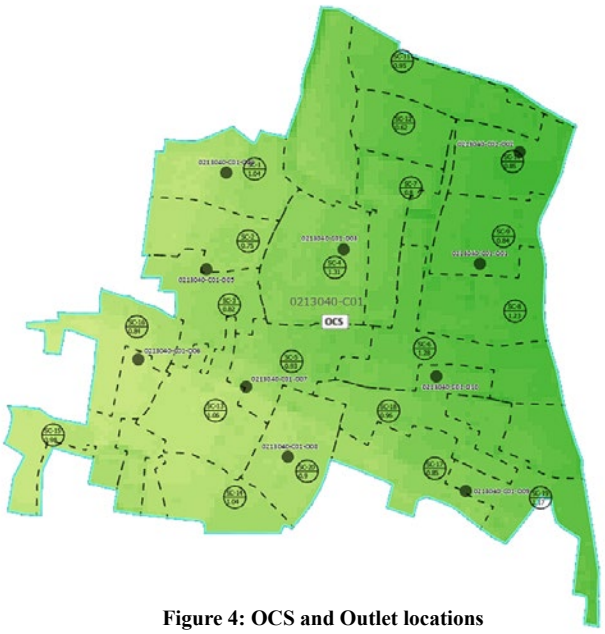


Figure 4: OCS and Outlet locations

Microdisnet Routing

Microdisnet is the pipeline routing from OCS to the outlet of each chak. Leveraging the attribute data, an in-house toolset has been developed to route pipelines from OCS to sub-chak outlets for all the chaks.

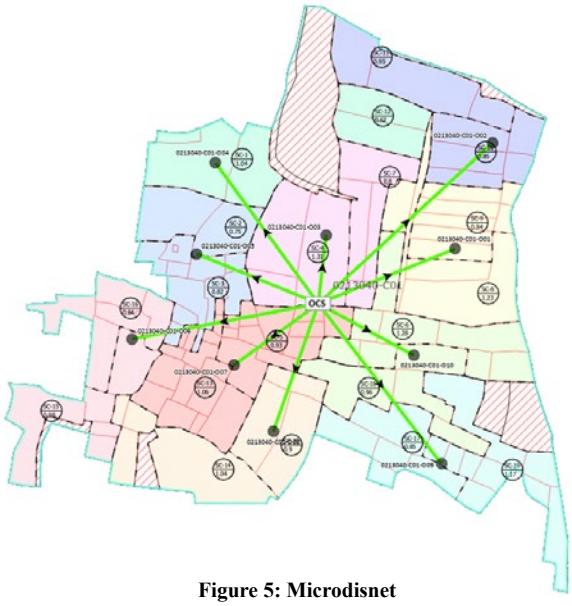


Figure 5: Microdisnet

GIS Layouts for Approvals

Map Series in ArcGIS enables the automated generation and updating of layouts for command maps, index maps, and schematic maps. The layout preparation in ArcGIS is object based and any changes in the design can be seamlessly updated to the entire database. With Map Series, maintaining consistency in layouts across multiple maps becomes efficient.

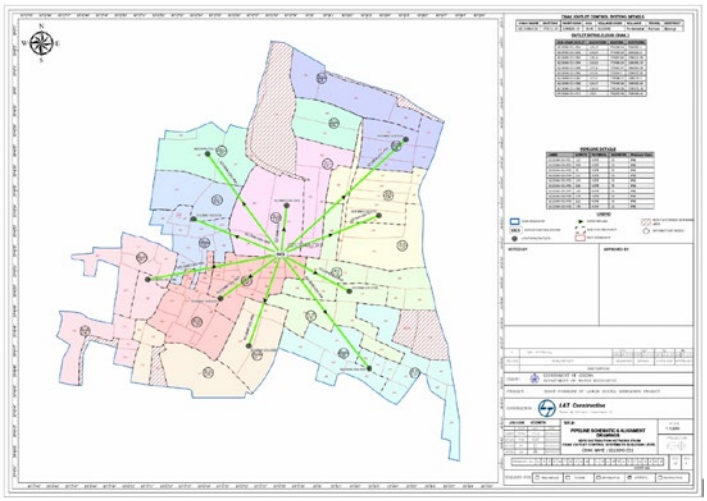


Figure 6: GIS Layouts

Digital Execution

The development of a dashboard using ArcGIS Online involves publishing all design data, including pipeline details, fittings, OMS (Outage Management System), and outlets on the web for streamlined execution. This approach allows site engineers to easily visualize both the data and associated design details directly from the dashboard, enhancing the efficiency of execution.

Progress Monitoring

Monitoring progress via GIS dashboards represents a potent method for visually tracking and analyzing diverse data types across geographical locations. These dashboards provide real-time or near-real-time insights, empowering users to make well-informed decisions based on the latest information.

Overall, the integration of GIS technology in lift irrigation projects has been a game-changer, revolutionizing the way these projects are approached, designed, and managed. The Lower Suktel Irrigation project stands as a testament to the potential of GIS in transforming agricultural irrigation systems.

> ArcGIS empowers the qualitative design of irrigation pipelines by seamlessly integrating spatial data, enabling precise planning and analysis for optimal infrastructure development, ensuring efficient water distribution, supporting sustainable agricultural practices through informed decision-making and resource management.
>
> **– Dr Rajesh Kumar, HEAD - EDRC (DIGITAL), III SBG - WET IC, L&T Construction**

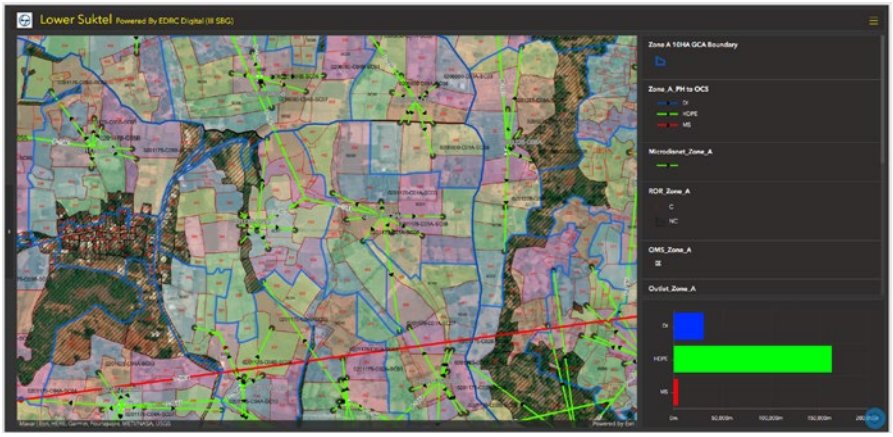


Figure 7: ArcGIS Dashboard Enabling Easy Visualization of Data & Design Details

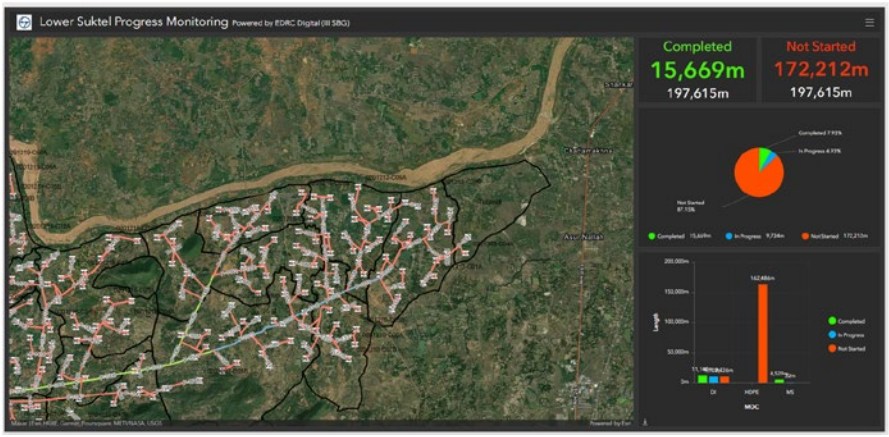


Figure 8: ArcGIS Dashboard Enabling Monitoring the Progress of the Project