BURNSIDE

Improving Water Supply in Northern Mozambique

Association of Consulting Engineering Companies | Canada

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Entry by:

R.J. Burnside & Associates Limited

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ASSOCIATION OF CONSULTING ENGINEERING COMPANIES | CANADA

CANADIAN CONSULTING engineer

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Entry Submitted By:

R.J. Burnside & Associates Limited
15 Townline
Orangeville ON L9W 3R4 CANADA

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(R.J. Burnside International Limited undertakes Burnside projects outside of Canada)

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Improving Water Supply in Northern Mozambique

Project Summary

Mozambique needed to improve drinking water supplies in urban centres. Burnside developed 20-year master plans for water infrastructure in eight critically underserviced cities, overcoming technical and cultural challenges unique to this seasonally dry, remote environment in Sub-Saharan Africa. Burnside designed immediate upgrades for each city, applied appropriate technologies and oversaw construction of works that doubled the water supply available to half a million people in the city of Nampula, improving health and saving lives.

Nampula water treatment facility before rehabilitation and expansion (left) and after, with construction mostly complete (below)

Project Highlights

Social and/or Economic Benefits

Half the population of Mozambique lives in poverty despite strong economic growth since emerging from a devastating three-decade civil war in 1992. Improving access to water supply is a key element of the Government's action plan to overcome this challenge.

Women fetch water at a community water point. Improved access will decrease the time necessary to obtain water and thereby allow more time for other productive activities.

The main objective of this project was to increase the accessibility, reliability and quality of water supply services in urban centres, thereby increasing productivity, reducing water-borne diseases and benefiting the most vulnerable.

Burnside led a team to complete feasibility studies for eight cities to assess the existing conditions, estimate future water demands, and propose solutions to meet needs over the next 20 years. This included socioeconomic studies and detailed water resources investigations. The outcome was a series of master plans to guide the necessary infrastructure investments. Burnside completed the detailed design for over USD 200 million in immediate water system upgrades for the eight cities. Our team then oversaw construction of immediate upgrades in the city of Nampula.

Over the duration of the project (2009-2013), Nampula's population increased from 515,000 people to 615,000 people. The project doubled the total available supply and also extended access to a large segment of the population in the south east of the city; an area of approximately 20 km². Access to the municipal water supply was increased from approximately 52% to 64% and the available daily supply increased from approximately 40 L/person to 65 L/person.

The construction of the water works in Nampula, an investment of USD 45 million over a period of approximately two years, provided an estimated 400 full time jobs in construction and support positions. This resulted in a direct infusion into the local economy estimated at USD 2.5 million.

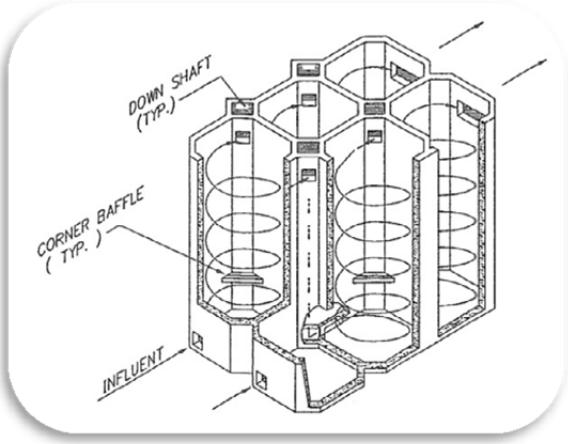
A significant project component was the Relocation Action Plan (RAP) which ensured that the physical assets of the population (dwellings, crops and "ability to derive a livelihood") impacted by the project were appropriately compensated. Most who were impacted benefited with "better than before" improvements or replacements.

The World Health Organization[1] estimates that every dollar invested to improve drinking water supply in Sub-Saharan Africa yields an average economic benefit of at least 2.5 dollars. The improvements to the quantity and quality of water available will improve health conditions and generally lead to longer, healthier lives. The improved access will decrease the time necessary to obtain water, thereby allowing for increased productivity. Bottom line? It saves lives.

See video here: https://www.youtube.com/watch?v=6saCalQPBG4

Technology Transfer

Sustainable design concepts learned on Burnside's projects in First Nations in Canada were incorporated.



Hydraulic spiral flow flocculators do not require mechanical mixers require mechanical mixers

Maintenance of mechanical components is a challenge in water treatment plants. This is exacerbated in Mozambique due to the lack of access to technical support. To mitigate these issues, passive hydraulic flocculators, similar to those in several Canadian plants (e.g., Ottawa and Toronto), were adopted, instead of mechanical systems. Inline static mixers were incorporated instead of electric motor driven rapid mix units.

Hydraulic flocculators designed by Burnside based on Canadian technology and implemented in Nampula, Mozambique

The electrical control and SCADA systems were based on well established, proven technologies in water works of similar size in Canada while incorporating equipment and components commonly supplied and serviced in the region.

The inclusive project management and team building styles that are prevalent in Canada are quite unusual in cultures where autocratic management styles prevail. While our in-country project team combined several nationalities, we strived to consistently apply the multicultural "Canadian" approach to build an effective consultant team. Open and effective communication not hindered by hierarchical paradigms was found to be particularly innovative. This was significant in addressing

[1] World Health Organization, *Global costs and benefits of drinking-water supply and sanitation interventions to reach the MGD target and universal coverage, WHO/HSE/WSH/12.01, 2012*

the many challenges that arose during construction inspection and contract administration. High ethical standards and professionalism were emphasised and adhered to throughout the project.

Throughout the project, local staff was trained in administrative tools and virtual management of project documents that integrated the in-country office with the home office in Canada. This was particularly effective in the processing of contractor submissions such as shop drawings, payment certificates and statement of claims.

Environmental Benefits

The project was funded by the Millennium Challenge Corporation (MCC) of the United States. This donor establishes firm guidelines for the review of environmental and social impacts to ensure compliance with internationally accepted best practices. A project-specific Environmental Management Plan (EMP) was developed and became a key reference document throughout construction. The Engineer's inspection team included one inspector fully dedicated to monitor compliance with the EMP and health and safety standards. This significantly raised the bar on environmental and health and safety practices as compared to accepted practices in the region. Potential environmental impacts were identified and effectively mitigated during construction.

A number of features were developed through the EMP, and incorporated to specifically address environmental protection and sustainability throughout design and implementation. A two cell sedimentation lagoon was constructed to provide treatment for the by-product physical-chemical sludge, prior to discharge. All site drainage channels were designed with protection to manage the erosive soils at the site. Watercourses impacted by transmission pipeline crossings were rehabilitated and measures were implemented to control future erosion. Particular attention was given to incorporating local grasses and plants to reinstate the areas impacted by construction.

Erosion protection at the outfall from the solids management lagoons at the Nampula water treatment plant

The improvement in the water supply services to the city provided a significant enhancement to the health and wellbeing of the population.

A separate parallel project was implemented to improve sanitation and drainage and to mitigate the impacts that would otherwise result from increased water use.

Complexity

Our project team overcame significant challenges in the delivery of this project. Challenges were rooted in the complex nature and scope of the assignment, which demanded a large and diverse, multidisciplinary, multicultural project team; the location and conditions, which presented logistics, language and cross-cultural challenges; the many stakeholders involved in decisions; and the very aggressive and rigid schedule mandated by the donor.

Workers install pipes at the new 5 ML reservoir, designated as "EB5" in Nampula

The existing water systems comprised remnants of infrastructure constructed prior to 1970. Very little maintenance and improvements and almost no future planning had been done over the last 30 years, due to the civil war. This made for a uniquely challenging starting point: grossly inadequate infrastructure, little or no documentation, and no urban planning. The team conducted extensive site investigations and gathered information first-hand to understand the situation, needs, and possible solutions. The scarcity of reliable water sources in this seasonally dry, Pre-Cambrian environment heightened the challenges. The inclusion of socio-economic, financial, water resources, and environmental studies required close coordination of a multidisciplinary team comprised of professionals from a number of countries.

The schedule for detailed design was extremely tight. The team had to produce individual designs for eight unique cities with differing treatment requirements simultaneously. Even identifying the appropriate design standards was a challenge.

Construction contract administration presented many challenges due to the poor capacity and norms of contractors in the region and the logistics of construction in a remote location. Unyielding funding disbursement deadlines added to the pressure.

Meeting Owner's Needs

The Government of Mozambique (GOM) needed assistance to improve access to drinking water in urban centres as a key element of its broader poverty reduction plan. The GOM received substantial donor funding which had to be disbursed within a defined and limited time. The overall goal was to maximize the benefit within the constraints of this funding. The GOM also needed to develop the capacity to manage and implement these large-scale infrastructure projects.

The feasibility studies provided a framework for planning upgrades to the drinking water system. The outcome was a series of 20-year master plans for the investments needed in the eight cities. Viable sources of water and infrastructure were identified to meet present and future needs.

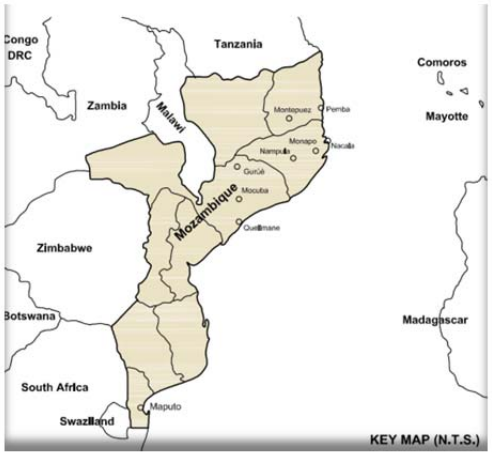
Burnside shows the new Nampula water treatment facility to Government of Mozambique officials

Construction-ready designs and bid packages for immediate upgrades were prepared. The designs were for robust infrastructure with appropriate technology, tailored to the specific needs and challenges faced in the region, and represented initial phases of longer term plans that maximized the immediate benefits.

A package of works for the city of Nampula was deemed to be one of the investments with the greatest immediate benefits that could be realized within the constraints of the funding. The implementation resulted in doubling the water supply to over half a million people.

We were able meet the GOM's needs, maximizing the immediate and future benefits of the donor's funding. Throughout the process, we assisted in building the GOM's capacity to manage such initiatives. We left a legacy of measureable, sustainable capacity and knowledge.

Feasibility Studies for Water Supply Infrastructure in Eight Cities



Nampula

Pemba

Quelimane

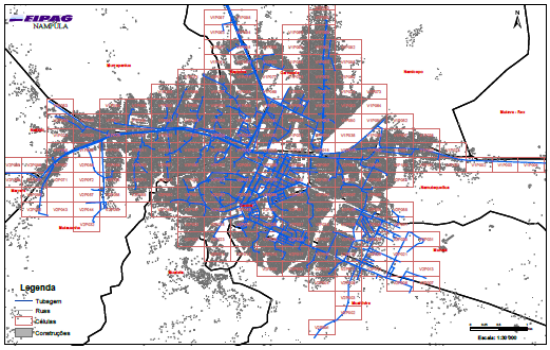
Nacala

Mocuba

Gurúè

Montepuez

Monapo



Assessment of Existing Infrastructure

Burnside led a team to:

- assess and diagnose the existing water works infrastructure;
- assess water lost due to technical losses, and illegal connections;
- undertake a socioeconomic study including analysis of willingness and ability of consumers to pay for improved services;
- complete social and public health studies that incorporated gender-balanced public consultation;
- estimate short and long-term water demands;
- determine appropriate water treatment technologies;
- complete additional groundwater field investigations in Pemba, Quelimane, Nacala, and Montepuez;
- develop scheme for the rehabilitation of the existing infrastructure and for expansion to those areas of the cities that do not receive any level of municipal water service;
- develop Relocation Action Plans;
- carry out a financial analysis of alternatives to assess their sustainability; and
- design implementation plans.

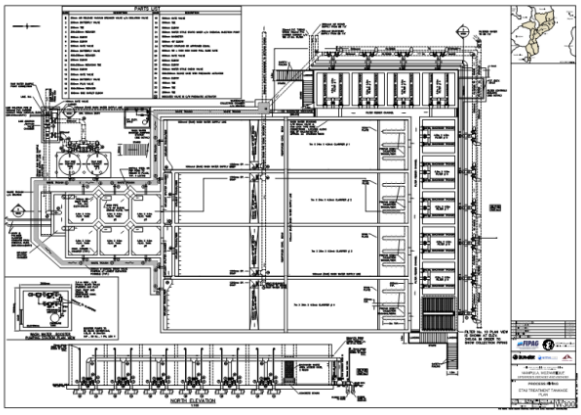
Surface Water Resources Study

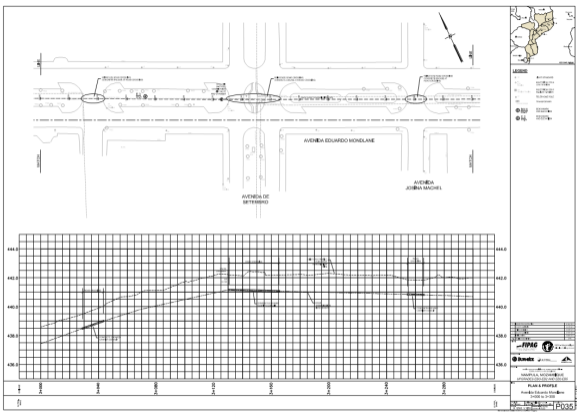
Groundwater Investigations

Outcomes:

- ✓ **20-year master plans** for water infrastructure to meet the needs of the current population of 1.4 million and projected future population 2.9 million people in eight cities
- ✓ 20-year master plans for sanitation and drainage in Nacala, Mocuba, and Gurúè
- ✓ additional water source capacity in four cities through new wells that were developed and constructed during groundwater investigations

Detailed Design of Water Supply Upgrades in Eight Cities





Detailed Design, Preparation of Bid Documents, and Procurement Support:

Burnside prepared detailed designs and tender documents for the following components in the eight project cities, with a combined estimated construction value in the order of USD 200 million:

- 5 new surface water treatment facilities (3 conventional and 2 slow sand treatment; capacities ranging from 10 to 25 ML/d each)
- complete electro-mechanical retrofit of an existing surface-water treatment facility (20 ML/d)
- 18 pumping stations (4 surface water intake/low lift, 14 high lift/booster; capacities ranging from 10 to 44 ML/d each)
- 9 grade level reservoirs (0.75 to 5 ML)
- 4 elevated reservoirs (0.25 ML each)
- on site wastewater treatment
- instrumentation and controls, including telemetry between facilities
- connection of groundwater wells, including well houses, feedermains, chlorination facilities, etc.
- 197 km of watermain/transmission main (sizes ranging from 150 mm to 800 mm diameter)
- site works and drainage solutions.

Outcome:

- ✓ complete, construction-ready designs and bid documents for the necessary water infrastructure to meet the medium term needs in eight cities

Construction Inspection and Contract Administration for Water Supply Upgrades in Nampula

Burnside provided inspection and contract administration services for the construction of the following works:

- 1 conventional surface water treatment facility (24 ML/d)
- complete electromechanical retrofit of existing treatment facility and one existing pumping station
- 3 pumping stations (capacities ranging from 20 to 44 ML/d)
- 2 grade level reservoirs (1.5 ML and 5 ML)
- on site wastewater treatment
- instrumentation and controls, including telemetry between facilities.
- 16 km water transmission main (600 mm diameter)

Construction value:
USD 45 million

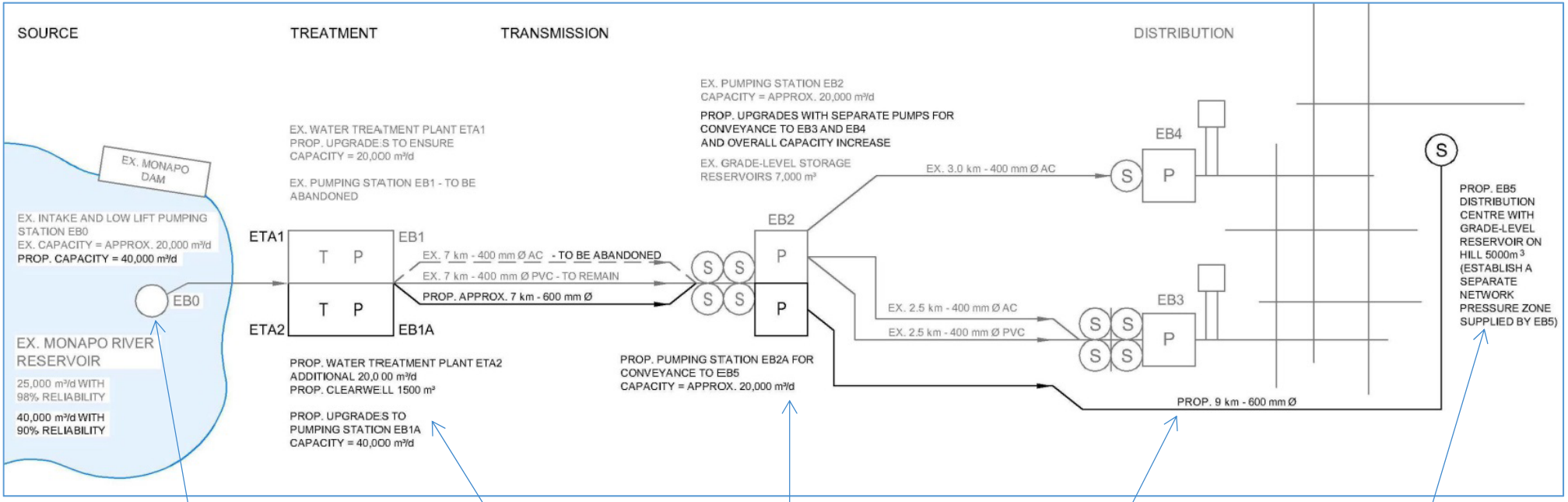
Installing filter process piping at the new water treatment plant

Workers place reinforcing steel for a new 5 ML reservoir perched on the side of a rock hill, elevated above the city

Outcomes:

- ✓ effectively doubled the water supply available to half a million people in the city of Nampula
- ✓ provided robust infrastructure and appropriate technology that will service the city in the long term

Nampula Water Supply Upgrades Overview









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