MINISTRY OF WATER AND IRRIGATION

TANATHI WATER SERVICES BOARD

Environmental and Social Impact Assessment Study Report

PROPOSED THWAKE WATER SUPPLY AND SANITATION PROJECT

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Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

Client: Tanathi Water Services Board

Assignment: Carry out Environmental and Social impact Assessment Study report on the Proposed Multi-Purpose Thwake Dam

Report Title: Environmental and Social Impact Assessment Study report – Proposed multipurpose Thwake Dam

Project Title: Thwake Water and Sanitation Project

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Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

For Prasol Training and Consulting Ltd

Client:

TANATHI WATER SERVICES BOARD
K.I.D.P BUILDING,
KALAWA ROAD
P.O. BOX PRIVATE BAG,
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acronyms</td>
<td>14</td>
</tr>
<tr>
<td>EXECUTIVE SUMMARY</td>
<td>15</td>
</tr>
<tr>
<td>CHAPTER 1: INTRODUCTION</td>
<td>29</td>
</tr>
<tr>
<td>1.1 Project Background and Rationale of Environmental and Social Impact Assessment (ESIA) Investigation</td>
<td>29</td>
</tr>
<tr>
<td>1.2 The Project</td>
<td>30</td>
</tr>
<tr>
<td>1.3 ESIA Terms of Reference</td>
<td>31</td>
</tr>
<tr>
<td>1.4 Objective of the Study</td>
<td>32</td>
</tr>
<tr>
<td>1.5 Scope of Assignment</td>
<td>33</td>
</tr>
<tr>
<td>1.5.1 Scoping Process</td>
<td>33</td>
</tr>
<tr>
<td>1.5.2 Review of policy, legal and administrative framework</td>
<td>35</td>
</tr>
<tr>
<td>1.5.3 Review of Baseline Information</td>
<td>35</td>
</tr>
<tr>
<td>1.5.4 Field assessments</td>
<td>35</td>
</tr>
<tr>
<td>1.5.5 Detailed ESIA study activities</td>
<td>36</td>
</tr>
<tr>
<td>1.6 Target Group for the Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) Reports</td>
<td>36</td>
</tr>
<tr>
<td>1.7 Methodology</td>
<td>37</td>
</tr>
<tr>
<td>1.7.1 Detailed Methodology</td>
<td>38</td>
</tr>
<tr>
<td>1.8 Constraints and Limitations</td>
<td>41</td>
</tr>
<tr>
<td>1.9 ESIA Team</td>
<td>41</td>
</tr>
<tr>
<td>1.10 Project Implementing Agency</td>
<td>42</td>
</tr>
<tr>
<td>CHAPTER 2: PROJECT DESCRIPTION</td>
<td>42</td>
</tr>
<tr>
<td>2.1 Project Details</td>
<td>43</td>
</tr>
</tbody>
</table>
2.2 Nature of the Project  44
2.4 Project History  45
2.5 Project Justification  46
2.6 Project Area  47
2.6.1 Zone 1: Catchment Area Upstream of the Dam  47
2.6.2 Zone 2: Dam Site and Buffer Areas  48
2.6.3 Zone 3: Area Served and the Adjoining Land  50
2.6.4 Zone 4: Downstream of the Dam  50
2.7 Design Concepts  51
2.7.1 Basic Considerations  51
2.7.2 Dam Components  53
2.8 Project Activities  54
2.8.1 Planning And Feasibility Studies  54
2.8.2 Design Work  54
2.8.3 Construction Phase  55
2.8.4 Commissioning  57
2.8.5 Dam Operations  57
2.9 Project Outputs  58
2.10 Project Schedule And Estimated Cost  58

CHAPTER 3:  ANALYSIS OF PROJECT ALTERNATIVES ....................................................................................... 59
3.1 Overview  59
3.2 No Action Option  59
3.3 Alternative Sites For Thwake Dam  59
3.4 Alternative Storage Option For Thwake Dam  60
CHAPTER 4: ENVIRONMENTAL BASELINE CONDITIONS ................................................................. 61

4.1 General Overview ................................................................. 61
4.2 Topography and Physiography .............................................. 62
4.3 Drainage and Hydrology 63
4.3.1 Drainage ................................................................. 63
4.3.2 Hydrology ............................................................. 64
4.4 Water Resources ............................................................. 64
4.4.1 Surface Water Sources ............................................... 65
4.4.2 Groundwater .......................................................... 66
4.5 Biodiversity ................................................................. 67
4.5.1 Vegetation .............................................................. 67
4.5.2 Animal Species ........................................................ 68
4.6 Geology And Soils ............................................................ 68
4.6.1 Geology ................................................................. 68
4.6.2 Soils ................................................................. 68
4.7 Climatic Conditions .......................................................... 70
4.7.1 Rainfall ................................................................. 70
4.7.2 Temperatures .......................................................... 71
4.8 Social And Economic Setting ............................................. 72
4.8.1 Administrative Setup And Location- The Dam Site .......... 72
4.8.2 Infrastructure In The Project Area ................................. 73
4.8.3 Institutions and Development Agencies in the Project Area 74
4.8.7 Agricultural Activities Around The Project Area ............ 78
4.8.8 Livestock .............................................................. 79
4.8.9 Poverty And Income Levels  80
4.8.10 Education  81
4.8.11 Labour Force And Economic Occupation  82
4.8.12 Health  82
4.8.13 Sanitation  83
4.9 Cross Cutting Issues  84
4.9.1 Gender  84
4.9.2 Cultural Issues  85
4.9.3 HIV/ Aids And Other Communicable Diseases  85
4.9.4 Climate Change Concern:  86

CHAPTER 4: POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK ................................................................. 86

5.1 An Overview  86
5.2 Policy Provisions  87
5.2.1 National Environment Action Plan (NEAP)  87
5.2.2 National Policy on Water Resources Management and Development  87
5.2.3 Sessional Paper No. 6 of 1999 on Environment and Sustainable Development  88
5.3 Legal Framework  89
5.4 The Water Sector  104
5.4.1 Institutional Structure of the Water Sector  104
5.4.2 Water Services Regulatory Board (WASREB)  104
5.4.3 Water Resources Management Authority (WRMA)  105
5.4.4 Water Services Trust Fund (WSTF)  105
5.4.5 Water Services Boards (WSBs)  106
5.4.6 Water Services Providers  106
### Proposed Multipurpose Thwake Dam

5.5 Other Sectors 106

5.6 NEMA Compliance 107

5.7 Sectoral Integration 107

5.8 Project Management Institutional Structure 107

5.8.1 Contractor 108

5.8.2 Supervisor 108

5.8.3 Environmental Division (TAWSB) 108

5.9 Relevant International Conventions and Agreements 109

5.10 African Development Bank: 110

5.11 The Equator Principles 111

### CHAPTER 5: POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

6.1 General Overview 113

6.2 Environmental Impacts and Mitigation Measures 114

6.2.1 Sedimentation 115

6.2.2 Water Quality 116

6.2.3 Water Loss 117

6.2.4 Species Diversity 119

6.2.5 Hydrology 120

6.2.6 Dam Failure 121

6.3 Social Impacts and Mitigation Measures 124

6.3.1 Positive Impacts 124

6.3.2 Negative Impacts 125

6.4 Economic Impacts and Mitigation Measures 126

6.4.1 Positive Impacts 126
Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

6.4.2 Negative Impacts 127
6.5 Historical, Cultural and Archeological Resources 128
6.5.1 Chance Find Procedure 129
6.6 Risk Indications 131
6.6.1 Overview 131
6.6.2 Immediately Upstream 132
6.6.3 Downstream Areas 133
6.6.4 Katumbua Storage Tank and the Rising Main 133
6.1.1 Approximate Risks 136
6.2 Impact – Mitigation Matrix 140

CHAPTER 7: CONSULTATIVE PUBLIC PARTICIPATION ............................... 153

7.1 Introduction 153
7.2 Preliminary Interviews 157
7.2.1 The District Commissioner (Makueni District) 157
7.2.2 The District Environment Officer and District Social Development Officer 157
7.2.3 The District Water Officer 158
7.2.4 Meeting of District Heads 159
7.2.5 General Community Opinions 160
7.3 Detailed Public Consultations 161
7.3.1 Public Meetings 161
7.3.2 General Public Concern 163

CHAPTER 8: ENVIRONMENTAL HEALTH AND SAFETY .......................... 165

8.1 Environment Health and Safety (EHS) 165
8.1.1 EHS Management and Administration 165

TAWSB Prasol Training and Consulting Ltd
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1.2</td>
<td>Policy, Administrative and Legislative Framework</td>
<td>165</td>
</tr>
<tr>
<td>8.2</td>
<td>Organization and implementation of the EHS Management Plan</td>
<td>165</td>
</tr>
<tr>
<td>8.2.1</td>
<td>The Guiding Principles to be adopted by the contractor</td>
<td>166</td>
</tr>
<tr>
<td>8.2.2</td>
<td>EHS management strategy to be adopted by the contractor</td>
<td>166</td>
</tr>
<tr>
<td>8.3</td>
<td>Safety Agenda for both the proponent and contractor</td>
<td>166</td>
</tr>
<tr>
<td>8.4</td>
<td>Emergency procedure during construction and operation</td>
<td>167</td>
</tr>
<tr>
<td>8.5</td>
<td>Ambient Factors in the Workplace</td>
<td>168</td>
</tr>
<tr>
<td>8.6</td>
<td>Training and Documentation</td>
<td>168</td>
</tr>
<tr>
<td>9.1</td>
<td>An Overview</td>
<td>169</td>
</tr>
<tr>
<td>9.2</td>
<td>AfDB’s operational procedure on forced resettlement</td>
<td>170</td>
</tr>
<tr>
<td>9.3</td>
<td>Structured Consultation</td>
<td>170</td>
</tr>
<tr>
<td>10.1</td>
<td>Management Plan Principles</td>
<td>172</td>
</tr>
<tr>
<td>10.2</td>
<td>Specific Management Issues</td>
<td>172</td>
</tr>
<tr>
<td>10.2.1</td>
<td>Management Responsibilities</td>
<td>172</td>
</tr>
<tr>
<td>10.3</td>
<td>Environmental Management Guidelines</td>
<td>173</td>
</tr>
<tr>
<td>10.3.1</td>
<td>Environmental Education and Awareness Raising</td>
<td>174</td>
</tr>
<tr>
<td>10.3.2</td>
<td>Management Plans</td>
<td>174</td>
</tr>
<tr>
<td>11.1</td>
<td>Monitoring Parameters</td>
<td>121</td>
</tr>
<tr>
<td>11.1.1</td>
<td>Construction</td>
<td>121</td>
</tr>
<tr>
<td>11.1.2</td>
<td>Operations</td>
<td>121</td>
</tr>
<tr>
<td>11.2</td>
<td>Monitoring Schedule</td>
<td>121</td>
</tr>
</tbody>
</table>

---

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CHAPTER 12: DECOMMISSIONING

12.1 Introduction
12.2 Purpose and objectives of decommissioning
12.3 General requirements ahead of decommissioning
12.4 Environmental Guidelines for Decommissioning Planning

12.4.1 Biophysical Environment
12.4.2 Surface hydrology
12.4.3 Soil
12.4.4 Flora
12.4.5 Fauna
12.4.6 Aesthetic environment
12.4.7 Socio-economic environment
12.4.8 Social issues
12.4.9 Land use and services

CHAPTER 13: CONCLUSIONS AND RECOMMENDATIONS

12.5 Conclusions
12.6 Recommendation

REFERENCES

ANNEXES

Annex I: Terms of Reference
Annex II: Project Location Map
Annex III: Selected Design Concepts and Drawings
Annex IV: Selected Communications during ESIA Process
Annex V: Water Quality Results
LIST OF FIGURES

Figure 1: Location Map of the proposed Thwake Multipurpose Dam ........................................45
Figure 2: Topographical Map of the proposed Thwake Multipurpose Dam .................................62
Figure 3: Brownish red sandy silty clay soil on the right bank (location of TP1) – Dam Axis ..........69
Figure 4: Reddish brown sandy silty clay (stony) soil on the left bank (location of TP5) – Dam Axis .................................................................70
Figure 5: A bridge at Kailembwa ................................................................................................122
Figure 6: An airstrip at Kitaani ..................................................................................................122
Figure 7: An airstrip at Tsavo East National Park ......................................................................123
Figure 8: Airstrips and Causeway at Lugard’s falls .................................................................123

LIST TABLES

Table 1. Project Details ........................................................................................................43
Table 2: Table Rainfall Distribution in Thwake Basin ..............................................................70
Table 3: Administrative areas to be covered by Thwake Dam Water Mass ..............................72
Table 4: Institutions and Development Agencies within the Project Area ........................................ 74
Table 5: The Project Service Areas ...................................................................................................... 75
Table 6: Statistics for Food and Cash Crops for Mavindini Division ................................................... 79
Table 7: Livestock Statistics for Mavindini Division ............................................................................. 80
Table 8: Institutional Presence around the Project Area ....................................................................... 81
Table 9: Household Headship in the Project Area ............................................................................... 84
Table 10: Legal Provisions .................................................................................................................. 90
Table 11: Risk Evaluation Scheme ....................................................................................................... 136
Table 12: EMP Matrix ......................................................................................................................... 140
Table 13: Consultation Meetings Log .................................................................................................. 155
Table 14: Environmental and Social Management Plans Matrix ...................................................... 109
Table 15: Monitoring Plan .................................................................................................................. 121
### Acronyms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AfDB</td>
<td>Africa Development Bank</td>
</tr>
<tr>
<td>ARV</td>
<td>Anti-Retroviral</td>
</tr>
<tr>
<td>ASAL</td>
<td>Arid and Semi Arid Land</td>
</tr>
<tr>
<td>CBOs</td>
<td>Community Based Organizations</td>
</tr>
<tr>
<td>CDF</td>
<td>Constituency Development Funds</td>
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<tr>
<td>CDM</td>
<td>Clean Development Mechanism</td>
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<tr>
<td>COMESA</td>
<td>Common Market for East and South Africa</td>
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<td>CPP</td>
<td>Community Public Participation</td>
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<td>CSR</td>
<td>Corporate Social Responsibility</td>
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<td>DC</td>
<td>District Commissioner</td>
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<td>DO</td>
<td>District Officer</td>
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<td>EA</td>
<td>Environmental Audit</td>
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<td>EIAs</td>
<td>Environmental Impact Assessment</td>
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<td>EMA</td>
<td>External Monitoring Mechanism</td>
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<td>EMCA</td>
<td>Environmental Management Coordination Act</td>
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<td>EMP</td>
<td>Environmental Management Plan</td>
</tr>
<tr>
<td>ESIA</td>
<td>Environmental and Social Impact Assessment</td>
</tr>
<tr>
<td>FBOs</td>
<td>Financial Based Organizations</td>
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<td>FSL</td>
<td>Full Supply Level</td>
</tr>
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<td>GOK</td>
<td>Government of Kenya</td>
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<tr>
<td>HIV/AIDS</td>
<td>Human Immune Virus/Acquired Immune Deficiency Syndrome</td>
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<tr>
<td>HPP</td>
<td>Hydro Power Plant</td>
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<tr>
<td>IEC</td>
<td>Information, Education and Communication</td>
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<td>Kenya Power and Lighting Company</td>
</tr>
<tr>
<td>KWS</td>
<td>Kenya Wildlife Service</td>
</tr>
<tr>
<td>LAP</td>
<td>Land Acquisition Plan</td>
</tr>
<tr>
<td>TAWSB</td>
<td>Prasol Training and Consulting Ltd</td>
</tr>
</tbody>
</table>
EXECUTIVE SUMMARY

Introduction
TANATHI Water Services Board (TAWSB) is proposing a water supply project to supply water to the semi-arid greater Makueni and Kitui. The name of the project is “Proposed Thwake Water Supply and Sanitation Project”

Prasol Training and Consulting Ltd was appointed by TAWSB for provision of consultancy services to undertake a revision of an environmental and social impact assessment report that was prepared in 2009 by Samez Consultants Limited for the Thwake Multipurpose Dam Project.

From the studies undertaken in the project area, it was established that water is a priority to all in terms of livelihoods and social requirements. The overall ecosystem will also get transformed for the overall benefit of the communities. The dam is proposed to be located immediately downstream (~1km) from the confluence of Athi and Thwake rivers in Mavindini Division of Makueni District, Kalawa division in Mbooni East District and covering sections of southern part of Yatta division in Kitui West District.

Overview

The Environmental and Social Impact Assessment findings presented in this report provides a critical examination of issues considered important in fulfilling the requirements of a clean, sustainable and healthy environment especially in a project that would involve relocation. This report is primarily aimed at establishing the impacts of the proposed Thwake Multipurpose Dam project on the environment and biodiversity; sustainability of resource utilization; resource use conflicts and socio-economic; socio-cultural and socio-political well-being of the nearby residents and the region. During the study, the ESIA team made wide consultations, interviews and field visits to the project area and offices of relevant stakeholders. The views and concerns of all relevant stakeholders were noted and considered when writing this study report.

The Project

The proposed dam is an embankment dam with a maximum height of 84 m. The reservoir is projected to cover an area of 2,900ha, with a catchment spanning about 10,276km². It will cover among other locations Mavindini, Kanthuni, Kitise, Kithuki, Kathonzweni and Mbuvo. Part of the inundated area will be in Kanyangi locations in Yatta division (Kitui West district). The dam has been designed for full reservoir storage of 825mcm with live storage of 594mcm. The reservoir will cover an area of 2,933ha at full storage. The embankments will require about 18.4Mm³ of earth fill materials. The crest of the main dam will be 1,600m long.
These works will require substantive acquisition of land for the dam and associated infrastructure. A resettlement Action Plan for the area directly affected is presented under a separate volume.

In accordance with Section 58 of the Environmental Management and Coordination Act (1999) and Legal Notice No. 101 of 2003, a project of this magnitude is supposed to be subjected to a full Environmental and Social Impact Assessment (ESIA). Procedural guidelines on the EIA study are spelt out in Legal Notice No. 101.

The procedural steps involved in this study included the following:

1. Identification of key stakeholders
2. Scoping and development of the ToRs using a variety of methods and tools
3. Baseline Studies
4. Consultation and public participation
5. Impacts identification and analysis
6. Development of mitigation measures
7. Analysis of project alternatives
8. Development of social and environmental management plan

Overall Objective of ESIA

The objective of the Environmental and Social Impact Assessment (ESIA) for the proposed Multipurpose Thwake Dam is to identify the probable positive and negative impacts of the project and the proposed mitigation measures to inform decision making. For subjective predictions of the impacts, the site area was subjected to environmental scoping process. This was a process of evaluating the significance of the project impacts and possibilities of handling the same. Detailed evaluation of the project area was undertaken to focus on any significant environmental issues as established in the scoping process.
Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

The Terms of reference for the ESIA study as per regulation 11(1) of the EIAAR, 2003, were to establish baseline conditions, impact assessment, development of mitigation measures and an environmental management plan with respect to habitat and vegetation, socio-economic and community participation, demography and settlement, historical, archeological monuments and cultural heritage, physical environment, wildlife and fisheries, livestock and range resources, agriculture, pests and diseases, forest products and wood energy, community environmental health, analysis of legislative and institutional framework for environmental management in Kenya, and analysis of project alternatives. It was also required to establish institutional needs to implement the recommended project action plans.

At scoping stage key issues to be addressed during the study were identified. It involved establishment of the diversity on physical environment, climatic conditions, demographic trends as well as the hydro-geological status in the area. Relevant policy and legal requirements were listed. The study team strived to share experiences on water resources and social issues in that part of the country, and in particular with regard to water demand and utilization. This enabled determination of project elements that would be emphasized on.

Scope of the Assignment

The consultant was to undertake an Environmental Impact Appraisal to the satisfaction of TAWSB and the affected stakeholders. The scope of the assignment included but was not necessarily limited to the following tasks:

1. Discussions in association with TAWSB, NEMA and other lead agencies to confirm the scope of the environmental issues and studies for this package.
2. Environmental studies (desk and new field investigations and community consultation as required) to identify anticipated environmental impacts of the proposed project.
3. Identification of potential mitigation measures and discussion of these with TAWSB, the project engineers and others as to practicality and likely cost.
4. Finalization of recommended mitigation measures required during design, construction and operation of the project.
5. Developing cost estimates of the mitigation measures.
7. Assistance to TAWSB in submission of findings to NEMA and subsequent discussions with NEMA and other agencies as required during their assessment procedures.

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Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

8. Carrying out Social Economic Survey

9. Carrying out a census of population to be affected by the project and prepare desegregated data

10. Determining social and economic impacts of the project to the stakeholders

Determining the land to be acquired and the tentative compensation values for land; Permanent, semi-permanent and temporary structures and both cash and subsistent crops.

Legal framework

Laws and regulations pertinent to the various aspects and activities of the proposed Thwake Dam include the following among others:

1. The Environmental Management and Co-ordination Act, 1999
2. The Environment (Impact Assessment and Audit) Regulations, 2003
3. Building Code By-Laws
4. The Occupational Safety and Health Act, 2007 and Regulations
5. Water Act, 2002
6. Water Quality Regulations, 2006 (Legal Notice 121)
8. The Local Government Act (Cap 265)
9. The Public Health Act (Cap, 242)
10. Physical Planning Act (Cap 286)
11. Land Planning Act, Cap 303
12. The Penal Code (Cap 63)
13. Occupiers Liability Act (Cap. 34)
14. Waste Management Regulations, 2006 (Legal Notice 121)
15. Noise and Excessive Vibration Pollution Control Regulations, 2009
Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

16. The Land Acquisition Act (Cap 295) Laws of Kenya
17. The Traffic Act (Cap 403) Laws of Kenya
18. The Wayleaves Act (Cap 292) Laws of Kenya
21. Wildlife Conservation and Management Act, Cap. 376
22. Conservation of Biological Diversity Regulations, 2006
24. The National Poverty Eradication Plan (NPEP) and the Poverty Reduction Strategy Paper (PRSP)
25. The National Land Reclamation Policy
26. The registered Land Act
27. The Surveys Act
28. The Land Acquisition Act
29. The way leaves Act
30. The Lakes and Rivers Act
31. The Public roads and Roads Access Act
32. The Public Health Act
33. OSHA 2007
34. The Water Sector Regulations
35. African Development Bank Environmental Guidelines

Project justification

Residents in the greater Makueni District and the region in general, are forced to walk long distances (5 – 10km) in search of water for domestic use and livestock. The little water found is mostly of inferior quality effectively risking the people’s health and hygiene. This is clearly depicted in the reported cases of water borne ailments (diarrhea, intestinal worms, bilharzias and skin problems). Intervention initiatives, therefore, are necessary form every possible quarter. The
Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

The proposed dam will open up the area for development by further being an enormous viable source of water for domestic and livestock use. Apart from other incidental benefits like fisheries and tourism the dam axis may provide a causeway that will open up the area by providing social and economic access between Makueni and Kitui Districts.

Land ownership

Land in the proposed project area is owned by individual land owners on a free hold basis, who constitute 888 households and 108 without household properties. These individuals have title deeds for the parcels owned. Tanathi Water Services Board would therefore have to acquire the land from the private owners for the purposes of constructing the proposed Thwake Dam and compensate them appropriately. A Resettlement Action Plan (RAP) has been prepared to provide information that would help decision making on the Project Affected by the Project and their properties.

Approach and Methodology

The study assessed and quantified the potential impacts, both positive and negative of the proposed dam project. The baseline information collected was used to analyze the potential impacts of the proposed project. The ESIA study team embarked on various methodologies such as field visits, literature review, consultations with the affected public and stakeholders, among others. In order to generate adequate baseline information which served as a benchmark for analyzing potential impacts and generating an Environmental Management Plan (EMP), the fieldwork was extensive and included several activities: A reconnaissance visit was made to the project area by the ESIA team which helped the team to set out key areas of observation during the study. This was then followed by field visits to the project area and the neighbourhood, taking records of observations as well as interviewing community members.

The Water Act 2002, Environmental Management and Coordination Act (EMCA) 1999 and other relevant statutes that have direct significance to the proposed project were reviewed. Other reports and reference materials on physical and biological data on the study area were also studied including literature on dams and their impacts. Questionnaires were administered to the community members in an attempt to get detailed individual views about the proposed project and data on the socio-economic landscape of the study area. Preliminary physical surveys, measurements and social evaluations were carried out in conjunction with all stakeholders and in reference to all other social and economic initiatives in the project area.
Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

Public consultation

Public participation followed AfDB civil society engagement framework of 2012 and was mainly achieved through direct interviews, observations, questionnaire administration, holding stakeholder and public meetings. Those consulted included Tanathi Water Services Board; opinion leaders within the community; local politicians; local members of the Provincial Administration consisting of the District commissioners; District officers; area chiefs and their assistants. Other people interviewed included representatives from relevant government ministries and departments including Ministries of Lands; Environment and Mineral Resources (NEMA); Public Health and Sanitation; Water and Irrigation; Gender, Culture Sports and Social Services; Water Resources Management Authority (WRMA) and the Makueni District Steering group.

The local consultative meetings were conducted at the following markets:

1. Miksi market in Mavindini Locations, Katithi sub-location,
2. Katithi Market in Mavindini locations, Katithi sub-location,
3. Syotuvali market in Kathulumbi Location, Syotuvali sub-location,
4. Kanyangi market in Kanyangi location,
5. Kanzokeani market in Kathonzweni Division

Study findings

Inundation of the areas currently under social, cultural, economic and institutional use will significantly affect social stability as well as the dam water quality. Among the associated aspects include:

1. The rivers upstream (especially Thwake river) show relatively high sediment transport capacity due to the nature of the catchment base rock formation. This has the potential to overload the dam over a short period of time reducing its effective capacity unless preventive measures are undertaken,
2. The current flows downstream of Athi river basin fluctuate between the dry and rainy seasons, effectively spreading fertile silt over wider areas of the basin. With the dam

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Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

complete and in use, the flow will be regulated to a constant rate throughout the year. While this could be beneficial for direct water dependants, the area of the basin partially inundate every year will reduce,

3. The geology of the project comprises of fissured and fractured rock with the potential to allow infiltration of water into the ground. This could translate to water loss from the dam,

4. There is potential disruption, loss or introduction of plant and animal species from the area during construction and upon commissioning of the dam,

5. Displacements of the settlements to alternative locations. While some may be marginally displaced to different locations on the same land, others (those whose land wholly falls within the dam and buffer area) will have to be shifted to other parts of the district or country. This also applies to the transmission pipelines and distribution tank locations. Considering that majority of the people lives below poverty lines, it would mean that prior relocation without support would not be possible,

6. Every homestead has at least one pit latrine. Such features will not be directly inundated due to their long term potential contamination of water, but will be decommissioned and the earth scooped for safe disposal to pre-agreed sites. The exact locations for each pit latrine will be established to enable smooth relocation,

7. There are grave yards (refer to annex VIII for records) around the dam area that would also not be inundated in the dam water. In addition to the views of the respective families regarding relocation of graves, there are general cultural values associated with the dead that need not be compromised,

8. There will be a link to the health and safety of the residents from possible enhanced vector breeding (mosquitoes, snails, etc.), attraction of wildlife to the area and water contamination. Accidental drowning into the dam sections is a potential occurrence affecting children, the aged as well as animals,

9. Some access roads in the dam area will be inundated, hence breaking means of internal communication from one community/village to another. However it is expected there will be easy communication between locations through the road over the embankment hence enhancing social links, markets, resources sharing, access to amenities, etc. In addition, access should be enhanced through the earth roads built during construction TAWSB should compensate appropriately any land acquired access roads.

10. Sections of the river banks (specifically Thwake) seem to have a special value to the livestock. It observed that goats and sheep chew the earth (whitish deposits) along the banks after watering. This value may not be found anywhere else away from the river flood plain.

11. Thwake and Kalawa rivers bring in high loads of sand into the dam area risking the lifespan of the dam. It would, therefore, be necessary to provide appropriate sand traps upstream of the dam along the rivers. The traps seems to have economic sustenance to the immediate communities,
Anticipated Impacts and Mitigation Measures

Development of large dams provides ecological as well as social challenges even though the ultimate facility is generally beneficial to the stakeholders and the country. Impoundment of large volumes of water has implications on the upstream systems through possible shifting of ecosystem boundaries upstream because of changes in water regimes. At the dam site and the inundated areas, implications ranges from slowed capacity for silt and pollutant transportation, loss and/or introduction of species, water quality changes, displacement of social and economic features and land use changes for the riparian landowners. Downstream impacts are associated with regulated flows in the river, shifting of species to upstream areas, safety risks and land use changes due to the fluctuation in water regimes trends along the river basin..

Proposed mitigation measures

1. Controlled burns and use as biomass i.e. the vegetation harvested from the reservoir area can be composted and used as manure in the farms.

2. Site planning for avoidance of negative impact and compensation. There is need for prior planning of activities so that the construction process does not negatively affect people. There is need to advice people when the construction work is about to begin so that those with crops in the proposed dam area are given enough time to remove their crops

3. Shoreline protection. This will reduce the possibility of erosion of the riverbed. Shoreline can be protected through plantation of trees and grass along the riverbed.

4. Relocation of people to suitable areas, especially for those who may be directly affected as a result of the dam construction. There should also be provision of compensation for resources lost and employment opportunities for those affected.

5. There is need to establish compensatory parks or reserved areas for animals that may be dislocated should there be any.

6. The dam should be planned and managed within the context of regional development plans so that it fits within the framework of the developments.

7. Reforestation should be done elsewhere to replace trees cut

8. Noise controls and traffic restrictions

9. Use of dust suppressants to protect workers

10. Recovery of merchantable timber and reforestation
11. Avoid camps by employing locals
12. Compliance to the provisions of the EHS management plan to safeguard workers
13. Prepare and print safety manual for distribution to workers
14. Assign a vehicle specifically for emergencies
15. Promote collection and storage of wastes during construction and operation in accordance with the management plan.
16. Use water boozers to minimize dust pollution
17. Sensitive construction vehicles and machinery shall switch off engines when not being used
18. Compensation for land and properties lost
19. Erosion control through conservation agriculture
20. Shoreline protection e.g. through riprap and gabions
21. People should be educated on the likely dangers of accessing the area especially if there is proof that certain animals like crocodiles may have inhabited the water.
22. Reservoir clearing, shoreline stabilization and removal and covering of organics so as to avoid greenhouse gas release.
23. Clearance of woody vegetation from inundation zone prior to flooding (nutrient removal)
24. Safety provision (e.g. fencing of the dam) and risk education.
26. Control of land use in watershed (especially prevention of conversion of forests to agriculture).
27. Basin-wide integrated planning to avoid overuse, misuse, and conflicting uses of water and land resources.
28. Land use planning efforts, which include watershed areas above dam

Output

The environmental impact assessment was designed to evaluate the project concepts and provide the key anticipated impacts associated with the project preparation, construction works and operations. As a non-consumable operation, the facility will not be expected to significantly affect...
Environmental and Social Impact Assessment (Study report)  

Proposed Multipurpose Thwake Dam

the flows in the river. Appropriate measures would, therefore, be necessary to ensure minimal impacts to the local environment, the river ecosystem and the neighbouring social interests. The process outputs include:

1. A description of the proposed project,
2. Details on the anticipated impacts,
3. Mitigation measures established for the impacts identified,
4. An environmental management plan (EMP) for integration into the project implementation,
5. A resettlement action plan

Conclusion

In view of the above findings, it can be concluded that there is a high level of acceptance of the Dam project by all stakeholders including the communities living at the site as well as the beneficiaries in all the affected districts. This follows acute shortage of water for domestic and livestock keeping as well as irrigation for basic food production, a phenomenon experienced in Makueni district and all the neighbouring districts. Among the most notable aspects include the following:

1. The dam will contribute immensely towards the long time interventions by various organizations working with communities in water projects such as to include the Red Cross Society, the World Vision, ADRA, etc.,
2. The dam will not only uplift the living standards of the communities, but will also lead to appreciation of land values, improve the livelihoods and enhance hygiene and sanitation at homestead levels.
3. The dam development will go further into developing a water treatment plant to ensure availability of clean water for domestic use in the target areas,
4. The dam will enable moderation of flows in Athi River downstream and ensure constant availability of water throughout the year, though with reduced high flood levels along the basin,
5. Management of the dam will contribute towards environmental conservation initiatives such as to include sustainable sand harvesting, and access to biological resources in the area.

It is also concluded that the project magnitude will be significant such as to impose impacts to the physical and biological environment as well as the social, cultural and economic setting of the area.

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Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

The negative impacts, however, are identifiable and can be mitigated through design and administrative measures. However, the overall positive impacts of the project far outweigh the negative projects through the mitigation measures outlined for the project.

Recommendations

It is recommended that the dam project proceed with the main objective remaining to uplifting the living standards of the beneficiary communities with minimum implications to the environmental and social setting of the areas to be affected. In order to minimize environmental and social impacts from the dam construction and operation, the following broad recommendations are also proposed;

1. Vegetation clearing shall only be done on the dam construction area such to reduce loss of indigenous plants around the dam site,

2. Over 3,000 people will be displaced by the project. In this regard, it will be necessary to undertake a comprehensive land acquisition and resettlement action plan (LAP & RAP) followed by appropriate compensations to the affected persons and families before the commencement of the project. Timely compensation will facilitate quick commencement of the project and smooth implementation of the same,

3. Water quality will be of high importance. It will, therefore, be necessary to identify and decommission all pit latrines and waste holding locations for total removal for disposal into approved and pre-agreed dumping areas. This should also apply to cattle pens found in each homestead,

4. Culturally, the water will be unacceptable for consumption if graves are submerged into the dam. In this regard, the project management will need to negotiate with the communities on the logistics of relocation of the graves to pre-agreed sites,

5. Among the critical environmental aspects ion the project area is sand harvesting. In order to protect the dam from accumulation of sand, provide sand trap/dams upstream of the dam site along Athi, Thwake and Kalawa rivers as well as other streams. The design of the facilities might also require additional acquisition of land,

6. Provide an opportunity for the local communities (land owners) dispose off natural resources on their land before acquisition. This could include controlled charcoal burning and briquette making as well as removal of sand accumulated at the dam site.

7. Undertake a comprehensive risks assessment study of the dam components downstream the entire Athi river basin with quantification and appropriate preventive propositions,
8. Preparation and inclusion of the affected into existing social associations of their choice in the “new” settlement areas through education, awareness creation and facilitation. There may be need to pay for disturbance costs to those affected.

9. An all-inclusive participatory resettlement Action Plan should be systematically conducted to establish who owns (interested parties and shareholders) what so as to determine the rightful owners who should benefit and the share each should receive.

10. In order to ensure safety, there is need to fence the dam and educate the communities on co-existence with wildlife. This also includes adopting economic activities that co-exist with wildlife such as eco-tourism.

11. Provide counseling services and spiritual support to those affected by the inundation and reburial activities. Further, those wishing to pay respects to their departed on agreed periodic basis either annual or five year periods should be facilitated.

12. Complete health centers under construction and build two new ones while opening Kathulumbi dispensary and adequately providing all with drugs. This will also include equipping these facilities with up-to-date machines and ambulance. This also includes providing health education.

13. Organization of the community into a strong unit to control local resources as well as social and economic benefits resulting from construction of the dam including sand harvesting and marketing of products such as fish, crops and livestock.

14. Put in place supportive and cushioning mechanisms and programmes for those affected such as training, enhancing access to alternative resources and livelihood means.
CHAPTER 1: INTRODUCTION

Project Background and Rationale of Environmental and Social Impact Assessment (ESIA) Investigation

The current access to clean water in Kenya is estimated at about 90% in urban areas and approximately 44% in the rural areas while the national average stands at about 57%. At the same time, provision for safe sanitation stands at a national average of 80% (95% urban and 77% rural).

This makes Kenya a “chronically water scarce” country and results from the limited endowment of water of only 647m³ per capita and this is projected to fall down to 245m³ per capita by the year 2025, well below the internationally recommended minimum of 1,000m³/capita/year. Kenya’s Water resources are also highly vulnerable to climate variability often resulting into floods and drought with inadequate storage capacity which limits the ability to buffer against the water shortage shocks.

Among the worst hit by water shortage is the greater Makueni and Kitui Districts that are among the notable ASAL areas receiving annual average rainfall of between 200mm – 900mm per year in the lower and between 800 – 1200mm in the higher zones. The project Divisions gets an annual average rainfall of 500mm per year that is also unevenly distributed over time with long periods of dry weather. As a result, sources of water are unreliable, far apart and of poor quality. Residents are forced to walk long distances (5 – 10km) in search of water, hence wasting significant economic time and energy in addition to poor hygiene. Seasonal rocky rivers that flow with water only during the rains and originate from the highlands are supplemented with shallow wells, earth and sand dams that stores water after rains.

Thwake Dam was first proposed for construction in 1953 during the colonial days and again in the 1980s. However, the project was never undertaken. Significant numbers of intervention projects in water and sanitation have been undertaken in Makueni district and other areas in the southern part of Eastern province, but the problem of water shortage continues to get worse particularly with regard to its sustainable availability. The Multipurpose dam is being designed to serve the greater Makueni district with Kalawa, Kathonzweni, Kibwezi and Makindu Divisions as the main target divisions. Other areas to benefit include sections of Wote, Nguu and Mutito Adei Divisions. Parts of Kitui District could also benefit depending on the topographical logistics, a possibility that was still being investigated at the time of this study.

Residents in the greater Makueni District and the region in general, are forced to walk long distances (5 – 10km) in search of water for domestic use and livestock. The little water found is mostly of inferior quality effectively risking the people’s health and hygiene. This is clearly
Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

depicted in the reported cases of water borne ailments (diarrhea, intestinal worms, bilharzias and skin problems). Intervention initiatives, therefore, are necessary form ever possible quarter. The proposed dam will open up the area for development by further being an enormous viable source of water for domestic and livestock use. Apart from other incidental benefits like fisheries and tourism the dam axis may provide a causeway that will open up the area by providing social and economic access between Makueni and Kitui Districts.

The National Policy on Water Resources Management and Development focuses on streamlining provision of water for domestic use, agriculture, livestock development and industrial utilization with a view to realizing the goals of the Millennium Development Goals (MDGs) as well as Vision 2030. Thwake Multipurpose Dam has been identified by TANATHI Water Services Board (TAWSB) as a necessary facility to supply water to the semi-arid greater Makueni District and parts of Kitui District. Following feasibility social baselines studies covering the affected districts, it was established that water is a priority to all in terms of livelihoods and social requirements.

Harnessing of the fluctuating flows in Athi River and the seasonal waters from Thwake River would provide water supply for domestic, livestock, irrigation, hydropower and even industrial activities in the beneficiary districts. It will largely serve areas in Makueni and neighbouring districts but also certain parts of Kitui district being determined such that topography allows. The overall ecosystem of the project area stands to get transformed to the benefit of the communities. This fact justifies this environmental and social impact assessment study

The Project

Thwake Multipurpose Dam has been identified by TANATHI Water Services Board (TAWSB) as a strategic facility to supply water to the semi-arid greater Makueni District and the adjoining areas downstream. Following feasibility studies of covering the entire district, it was established that water is a priority to all the residents in terms of livelihoods and social requirements. The overall ecosystem will also get transformed to the benefit of the communities.

The dam is proposed to be located immediately downstream (~1km) from the confluence of Athi and Thwake rivers in Mavindini Division (on the Makueni side) and Kanyangi Division (on the Kitui side) while the flow back will extend into Kathulumbi Division of Mbooni district to the northwest of the dam site. The proposed dam will cover an area of approximately 2,900ha spanning Makueni, Kitui and Mbooni districts with a catchment area spanning about 10,276km² reaching as far as the Ngong hills, Kikuyu escarpments and the lower reaches of the aberdares.

The project is designed to serve among other locations Mavindini, Kanthuni, Kitise, Kithuki, Kathonzweni and Mbuvo in Makueni district and other areas within Kibwezi district downstream of the dam site as well parts of Kitui district that are favoured by the topography of the project site.

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ESIA Terms of Reference

Prasol Training and Consulting Limited were appointed by the Tanathi Water Services Board (TAWSB) to undertake a revision of the ESIA Report that original TOR included the following:

1. Identifying appropriate alternative dam sites,
2. Conduct environmental and social impact assessment (ESIA) of the selected project site and the entire project coverage area,
3. Undertake literature review on previous studies in the Athi River basin and reappraise recommendations on the dam sites alternatives,
4. Undertake design works of the most appropriate dam site and include the intake, water draw-off facilities, treatment works, transmission mains and strategic storage tanks,
5. Prepare tender documents

The scope of the ESIA was to develop suitable recommendations to be integrated in the project design and implementation for mitigation of anticipated adverse impacts to the environment and social setting the project and service areas. An evaluation of public opinions and stakeholders attitude towards the project was captured through interviews and consultative forums conducted throughout the project area. The study was conducted in compliance with the Environmental Impact Assessment Regulation as outlined under the Gazette Notice No. 56 of 13th June 2003 established under EMCA, 1999.

Defined specific objectives of the ESIA include (see detailed TOR in annex II);

1. To determine whether the ESIA report responded adequately to the ESIA Terms of Reference
2. To find out whether the ESIA study followed all the key stages of ESIA in accordance with the Environmental (Impact Assessment and Audit) Regulations, 2003
3. To assess whether the consultant who carried out the ESIA study conducted adequate involvement and consultation of all the interested and affected parties in the project at all key stages of the ESIA
Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

4. To find out if baseline environmental and socio-economic survey was adequately done and documented during the ESIA

5. To determine if the project alternatives were adequately identified and analyzed and whether sufficient justifications were given for the preferred alternatives

6. To determine whether all the applicable policy, legal, regulatory and institutional frameworks were reviewed and cited accordingly during the ESIA

7. To assess whether all the potential environmental and socio-economic impacts of the proposed project were identified, predicted and evaluated

8. To determine whether sufficient and feasible mitigation measures were recommended for the potential negative environmental and socio-economic impacts of the proposed project

9. To find out if the report was prepared in accordance with guidelines specified in the Environmental (Impact Assessment and Audit) Regulations, 2003

Objective of the Study

In accordance to the ESIA regulations the objectives of the study should include:

1. A clear description of the proposed project including its objectives, design concepts, proposed water uses and anticipated environmental and social impacts,

2. Description of the baseline conditions in the project areas that cover the physical location, environmental setting, social and economic issues,

3. A description of the legal, policy and institutional framework within which the proposed dam project will be implemented,

4. Description of the project alternatives and selection criteria,

5. Details of the anticipated impacts to the environmental, social and economic aspects of the area covered by the project.

6. Appropriate mitigation and/or corrective measures,

7. An environmental management plan (EMP) presenting the project activities, potential impacts, mitigation actions, targets and responsibilities, associated costs and monitoring indicators

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Scope of Assignment

The consultant was required to undertake an Environmental and Social Impact Assessment and Appraisal to the satisfaction of TAWSB and affected stakeholders, including but not necessarily limited to the following tasks:

1. Discussions in association with TAWSB, NEMA and other affiliated lead agencies to confirm the scope of the environmental issues and studies for this proposal.
2. Environmental studies (desk and new field investigations and community consultation as required) to identify anticipated environmental impacts of the proposed project.
3. Identification of potential mitigation measures and discussion of these with TAWSB, the engineers and others so as to analyze practicality and likely cost.
4. Finalization of recommended mitigation measures required during design, construction and operation of the project.
5. Development of cost estimates of the mitigation measures.
7. Assistance to TAWSB in submission of findings to NEMA and subsequent discussions with NEMA and other agencies as required during their assessment procedures.
9. Carrying out of a census of population to be affected by the project and preparation of desegregated data.
10. Identification of socio-economic impacts of the project to the stakeholders.
11. Carrying out of an aerial survey of the project area and cadastral survey of the land parcels to be affected and accompanying list of the registered land owners.
12. Determination of the land to be acquired and the tentative compensation values for both land, permanent, semi-permanent and temporary structures and both cash and subsistent crops.

Scoping Process
At scoping stage/phase of the assessment process key issues to be addressed during the study are identified. It involved establishment of the diversity on physical environment, climatic conditions, demographic trends as well as the hydro-geological status in the area. Relevant policy and legal requirements were listed. The study team strived to share experiences on water resources and social issues surrounding the project area, particularly with regard to water demand and utilization. This was to enable determination of the project elements that would be emphasized on. Among the aspects identified and have been discussed in detail under this report included;

**Environmental Aspects**

1. Submergence of Thwake and Athi Rivers’ streams including the related ecosystems (unique indigenous vegetation species and habitats for indigenous micro and macro organisms and fish breeding areas,
2. Sand transportation and storage in the dam and immediately upstream,
3. Removal of biomass (live and dead) accumulated over time (in the hundreds of years),
4. Water quality effects from point sources dotted all over the project area (pit latrines, grave sites, livestock pens, settlement and market centers,
5. Emergence of new species in the area such as to include vectors, wild animals and plant species
6. Effects on micro climatic conditions in the neighbouring areas

**Social and Economic Aspects**

1. Land issues with respect to land ownership, land acquisitions, compensations and resettlement of the landowners,
2. Social linkages of the dam such as to include public health (HIV/AIDS, Malaria, typhoid, bilharzias, etc.), income generation (employment, economic opportunities, irrigation, etc.) and access to water,
3. Cultural linkages, which include the relocation of graves and interference with other cultural sites
4. Economic values of existing natural resources (biomass, sand, soils, stones, etc.)
Review of policy, legal and administrative framework

The consultants reviewed the policies, legal and administrative arrangements, and local and international protocols that have a direct bearing on the proposed project, in an attempt to establish the frameworks within which the significance of the various impacts anticipated from the proposed development could be evaluated. As would be expected for any water related project, emphasis has been placed on those frameworks and protocols that have a direct bearing on the water industry, which include, among others the Water Act of 2002, Environmental Management and Co-Ordination (Water Quality) Regulations, 2006, the Agriculture Act, Environment Management and Coordination Act, 1999, Environmental Impact Assessment and Audit Regulations 2003, The Registered Land Act, The way leaves Act, The Public Health Act and Occupational Safety and Health Act (OSHA). These have been considered, and have to a large extent formed the basis for the determination of the significance of the various impacts associated with the proposed project.

Review of Baseline Information

Baseline information formed the basis of determining the degree and magnitude of impacts since they gave the conditions of the environment in terms of resources and impacts before the implementation of the project and associated infrastructure. This information was critical in project monitoring and also brought into focus the level of the accuracy of the prediction of the specific impacts on the project.

Field assessments

Field assessments were designed to address the physical and biological environment as well as the project affected persons (PAPs). Determination of the affected environmental and social features would not only be felt within the dam area but also in the neighbouring districts (upstream, around the dammed area and downstream). The field work session was, therefore, focused on establishing the anticipated positive and negative impacts in terms of physical and biological environment (hydrology, climatic patterns and water resources related aspects), social and economic trends, (population trends, settlement trends, economic patterns, cultural setting and linkages, land ownership issues, etc.). Specific objectives of the field assessment included;
Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

1. Obtaining any available information and data from the local public offices including environment, water, lands and agriculture. Public consultations were also organized with the stakeholders both in the rural and urban setting.

2. Evaluation of the environmental setting around the proposed site. General observations were focused on the topography, land use trends, surface water sources, public amenities, wetlands, settlements, forests, soils, etc. as well as identifying climatic and land cover variations along the affected areas,

3. Evaluation of the social, economic and cultural settings in the entire project areas,

4. Undertaking of comprehensive consultative public participation exercises in order to reach a large section of the project affected persons as well as other stakeholders.

Detailed ESIA study activities

This assignment involved a series of activities carried out in liaison with the Client, relevant government departments, local authorities, community groups and other organizations in the area with a view to sharing their experiences and information with respect to environmental resources and social aspects. Effective evaluation of the social baseline status achieved through interviews (consultative meetings and discussions) and physical inspection of the entire project area. The baseline conditions provided the starting point for the impacts predictions and benchmark for the mitigation measures.

These measures were meant to limit the extent of negative impacts that may arise as a result of a particular development alternative. Potentially negative environmental impacts may be bearable both to the environmental elements and the community depending on the measures put in place to mitigate such impacts as detailed elsewhere in this report

Target Group for the Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) Reports

The ESIA and RAP reports have been prepared for use by different stakeholders involved in the project. The reports contain useful information on policies and procedures to be adhered to; implementation modalities; analysis of potential environmental and social impacts and suggested mitigation measures at various stages of the proposed project activities. The information contained in the reports will be useful in the planning, implementation, management and maintenance of the proposed Thwake Dam.

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TAWSB Prasol Training and Consulting Ltd
Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

In this regard the report will be useful to the following stakeholders:

1. Implementing Agency, Tanathi Water Services Board and Ministry of Water and Irrigation;
2. WRMA
3. TARDA
4. Affiliated Lead Agencies;
5. NEMA Monitoring and Compliance section;
6. Funding agencies and donors;
7. Professionals to be involved in the preparation of designs for the project
8. Construction works contractors;
9. Project Affected Persons (PAPs);
10. Beneficiaries of the project.

Methodology

In undertaking the Environmental and Social Assessment process for the preparation of the ESIA the following steps were followed:

1. Preliminary meetings
2. Project description based on previous studies done and discussions with the project proponent
3. Stakeholder meetings
4. Screening and scoping of environmental impacts
5. Identification of impacts
6. Assessment of impacts
Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

7. Socio – economic and census survey
8. Baseline environmental analysis – water sample analysis
10. Preparation of ESIA interim report
11. Preparation of Final ESIA Report

Detailed Methodology

Throughout the ESIA process for the proposed Thwake Dam, Prasol Training and Consulting Ltd worked with the stakeholders taking note of any concerns raised by them. The ESIA process was based principally on EMCA and African Development Bank (AfDB) guidelines. This included the following:

1. **Public Consultations**

The process of these public consultations followed AfDB civil society engagement framework of 2012 and involved identification of the affected communities, informing the provincial administration, from District Commissioners to the assistant chiefs through letters and follow-up calls, awareness creation and mobilization of communities through the chiefs and their assistants, as well as drawing up a timeframe. This was followed by debriefing of the Makueni District Steering Group which also paid a visit to the project site. Public consultation meetings, chaired by the provincial administrators, were then held at the dam site and target beneficiary sites. The consultative meetings were conducted at the following markets:

1. Miksi market in Mavindini Locations, Katithi sub-location,
2. Katithi Market in Mavindini locations, Katithi sub-location,
3. Syotuvali market in Kathulumbi Location, Syotuvali sub-location,
4. Kanyangi market in Kanyangi location,
5. Kanzokeani market in Kathonzweni Division

6. **Preliminary Meetings**

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Initial preliminary meetings were held immediately after signing of the contract which took place on February 2012. The initial meetings were held between the client and Prasol Training and Consulting Limited, as well as between the client representatives, the community leaders from around the proposed dam site and Prasol Training and Consulting Limited. The main objective of these meetings was to agree on expectations of the assignment, its execution procedure, focal and reference points of the proposed project and work plan. Minutes of this meetings can be found in annex IV of this report.

7. **Project Description**

Based on the Environmental Impact Assessment and Audit (EIA/EA) regulations 2003, the previous ESIA studies done in March 2009 and discussions with the project proponent, a Study report was prepared and submitted to the client for review on March 2012. The proposed Thwake Dam falls under the prescribed list of projects which Environmental and Social Impact Assessment is mandatory prior to implementation and was therefore recommended for full study. Terms of Reference (ToR) for the proposed Thwake dam were provided by the client TAWSB. The ToR guided the remaining steps of the ESIA/RAP Study for the proposed dam

8. **Scoping of Environmental Impacts**

The method used was based on previous studies, community participation, and review of available documents and experience of the ESIA team

9. **Impacts Identification**

The project impacts were assessed in terms of five primary impact criteria which included *scale, duration, severity, certainty*, and *direction*. A checklist was used for this purpose

10. **Water Quality Sampling and Analytical Methodologies**

Sampling of river water was carried out on the Athi River for analysis. Sampling points were selected at strategic locations upstream and downstream of the proposed dam site. The analysis
Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

was carried out at AgriQ Quest Limited and a certificate of analysis was submitted on 14\textsuperscript{th} March 2012 (See Annex V)

11. **Socio-Economic and Census Survey**

To collect socio-economic information on the proposed project area and the project affected persons, a socio-economic and census survey was carried out using a questionnaire between March and May, 2012. This was conducted by visiting each of the PAPs household and a few sampled households outside the proposed project area.

Focus group discussions were also held where in-depth information was sought from the people on issues such as land, incomes and beliefs/culture.

Preparation of the socio-economic and census survey process involved preparing a list of plot numbers and obtained names of owners from the land registry. The list was however not up to date because some of the changes on the ground such as sub-divisions had not been updated at the land registry. The census was conducted by enumerators recruited from the proposed dam site and the immediate neighbourhood.

The processing of the socio-economic survey data began with data entry for the completed audited questionnaires using Statistical Package for Social Sciences (SPSS) by data entry clerks. Upon completion of data entry, the data was analyzed and descriptive statistics were generated for use in preparation of this report.

12. **Preparation of Environmental Management Plan**

An Environmental and Social management plan has been prepared describing the mitigation measures to be implemented indicating the responsible parties. The contractor will also prepare their own environmental management plans, including a schedule of works. This will be shared with all the stakeholders to ensure that their views are also incorporated and they have information that would enable them participate in monitoring.

13. **Reporting**

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Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

The reports (inception, draft final and final draft and final) were done at pre-agreed timeframes such as to cover the requirements of the National Environmental Management Authority (NEMA) guidelines. The report schedule comprised a scoping report, draft final ESIA study report and final ESIA study report. The scoping report and the final study report were submitted to NEMA review. Besides continuous briefings to the Client and local NEMA office also undertaken.

Constraints and Limitations

The information presented in this report is by and large consistent with the data and information gathered through the various sources and approaches outlined above.

The findings and issues advanced in this report reflect the general views and perceptions of some selected people and stakeholders. They may not cover the specific issues from unique situations or individuals.

Some of the information in the report was processed from secondary sources and it is therefore necessary to understand the report with the time reference beside the limitations.

ESIA Team

The assessment team comprised of the following Team Members

1. Haroub Ahmed  Lead EIA Expert/EIA Team Leader
2. Paul Masavi  Sociologist Economst (Prasol)
3. Joseph Edebe  Ecologist
4. Guyo Malicha  Environmentalist/Co-coordinator (Prasol)
5. Dan Odero  Hydro Geologist (Prasol)
6. ....................  Project Manager (Prasol.)

TAWSB  Prasol Training and Consulting Ltd
Project Implementing Agency

The project Implementing Agency is Tanathi Water Services Board under the Ministry of Water and Irrigation.

Contact Details of Tanathi Water Services Board are as follows:

Contact Person: Chief Executive Officer,
Physical Address: Africa Re-Centre, Hospital Road,
Postal Address: P. O. Box 45283 – 00100, Nairobi
Telephone Numbers: +254-20-2724292/3 or +254-20-27224295

CHAPTER 2: PROJECT DESCRIPTION
Proposed Multipurpose Thwake Dam

1. Project Details

Table 1. Project Details

<table>
<thead>
<tr>
<th>Project</th>
<th>Thwake dam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Province</td>
<td>Eastern</td>
</tr>
<tr>
<td>District</td>
<td>Makueni</td>
</tr>
<tr>
<td>Design stage</td>
<td>Preliminary Design Stage</td>
</tr>
<tr>
<td>Sub Basin</td>
<td>3F</td>
</tr>
<tr>
<td>River</td>
<td>Athi river</td>
</tr>
<tr>
<td>Maximum dam height</td>
<td>84 m</td>
</tr>
<tr>
<td>Type of Dam</td>
<td>Earth fill</td>
</tr>
<tr>
<td>Dam crest elevation(main dam)</td>
<td>923 m</td>
</tr>
<tr>
<td>Dam crest length(main dam)</td>
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<tr>
<td>Dam crest elevation(saddle dam)</td>
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<tr>
<td>Dam crest length(saddle dam)</td>
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<tr>
<td>Dam fill volume</td>
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<td>Full pool reservoir</td>
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<td>Gross Storage</td>
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<tr>
<td>Useful live Storage</td>
<td>594 million m3</td>
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<td>Safe yield x106 (m3/day)</td>
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<td>Reservoir fill (months)</td>
<td>11</td>
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<tr>
<td>Mean river flow</td>
<td>53 m3/s</td>
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<tr>
<td>Steady release rate</td>
<td>25 m3/sec</td>
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<tr>
<td>Average power head</td>
<td>70 m</td>
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<tr>
<td>Firm power</td>
<td>20 MW</td>
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</table>
Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

<p>| | |</p>
<table>
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<th></th>
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<tbody>
<tr>
<td>Installed power capacity</td>
<td>20 MW</td>
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<tr>
<td>Estimated Cost of Dam</td>
<td>Ksh 8.38 Billions</td>
</tr>
<tr>
<td>Cost of power facility and transmission</td>
<td>Ksh 2.12 Billions</td>
</tr>
</tbody>
</table>

2. Nature of the Project

This is a ground breaking project and shall involve construction of a dam across River Thwake to provide water for use in Makueni District. The project shall involve construction of a dam to impound run off water. The dam wall will measure 84 metres high and the key components of the dam will include river diversion and intake works, embankment and spillway. The dam will physically cover an area of about 2,900ha spanning from the dam axis to 2 – 3km wide and a throwback of about 9km upstream, mainly on Thwake river basin. The catchment is estimated at about 10,276km² comprising of about 35% arable and 65% semi-arable land (see location map and project layout plans on annex II).

3. Project Location

Thwake multipurpose dam is located in Katithi locations of Mavindini Division in Makueni District approximately 1km downstream of Thwake and Athi river confluence. Across Athi river is Kanyangi location of Kanyangi Division of Kitui District. To the northwest of dam site lays Kathulumbi location of Kathulumbi division in Mbooni District. Lying at an altitude of about 840m above sea level, the proposed dam embankment is located near RGS 3FO2 at approximately 01° 47’ 09” S and 37° 50’ 34” E and about 30km to the north of Wote town and about 8km north from Mavindini market. The project site is located at a distance of 188 Kilometres from the capital city of Nairobi.
The proposed Dam will encompass an area of 10,276 square kilometers, and will achieve a height of 84 metres. Its area will stretch to an approximate length of 12 kilometres along the Athi River, and 8 Kilometres along the Thwake River.

4. Project History

Thwake Dam was first proposed for construction in 1953 during the colonial days and again in the 1980s but construction never commenced. While in the 1950s and 1960s rivers in the project area had notable water flows, the flow quantities have been declining over the years creating acute water shortage for both irrigation, livestock watering and domestic requirements. Significant numbers of...
intervention projects in water and sanitation have been undertaken in Makueni district and other adjoining areas, but it seems the problem continues to get worse particularly with regard to sustainable availability of water.

The perennial flow in Athi River and the significant seasonal flows in the Thwake and Kalawa streams have a potential to provide water for use all year around by the communities in the area. Harnessing of this capacity is, therefore, more important now than ever before to satisfy the desires of the initial expectants of the dam and the dreams of the younger generations in the area.

5. Project Justification

Makueni District and the neighbouring districts are among the arid and semi-arid lands (ASALs) of Kenya with generally a sedentary land use practice, i.e. keeping of limited livestock and limited farming. This way of living is influenced by low rainfall as well as inadequate sources of surface and ground water sources. Increasing population, demand for land and water resources, the welfare of the residents with respect to productivity, health, sanitation as well as livestock sustenance is continually challenged. Residents have to walk long distances (5 – 10km) in search of water for domestic use and livestock. What they find is mostly of inferior quality effectively risking the people’s health and hygiene. This is clearly depicted in the reported cases of water borne ailments (diarrhea, intestinal worms, bilharzias and skin problems).

Intervention initiatives, therefore, are necessary form every possible quarter. To reduce cases of water borne diseases, the DDP (2008 – 2012) proposes to increase the rural water supply and enhance water use management capacity. Enhancing opportunities for water harvesting distribution of water and increasing number of consumption points are also listed as priorities. The proposed Thwake dam will open up the area for development by further being an enormous viable source of water for domestic and livestock use. Apart from other incidental benefits like fisheries and tourism the dam axis may provide a causeway that will open up the area by providing social and economic access between the two Districts.

The Athi River Basin covers an area of about 67,000 km2 and is one of the five major drainage basins in Kenya (others being Lake Victoria Basin (46,000 km2), Rift Valley Basin (125,000 km2), Tana River basin (127,000 km2) and Ewaso Ngiro North River Basin (209,000 km2). The Athi River stretches for over 600km long and has a mean annual rainfall of 610mm covering two water services boards, namely Athi Water Services Board and Coast Water Services Board. Of the total area covered by the basin, about 19,000km2 (~29.7%) is arable and just over 46,000km2 (~70.3%) is non-arable.
Proposed Multipurpose Thwake Dam

The basin has a total population of 7,850,897 according to the 2009 census. The total number of households in the basin area according to the 2009 census was 1,061,218 people. Thwake multipurpose dam is being designed to intercept runoff flows from Thwake and Athi Rivers for the benefit of an estimated 80,000 people in over 16,000 households in the greater Makueni District. The dam is expected to provide about 249,000m³ per day of water for irrigation, 10,565m³ per day for domestic use and 53m³/s for power generation. Social and economic benefits associated with the dam far outweigh the negative impacts to the physical and biological environment that would also be mitigated.

6. Project Area

The topography of the land dictates that only the area lying below 870m contours can be served without the need of a pumping scheme. But with limited pumping on to the nearby Katumba hills near Mavindini market, the water could be distributed to a much larger area in Kathonzweni, Makindu and Kibwezi divisions. Katumba hill is located about 8km south west of the dam site and adjacent to Mavindini market center. The immediate Kilisa hill on the Kitui side creates a natural barrier on the northern bank of Athi River while the southern is relatively low. Pumping water to Kilisa hill could also facilitate supply to low lying areas in Kitui District. The proposed western boundary of the supply area is road reference E207 linking Wote and Kalawa towns while the extreme southern boundary could be river Kikuu providing an approximate supply area will be 550km². Extract maps of the project area are in annex II.

The project area could be divided into four zones described below

1. Zone 1: Catchment Area Upstream of the Dam

   1. The larger water catchment that includes the far reaches of Athi River watersheds spans as far as Kiambu, Nairobi and Ngong hills. The immediate catchment areas cover the watersheds of Thwake and Kalawa rivers among other minor seasonal streams through which surface runoff will be collected into the dam. The immediate catchment is basically Mbooni hills where Thwake and Kalawa basin originates,

   2. While the far reaches of the catchment areas are characterized with dynamic social and economic activities completely different from the local setting, the immediate catchment comprises hilly vegetated slopes in the watersheds (Kibauni hill, Kalimani forest, Waiya
Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

forest, Kithendu forest and Nthangu forest among others) but vegetation cover thins out towards the south downstream of the dam area.

3. Among tributaries of Thwake River with high potential to contribute to the dam include Kalawa, Miu, Mukio, and Kaiti rivers. The streams are all seasonal with potential for sand storage of water to the advantage of the immediate communities. The streams also have heavy capacity for sediment transportation.

4. Land in the immediate catchment is freehold owned on family basis, though varying in the size of land parcels. Land use is largely uniform throughout and is characterized with limited settlement, limited farming (due to shortage of water) and significant livestock keeping.

5. The geological and soil characteristics of the watersheds provide rich depositions of sand carried into the streams and transported downstream to the Athi river basin. There is a notably higher sand loading potential from the Thwake river catchment as observed at the confluence. Inadequate access roads to the basin limits sand harvesting compared to Athi river basin upstream

1. Zone 2: Dam Site and Buffer Areas

1. The zone to be inundated by water upon completion of the dam is expected to extend 2–3km at the dam axis and narrow down to 100 – 500m towards the far upstream (~9km upstream of the dam axis). This implies that all the low lying areas will be inundated leaving “islands” of the few raised grounds. Such “islands” will provide opportunities for biodiversity conservation,

2. The larger dam area is situated in a depression (~840m a.s.l.) in the midst of a hilly terrain within 80km radius comprising of among other key features Katumbua (~1,250m a.s.l. at 8km near Mavindini market) and Kamwithi (~1,187m a.s.l. at ~10km to the south of Mavindini market) peaks on the southern and ragged rise towards Wote. On the north and eastern is the Yatta Plateau system with Kilisa peak (~1,150m a.s.l.) forming the northern anchor for the dam axis and a peak at Kanyangi hill (standing at ~1,167m asl). The dam axis is located about 1km downstream of the Athi – Thwake river confluence and approximately 200m downstream of RGS 3FO2 such as link Kilisa hill to the north and Kathukuni to the south.

3. The Athi river flow that is downstream of the confluence is relatively wide (reaching up to 150m in some areas) compared with the proposed dam axis location estimated at 80m wide.

4. The dam area is characterized with dense vegetation comprising of indigenous trees, shrubs and grass on the dry land while reeds (phragmites) and cyperus species and aquatic grasses are found on the river banks. There are trees that are reported (and also observed) to be more than 150 years old in some of the areas to be covered by the dam.
5. Thwake and Athi river waters provide water sources for the immediate communities (who use it for small scale irrigation of food crops), watering their livestock and drinking water. Communities from as far as 10km also access the rivers for livestock watering and fetching water for domestic use.

6. There are at least four homesteads, all on the Makueni side of the dam close to the proposed dam axis and the confluence. The homesteads comprises of houses, granaries and cattle pens. Other notable features are pit latrines (in use and other abandoned) in all homesteads and also reportedly graves on some,

7. Typical land use in the dam area includes limited agricultural activities, livestock keeping, settlements and development of commercial centers (Mavindini, Katithi, Miziki, Kanyangi, etc.

8. There are no clear access roads to the dam site and it surroundings. Most access paths are established from cattle tracks and are, therefore, not motorable.

Part of the strip around the entire water line of the dam and extending for about 100 – 200m will be isolated and conserved as a buffer zone. While this is not marked on the ground, it will provide a vegetated zone to ensure filtration of runoff into the dam and also limit direct access of the dam water risking contamination. Implications to the landowners will be similar to the actual area covered by the dam though no inundation is expected. The design of the dam is expected to integrate this zone as part of the dam.
1. Zone 3: Area Served and the Adjoining Land

9. The service area and the adjoining zones are characterized with dry water courses and flows with water only during rainy seasons. While there are efforts from various intervention projects to enhance provision of water to the area, the related change is still not significant, especially on agricultural activities and livestock keeping since available water is utilized for domestic purposes. The area is generally dry with characterized arid vegetation basically of indigenous nature.

10. Topography is ragged and steep slopes along the Athi river basin though without a particular pattern but has a general slope towards the south and eastern direction. The geology provides sedimentary type of rocks that easily erodes during rains leading to heavy loading of sand in the surface runoff and the streams.

11. Water harnessed from the dam will serve the people living in the central and south of the greater Makueni District, (now comprising Makueni and Kibwezi) as well as parts of the greater Kitui District (Kitui and Mutomo) depending on suitability of the topography.

12. Most areas are not accessible with roads where all are earth surfaced some adopted from cattle tracks. Development of market centers in various locations, establishment of new administrative and political units across the service has led to establishment of access earth roads, a process that is ongoing.

13. The storage and distribution tanks will be located on Katumbua hill near Mavindini market just outside the dam influence area on the Makueni side and on Kilisa hill on the Kitui side.

14. Katumbua hill is surrounded on all sides by settlements and limited farming. There are, however, notable indicators of safety risks to the land owners and their settlements in the event of a bursting storage tank unless preventive measures are undertaken.

1. Zone 4: Downstream of the Dam

This zone covers the entire Athi river basin traversing Makaueini, Kitui, Mutomo, Taveta, Malindi districts upto the ocean. The basin is characterized by ecological features (riverine vegetation and aquatic wildlife), settlements and limited irrigation (landowners preferring the proximity to water) and public amenities such as bridges. This zone is would identified with potential risks to the ecological setting, physiological features, infrastructure, human life and property.
2. Design Concepts

1. Basic Considerations

Basic dam design principles are driven by safety and economic sustainability. The key principles adopted for Thwake dam include:

1. Structural stability of all components of the dam (foundation, abutments and the embankments)
2. Ensuring minimum seepage through the embankments,
3. High enough crest level to prevent overtopping and wide enough to prevent breaking,
4. Adequately sized and firm spillway structures
5. The treatment works are also anticipated to comprise of flocculation of the turbid water, sedimentation and filters as well as disinfection units

Hydrology criteria

In designing the dam runoff from the catchments was important. It was analyzed with respect to the total surface area, shape and slope as well as intensity and distribution of rainfall. Measurements of runoff measured at RGS 3FO2 between 1950 – 1990 gives averages ranging from 10m3/s to173m3/s. Calculations factoring other aspects has provided a value of 5350m3/d for the spillway design

Land use

It has been observed that the land around the project area is potentially agricultural and livestock keeping is limited by water shortage. With abundant water, larger areas of land will get cleared of vegetation leading to increased surface runoff and peak maximum flood flows as well as higher siltation of the dam. There should be Control of soil erosion and siltation from the catchments and the immediate agricultural land through sand traps and silt washout valves.
Farmers should be supported on sustainable land use practices in liaison with relevant organizations.

**Water demand**

Water demand applied in the dam design is a maximum of 260,000 m³/s for domestic uses, commercial and livestock while irrigation maximum demand is estimated at 249,000 m³/d focused on the year 2030. Based on these estimates, the total flow required to meet this demand is 56 m³/s, justifying the design dead storage. The storage capacity of the dam will be 85 mcm standing at a height of 75 m level against a full crest height of 84 m.

**Geology**

The dam site and its surrounding are characterized with rocks of the basement system, volcanic of Kapiti phonolites (yatta Plateau) and aruphibolites (Athi basin upstream). The dam site was confirmed to be underlain by a firm foundation of banded gneisses and granitoid gneisses with average thickness of 10 – 20 m.

Occurrence of earthquakes within close proximity of the dam is also a factor for consideration. In this regard a seismic loading of 0.12g has been applied for this dam (details in the design report) following studies of parameters associated with other dams around the country namely Turkwel (0.2g), Chemususu (0.22g), Kiambere (0.12g) and Thika (0.13g). The area is reported to be within low earthquake intensity but still described as destructive zone (Zone VIII as in the annex VI).

**Hydrogeology**

The possibility of dam construction material within project area is also an important factor. The nature of soils at the site (including Katumbua hill for water storage tanks) is closely suitable for construction of core and dam embankment in addition to either formations. High potential for groundwater in the area makes the soil moisture content higher and hence allows for easy compaction. Additional material will be obtained from Mikisi area (just southwest of the dam site) for the construction of the impervious core. Water would be plenty (abstraction compaction of the embankments.
1. Dam Components

1. **Embankments**

The dam location was selected to facilitate use of contour layout and ensure the use of the shortest but stable crest length and spillway. The top soil (3m) and the 20m thick base as well as good materials for the foundation were also attractive factors for the selection. The design of the embankment wall has addressed the following parameters:

1. Embankment slopes and protection measures
2. Long term stability,
3. Rapid draws down stability,
4. Seepage control (for the embankment, foundation and reservoir area),
5. Free board management to prevent overtopping under any circumstances.
6. Crest width (7m) use for services access.

7. **Spillway**

This will be located on the left of the dam axis approximately 1km upstream. It will be constructed of concrete channel with 9m sidewalls at the diversion point reducing to 6m towards the discharge point and spanning for 200m wide to accommodate flow of 1: 1000 years. The channel flows back into the main river stream just downstream of the treatment works. Other spillways provided include (details in design report);

1. Alternative spillway to add safety to the structure when flows are greater than the capacity of reservoir,
2. Emergency spillway for the safety of the dam in the event of water evaluation if flood is greater than the design capacity

3. Draw off and diversion works

These are components designed to enable removal of water for use in irrigation at a rate of 1:25 years return period. Diversion culverts measuring 6m wide and 10m high constructed of reinforced concrete will be provided for this purpose. On the other, draw off however, will be constructed for drawing water at various levels and lifted to the consumer storage tanks.

1. Project Activities

1. Planning And Feasibility Studies

The dam project begins with the concept development that involves desk and field assessment with a view to establishing the need for the project. A wide range of considerations including the capacity of the existing water sources, water demand and uses as well as social and economic linkages of water in the target area have been undertaken.

The concept is followed by a detailed feasibility study. Like the environmental scoping process, this study involved determination of the viability of the proposed dam project with respect to sustainability of water feed, environmental suitability, social acceptability and economical justifications. Preliminary physical surveys, measurements and social evaluations were carried out in conjunction with all stakeholders and in reference to all other social and economic initiatives in the project area. According to the feasibility study produced, the project is a fulfillment of the communities’ longtime dream of water availability while the positive implication over-rides the negative impacts that would otherwise be mitigated through integrated measures through the dam construction and use of the water thereof.

2. Design Work

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While design work is mainly a desk activity, there are significant ground activities. Topographical surveys, cadastral surveys, hydrological evaluations and measurements, geological and soils tests and other environmental considerations are among the other physical activities. These activities involve partial clearing of vegetation in some sections, intrusion onto private lands and excavations in some parts to determine geological profiles among others. Interactions with the local communities for first-hand information particularly with respect to special physical features, land ownership and desired design considerations is also undertaken during this stage.

The rest of the work is carried out at the desk levels such as to include design calculations and drawings, consultations between various stakeholders and the client, design reporting and development of project costs estimates. Implementation schedules and responsibilities are also prepared under this stage. Environment and social impact assessment study utilized the design outputs, particularly at the preliminary stage, in determining quantified impacts and appropriate preventive action plans. The environmental management plan is guided by the details in the design principles.

3. Construction Phase

Activities at this stage will include the following:

1. **Procurement of materials, tools, equipment hire and labour recruitment (skilled and unskilled)**

   This shall involve floating of quotations for supply and selection of suppliers in line with the procurement guidelines. Transportation of machinery and deployment of the workers to the construction site shall also be done at this stage. The machinery will be used for groundbreaking works and for transportation of materials from the sources to the site.

   The contractor shall also mobilize human workforce to the site. Both unskilled and skilled labour will be hired. Most of the workers shall be drawn from within the ranks of the project beneficiaries. Gender balance shall be observed during the recruitment of labour.

2. **Construction of the dam and associated infrastructure**

   The main activities at this stage shall include the following:
Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

1. Inspection and certification of materials
2. Storage and maintenance of materials
3. Provision and Management of labour
4. Construction of water facilities
5. Construction of sanitation facilities

The contractor will source for materials for construction from the various available suppliers. The materials that shall be used for construction include among others: building blocks, stones, sand ballast, cement, G.I. pipes, water taps, PVC pipes, pavement blocks, concrete slabs, murram, hardcore, and timber among others. In situations where the extraction of these materials involves mining activities, which may interfere with the landscape, as in the case of building stones, it is recommended that the restoration of the sites from where these sources extracted is ensured. This can be done through backfilling of the sites and afforestation programmes where the community members are encouraged to plant indigenous trees at these sites.

Other significant activities in this phase will include:

1. Displacement and resettlement of the residents in the affected area that will include among others demolition of the houses, removal of the building debris and relocation of the residents to alternative areas,
2. Decommissioning of pollution point sources throughout the area proposed for inundation. Pollution point sources include pit latrines, septic tanks (where they exist), cattle pens, graves and any waste dumping sites,
3. Vegetation clearing of the area covered including extraction of root zone and the removal of all dead plant matter away from the project area to suitable disposal areas,
4. Excavations and earth moving as per the design including removal of spoils to the designated duping locations. This will also overlap with vegetation removal and decommissioning of the point sources of pollution,
5. Construction of access roads, workmen camps, construction sites (workshops, offices, machinery yards, material sites, etc.), communication facilities, water storage facilities, etc.,
6. Masonry works and erection of structural components at the various locations as per the designs.
7. Rehabilitation works of the affected areas including deep excavations and material sites, re-vegetation of appropriate zones, polluted sites, etc.
8. Products, by-products and Waste

There will be liquid, solid and gaseous wastes from the project site. These will be from project activities during construction, operation and decommissioning. There shall be effluents from civil works, workers and the storm water. It is envisaged that at the construction stage, wastewater that shall be discharged will also be sprinkled on routes and working areas to reduce dust generation by construction machinery. Other wastes from construction site will be mainly material residues of the construction materials. These include pieces of concrete, heaps of sand and aggregates, bits and pieces of various pipe types, cans of paint, polythene sheets, paper packaging materials, pieces of timber, pieces of iron (metals) among others scattered within the project site.

Wastes during operation will include packaging wastes from the various packaging materials used in cargo handling. Solid waste shall be managed in strict recognition of the existing legal framework. Relative air emission is expected during construction when dust from traffic, construction activities and construction machinery will be emitted. It is recommended that watering be enforced to keep dust at minimal levels. The employees at the site shall also be provided with gas masks to protect them from dust emissions.

1. Commissioning

This will be the formal hand-over and operationalization of the dam upon completion. Among other activities, the contractor and the client will ensure there are no unresolved social concerns, the facility has been completed to the design details, affected sites have been well rehabilitated and that all components are operational. In addition to the paper work, there will be a physical evaluation of the facility that will involve the contractor, TAWSB, relevant Government departments and the design consultant.

2. Dam Operations

The very initial stage of the dam operation will be to ensure it is relieving water from the catchment through the rivers and runoff during the rains. This could take a period of up to one year during which there will be strict management of flows in the river to ensure dependants and ecosystems downstream are sustained. Upon the dam filling, the water will be utilized in
accordance to established guidelines and regulations agreeable to the Water Act and other regulatory authorities

2. Project Outputs

The feasibility study report found out the proposed dam will have a potential of water supply for both domestic and industrial use, as well as hydropower and irrigation purposes. The preliminary design report gives a summary of the design parameters that was considered for the three components of the Thwake Multi-purpose Project. It is anticipated that the key output of this project is a multi-purpose dam to provide water for domestic use (10,565 m³ per day that is also the main target of the project) by the communities living in Makueni and the neighbouring districts, irrigation activities (249,000 m³ per day) mainly within Makueni district where water could easily gravitate and also hydropower generation (53 m³ per day). In addition to offsite water use, it is expected that onsite benefits will be realized by the residents such as to include fishing, direct irrigation for small scale food production, possible tourism potential and improved sanitation and hygiene.

3. Project Schedule And Estimated Cost

The project is estimated to cost approximately Ksh. 9.2 billion spread as follows: please refer to annex VIII for the complete bill of quantities

1. Dam, spillway and draw-off tower KShs. 5.23 billion
2. Water supply KShs. 0.526 billion
3. Hydropower component KShs. 1.96 billion
4. Allowance for land and property compensation KShs. 0.343 billion
5. Preliminary and contingencies KShs. 1.76 billion

**TOTAL** KShs. 9.2 billion

The construction period is estimated to take 3 years
CHAPTER 3: ANALYSIS OF PROJECT ALTERNATIVES

1. Overview

A major review of water by national water conservation and corporation concluded that water provision and attendant infrastructure for supply is inadequate. A wide range of considerations including the capacity of the existing water sources, water demand and uses as well as social and economic linkages of water in the target area have been undertaken. To address the persistent water shortages in the project site and its satellite towns, various alternatives have been investigated. The investigations have covered both run-off water and storage schemes. Below is a brief discussion of the various alternatives that have been considered.

2. No Action Option

The implication of this means the status quo remains i.e. the current water shortage in Thwake area and the associated problems will persist. This option would mean that the local and regional/national benefits would not be realized. With the “no-action” alternative, the potential social and socio-economic benefits to the area would be foregone, and quality of life would remain at a low level. Long-term development plans for the area would be compromised and slowed down, since a reliable water supply and the improved service associated with it are fundamental to achieving the full benefits of other development initiatives and meeting the Millennium Development Goal (MDG). Therefore, from both an environmental and social viewpoint, the “no-action” alternative is not preferable to project implementation. Overall, it is considered that the advantages of proceeding with the Project outweigh the negative impacts and that with the adoption of the recommended safeguards the disadvantages can be minimized and managed to acceptable levels.

3. Alternative Sites For Thwake Dam

According to the National Water Conservation &Pipeline Corporation, as compiled by the Ministry of Water, the Thwake project site is generally suitable with exceptional river water resource and suitable point of confluence of major rivers. Based on this information, several sites in the District were explored for suitability of Dam construction. The proposed site was selected following extensive studies taking cognizance of each of the various site attributes, namely environmental, social and sustainability, technology and commercial consideration, including the strength and stability of the water flows in the area, proven technology, benign environmental setting, low population density,
Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

security of the area, water availability and road accessibility. Consequently, sound justification and analysis conclude that the current proposed location of the dam appears to be the most suitable location because of e.g. low density of the population of the area and the steep to vertical configuration of the banks of the river in the area of the reservoir resulting in less impact than if the bank gradient was smoother.

4. Alternative Storage Option For Thwake Dam

Storage options were investigated for the proposed Thwake Dam. All the storage options were based mainly on one dam axis and other dam variables. The dam axis is located downstream of the confluence of Thwake and Tana Rivers. In the absence of a design of the proposed dam, the evaluation of the alternatives is limited to the reservoir storage, reservoir yield and the volume of earthworks quantities. The assessment has evaluated the hydrology of the Thwake and Tana Rivers downstream of the confluence of the two rivers.

The following are the three options that were considered in this study:

i) Storage Option 1

• A small size reservoir with a capacity of & &Mm$^3$ and a yield of & &m$^3$/day

ii) Storage Option 2

• Medium size reservoir with a capacity of & &Mm$^3$ and a yield of & &m$^3$/day

iii) Storage Option 3

• A large size reservoir with a capacity of & &mm$^3$ and a yield of & &m$^3$/day

1. Alternative Ancillary Facilities For Thwake

In addition to the alternative dam sites considered previously the current Feasibility Investigation is looking at alternative transmission line routes to closest urban centre such as Konza city among others as well as worker camp locations. These alternatives have been included as far as possible in this ESIA report to ensure social and environmental considerations are included in the investigation of these alternative Project components. However, further environmental assessment will need to be undertaken for the ancillary facilities during final design. The alternatives that have been considered include controlled releases of water from the dam and provision for outlet to
supply the neighbouring emerging city like Konza upon the final design. Besides the issues of costs and yield that led to the current choice, on the public health point of view the analysis indicates that the water quality will be better with the water treatment works located at Thwake and is consequently preferred. Further, the major health impacts are in relation to the location and construction of the dam, not so much the treatment works.

CHAPTER 4: ENVIRONMENTAL BASELINE CONDITIONS

1. General Overview

Makueni District is within the ASAL areas with limited rainfall, relatively elevated temperatures and high levels of evaporation. As a result, vegetation is generally withered though soils are reported to be fertile. Generally, most parts of Makueni District lie within a water scarce zone with very limited water resources. Kaiti, Thwake, Thange, Uani, Muoni, Tawa, Kiboko and Kiangini contain rivers with very low flows that traverse the area with mainly seasonal tributaries. Suitable sites suitable for earth dams are few and far apart with inadequate catchments while groundwater potential is generally poor in most locations due to poor recharge except for low lying areas and river flood plains.
The project area is basically agricultural (though limited by inadequate rainfall), with both cash crops (coffee, cotton, horticulture, etc.) and food/subsistence crops (maize, beans, pigeon peas, cow peas, cassava, sweet potatoes, etc.).

2. Topography and Physiography

The dam project area is located on relatively undulating terrain with a general slope running in a north-easterly direction and an elevation of between 600m above sea level in the southeastern to 1,900m above sea level in the northwestern. Among the notable physical features dominating the area and the adjoining districts include Unoa Hills (1,280m above sea level), Malivani Hills (1,340m above sea level) and Nzueni hills at (1,403m above sea level). Further north are highlands constituting surface water sources among them Nthagu, Kitondo and Iuani Hills where seasonal streams originate flowing south and east eventually draining into Kaiti River and eventually into Athi River.
On the Kitui side, Yatta plateau stands high at an average of 1,170m above sea level and creates a major physiological barrier between the larger Makueni and the larger Kitui districts. The plateau runs in a northwest – southeast direction with Athi river flowing in the same direction to the south sits on hard basalms that also determines the drainage trends of the area. Among the outstanding physiological features on the Yatta plateau and within the immediate proximity of the dam project area include Kanyangi hill (1,160m a.s.l.), Kilisa hill (1,146m a.s.l.) and Ndandoni hill (1,056m a.s.l.). This is in addition to numerous depressions and valleys as well as notable peaks.

Basement activity has dominated history of the area and has controlled the geomorphologic evolution as well. The rocks of the area (mainly tertiary strata) rest directly on the Basement system and generally have a gentle easterly slope. Most of the land surface and related landforms has been interfered with by human economic and settlement activities over the years through massive excavations, charge of drainage pattern and clearing of vegetation. Notably the eastern direction of the area is dominated by a gentle slope, while other direction is fully dominated by slope intercalated by ridged valleys.

3. Drainage and Hydrology

1. Drainage

The project area falls within the greater Tana and Athi drainage basin which includes mostly the central and eastern parts of the country. Management of water resources in this drainage mainly falls under Tanathi Water Services Board that sits in Kitui Town, though the upper sections of Athi river basin are under the Athi Water Services Board sitting in Nairobi. The drainage pattern of the greater Makueni District (now comprising of Makueni, Mbooni East, Kibwezi, Nzaui and Kathonzweni) is highly influenced by the Athi River and its tributaries (Kambu, Kaiti, Kiboko, Mtito Andei, Thwake, Thange, Uani, Muoni, Tawa and Kiangini among others) rising from the central highlands running eastwards toward the Indian Ocean as the Galana/Sabaki River. The flow route of the river in the area follows the topography trends. Due to the flat terrain, clear catchments and un-cohesive soils, flush rainfall has the potential to flood or wash down infrastructure (roads and bridges) and, therefore, there is evidence of drainage structures (culverts, drifts and bridges across major river streams). Furthermore, farmers and landowners have internalized soil control measures including terracing.
The Yatta Plateau is the main influencing physiological feature to the north of the dam area on the Kitui side. While Athi River runs southeasterly direction on the southern edge of the plateau following its alignment, part of the watershed and tributaries are to the north of the plateau and join Athi River far downstream of the plateau. Among the stream is the Tiva river and its main tributary Mwitasyano river (seasonal) that traverses Kitui Influencing general drainage towards Athi river.

2. Hydrology

Thwake dam falls within the Athi Catchment drained by the Athi River basin and its tributaries. The hydrology is, therefore, influenced by the flows from Nairobi’s river system (Nairobi, Ngong, Mbagathi, Ruaka, Ruiru, etc.) in the upper reaches of the catchment that spans as far as Ngong hills, Kikuyu Plateaus and the lower slopes of the Aberdares. Nearer the project area, are notable rivers (most of them seasonal) including Thwake, Tawa, Kaiti, Iuani and Kalawa rivers upstream of the proposed site while Kiboko, Makindu, Muoni, Kiangini, Mbanya, Mtito Andei, Kibwezi, Kambu and Thange rivers discharge into Athi River downstream of the dam location. From the Kitui side, the streams discharging into Athi River include seasonal rivers Tiva and its tributary Mwitasyano and their smaller streams. Tsavo and Voi rivers join the river far downstream of Kitui district in Taita Taveta district.

Physiologically, the hydrology is influenced by the rainfall potential in Mbooni hills, Nzau hills, Kiima Kiu, Muumandu Hills, Kilungu hills and Iuani hills to the west of the project area where most of the streams originate from. The Yatta plateau alignment determines the flows to the main Athi River, and limiting inflows and surface runoff from the Kitui side into Athi River. It would also limit flow of water into the Kitui from the dam site.

Due to the stream network combined with effective drainage and gentle slope, Makueni and Kitui districts has not reported cases of significant flooding. There were no ready records on flow trends of the rivers for use during this study due to low level hydrological monitoring resulting from their seasonal nature. All the streams contribute to the Sabaki river system flowing down to the coast.

4. Water Resources
Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

Major sources of water in the region include earth dams, boreholes and seasonal rivers (it is only Athi River that is permanent). Only about 29% of households in Makueni district have access to adequate water in dry seasons and 41% in wet seasons (similar situation experienced in the neighbouring districts. Many of the sources that provide water are unsafe and only 18% to 22% of the population have access to safe water in the dry and wet seasons respectively. Distance travel to water sources range from 5 – 10km (Makueni District Profile, AMREF 2000).

Athi River is physically coloured (brown) due to inflows from the catchments upstream and other pollutants from as far as Nairobi city, as well as upstream urban settlement effects. The observed physical water quality showed high levels of turbidity and suspended matter associated with the catchment status. It is also expected that the water could have high residual levels of agro-chemicals from the potential areas upstream, which include industrial pollutants’ residuals arising from industrial activities in Nairobi City and Athi River towns. Sampling of river water was carried out on the Athi River for analysis. Sampling points were selected at strategic locations upstream and downstream of the proposed dam site. The analysis was carried out at AgriQ Quest Limited (NEMA Certified), a water quality laboratory. Among the water quality aspects analysed include,

1. Low dissolved oxygen,
2. High nutrients (N, P, K) as nitrates, phosphates,
3. High suspended matter and turbidity (colour)
4. Elevated dissolved solids,
5. High alkalinity but relatively neutral,
6. Could be high in calcium and sodium contents (the two elements determining sodium absorption ratio (SAR),
7. Heavy metal residuals (Fe, Mg, Mn, Cr, Pb, Ni, Cu, Cd, Co, Bo, Al, etc.)
8. Biological content including faecal coliforms, algae and other aquatic micro-flora.

Households in Makueni and the adjoining districts (Mbooni East and Kitui West) are dependent on two main categories of water sources as follows;

1. Surface Water Sources
The main surface sources of water in the project area (Thwake, Muoni, Kaiti, Kalawa, Kiangini, Mbanya, Thange and Uani rivers among others) flow west – east general direction and has sources from Mbooni Hills in the North while other tributaries originates from Kikima and Kiu hills to the East. The rivers and their tributaries do not only influence surface water sources in the area but also groundwater recharge capacity. Most of the rivers are semi-permanent (seasonal) draining into Athi river system while most of the tributaries are seasonal.

Specific sources included Kambi ya Mawe and Kikumini dams and Kaiti River as the notable surface water sources for Wote Division. Sources in Kalawa division include Kyamakuthi, Mkuku, Yumbuni and Kiatiriieni earth dam as well as access to the seasonal Kalawa stream, Thwake river and Athi river with the latter being the only permanent source. Kathonzweni division benefits from about 9 earth dams provided by various groups including the Red Cross (Ituka and Kwa Musele dams), CDF initiatives, World Vision, Catholic Church and the Ministry of Water. Kikuu and Athi River are also accessible whenever there is surface of sub-surface flow. Finally, notable sources in Nguu division include Nthunguni and Mwingati rock catchment dams as well as the seasonal Muoni and Kikuu rivers.

During dry seasons, small sand holes of between 0.5m and 2m are used by the local consumers and often by water vendors to extract water from the riverbeds. More than 50% of water consumers in the urban centers and the District in general depend on surface and sub-surface water sources.

A significant number of households have installed rainwater harvesting systems (direct from roofs) and communal rock catchments systems. Where rock catchments have been provided, storage tanks and water kiosks have also been installed under the management of the same communities. A good example is found at Mathangathi village in Mavinding Division.

2. Groundwater

Groundwater is perhaps the most reliable source of water in Makueni district, though exploitation is limited by unsustainable depths, poor yields as well as the associated costs. For example, Wote Water and Sewerage Company extracts water for public supply from a borehole constructed in 1947 while a host of many other private and institutional boreholes exist in various parts of Makueni district. Wote Division has the highest ground water yield and also has the most boreholes in the area in terms of number and presence, with over 25 boreholes as compared to an average of less than five in other divisions. There are more boreholes in the lower zones including Kibwezi, Kitui and Mutomo districts.
2. Biodiversity

1. Vegetation

The project area depicts a homogenous mix of plant species adapted to dry conditions and low rainfall experienced throughout the year. About 80% of the area anticipated to be inundated has a rich accumulation of life and dead biomass that will not be allowed to be covered under water due to the implications on water quality thereafter. Human activities have significantly eliminated natural vegetation for agriculture and settlement, but indigenous plants are still notable in most areas. River basins are the worst hit by the reclamation due to availability of water. Forested areas are confined to the hill tops (approximately 2% of the forest cover) while lower areas have been cleared to pave way for commercial, residential and institutional activities. At the site, elevated areas (Kathukuni hill, Kilisa hill slopes and Kanyangi hill) are among zones with very high biomass accumulation comprising of indigenous trees and shrubs.

The greater Makueni district has a total of 5 gazetted forests and 4 un-gazetted forest areas covering 25 km2 and 5 km2 respectively. In addition, it seems efforts in encouraging landowners to plant trees for farm forest or other noise with close 30% willingly do it. Key forest products in the region include timber, poles, fence posts, charcoal and wood carvings. The five gazetted forests (Nthangu, Mbooni, Makuli, Kibwezi and Kilungu) are estimated to produce over 3,000m3 of timber in addition to volumes of firewood every year. Makueni District (and most of Eastern Province) has been undergoing massive agro-forestry and the results are visible, though the tree species are mainly exotic. Successful zones in this regard include Mavindini, Wote, Kathonzweni, Nguu, Mbooni, Kilome and Kaiti among others.

Among the major notable plant species include:

1. Grasses – Chloris gayana, Common star grass and Themeda triandra,
2. Poisonous weeds – Solanum incanum and Datura stramonium,
3. Acacia species – Acacia tortilis, Acacia melifera and Acacia Karki
4. Shrubs – Banalities aegypttica and Lantana kamara,
5. Horticultural crops like pawpaw, mangoes, maize, oranges, and bananas among others,
6. Indigenous trees like Croton megalocarpus and Exotic trees

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1. Animal Species

Historically the area had a wide variety of wild animals. These include the Elephants, African Buffalo, Grey Duiker, Black backed jackal, lesser kudu, spotted hyena, olive baboon. The animals are concentrated there due to increasing human settlement and agricultural activities. There have been cases of human wildlife conflicts involving the Hippos and crocodiles, the baboons and velvet monkeys are a nuisance as they are notorious crop raiders. Hyrax and squirrels can be observed all over the area.

The fish in the area are mainly found are Common Carp *Cyprinus carpio*, *Claris spp*, *Barbus spp*, *Momyrus spp*, *Labeo spp* and the eel *angula anguila*

The proposed project is expected to attract additional aquatic animal species to location (hippos, crocodiles, snakes, etc.).

2. Geology And Soils

1. Geology

The geology of Makueni and the neighbouring districts is characterized with Achaean gneisses of the Basement system. These are the oldest rocks in the area comprising of *quartz-felspathic gneisses* and *biotite gneisses* beneath the recent soils. The project area overlays a Basement System, which in the low lying areas is characterized by low groundwater, yields. The base rock is observed to only recharge fast when it is adjacent a riverbed that provides direct infiltration of water. This explains the great depths attained to strike reliable aquifers. It is also notable that boreholes drilled on Basement rocks running in parallel trends within short distances hardly interfere with each other due to the special morphological strata in the area that limits lateral flow of underground water. This is the kind of base rock running across Athi River at the point proposed for the dam embankment.

2. Soils
Proposed Multipurpose Thwake Dam

Most areas around the Makueni and Kitui Districts are generally covered by deep sandy alluvium and red sandy soils in addition to patches of black cotton soils and murram that exist at the project site. Typical soils are sandy (eroded from the base sedimentary rock) and contain little organic matter and hence have low fertility. Valleys and river flood plains, however, have notable productive soils due to accumulation of silt and minerals though they are limited by lack of adequate rainfall. Though most areas have been cleared of vegetation for agricultural purposes, and soil conservation initiatives seem to have been integrated in the land use practices through construction of terraces in almost all cultivated land. There is, however, still notable siltation (soil loss into river beds) in most rivers in the area. Soil fertility is high in most areas, but productivity is hampered by poor rainfall.

Figure 3: Brownish red sandy silty clay soil on the right bank (location of TP1) – Dam Axis
3. Climatic Conditions

1. Rainfall

The hills to the north and central parts of the District highly influence the climate in Makueni District. These higher zones are cool and wet and receive 800mm – 1,200mm rainfall per year whereas the low lying areas are hot and dry receiving 200mm – 900mm rainfall per year. The project Districts receive scarce rainfall throughout the year with an average of 500mm per annum spread over two seasons, a situation that contributes to the serious scarcity of surface water sources in the area. Rainfall is also unevenly distributed over time and space with long periods of dry weather. The long rains occur in March/April while the short rains occur in November/December. Low rainfall is attributed to the trends in winds from the ocean towards the central highlands and high temperatures. Due to the rainfall fluctuations and long dry spells, the generation of silt from the catchments (especially from the Thwake river basin) is relatively high. High flash floods; therefore, bring down heavy loads of silt (sand) towards the location of the dam (tonnes of sand were observed in the area). From Table 2, it can be observed that the maximum rainfall occurs in November-December, March-April and May. June-September has the minimum rainfall.

Table 2: Table Rainfall Distribution in Thwake Basin

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TAWSB</td>
<td>TAWSB (I) Limited</td>
</tr>
</tbody>
</table>
2. Temperatures

Makueni and Kitui Districts in general experiences homogenous climatic conditions characterized by high temperatures during the day measuring up to 32oC and low temperatures at night at an average of about 25oC. During the dry season between May and October extreme heat is experienced in the low lying zones while the high altitude zones experience relatively cool...
temperatures. The high temperatures experienced in the low lying areas cause high evapo–transpiration and moisture losses from soils and plants.

4. Social And Economic Setting

This section reports the results of the socio-economic survey. It provides information on the relationship of the project area to the socio-economic aspects which will assist in determining how the project will affect the social component of the environment. The impact areas for the socio-economic assessment are within the proposed dam site area and the neighbourhood.

1. Administrative Setup And Location- The Dam Site

Thwake Multipurpose Dam will be located 188 kms south of Nairobi in the Eastern Province. The dam wall will be sited 1km immediately downstream from the confluence of Athi and Thwake rivers. The dam wall will be situated across Athi River at Mavindini location of Mavindini division in Makueni district and Kanyangi location of Yatta division in Kitui district. The dam barrier will cut across Athi River thereby joining Kilisa hill, part of the Yatta plateau, in Syomunyu sub-location (Kanyangi location - Yatta Division) and Kathukuni hill in Kathukuni village, Katithi sub-location of Mavindini location (Mavindini Division).

Thwake dam water is earmarked to cover a total land area of 2,900 hectares across the three districts of Makueni, Mbooni East and Kitui. The administrative areas that will be fully or partially covered with the envisaged dam water are analyzed in Table 3.1 below:

Table 3: Administrative areas to be covered by Thwake Dam Water Mass

<table>
<thead>
<tr>
<th>District</th>
<th>Division</th>
<th>Location</th>
<th>Sub-location and size</th>
<th>Villages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Makueni</td>
<td>Mavindini</td>
<td>Mavindini</td>
<td></td>
<td>Kathukuni</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Nguumo</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Kiatine</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Miksi</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mavindini (93.7km2)#</td>
<td>Thwake</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ndulumoni</td>
</tr>
<tr>
<td>Mbooni East</td>
<td>Kalawa</td>
<td>Syotuvali</td>
<td>(38.6km2)</td>
<td>Athi</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ngomano</td>
</tr>
</tbody>
</table>

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Proposed Multipurpose Thwake Dam

<table>
<thead>
<tr>
<th>Location</th>
<th>Size (km²)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kathulumbi</td>
<td>(31.4)</td>
<td>Assistant Chiefs and Village Elders offices</td>
</tr>
<tr>
<td>Kathulumbi</td>
<td>(20.3)</td>
<td></td>
</tr>
<tr>
<td>Mililiuni</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Katangini</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kathongo</td>
<td>(20.3)</td>
<td></td>
</tr>
<tr>
<td>Ndulunoni</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kitungulu B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Syomakanda</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mukameni (Partly)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kilisa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kitungulu “B”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kinyaau</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total: 3 3 4 6

# - Size includes that for Katithi sub-location Source: Assistant Chiefs and Village Elders offices

2. Infrastructure In The Project Area

The project site and its surface area can be accessed through the road network using public or vehicles, motor bikes, bicycles and on foot while transportation of goods involves the use of all these means plus donkeys and ox-drawn carts. The main roads serving the dam location and its surface area is the Nairobi-Machakos-Kathonzweni and the Nairobi- Mombasa road where one has to divert at Makindu junction and proceed to Kathonzweni Market. Both roads are entirely tarred. Another road accessing the project site is the Machakos - Kitui road through Masii-Tawa road, or alternatively using the Kwa Vonza - Yatta plateau road to Syomunyu Kanyangi Markets (on the banks of Athi River) in Yatta division.

Specifically, the project site can be accessed from Kathonzweni market through Mavindini via Mathemba market or through Kyemuole market junction via Muusini market where roads are well murred and maintained. From Wote market, the project site can be accessed through Mavindini via Kikumini and Ngosini markets in Makueni district or Kathulumbi market via Kalawa town in Mbooni East district. In most cases bicycles and public service vehicle are used for transport. According to the household survey, the most common mode of transport is the use of PSV vehicles accounting for 45% of all travel means. The alternatively common mode of transport is bicycle (43.6%) followed by walking (10.1%) and personal vehicles (0.7%).

Communication is mainly by use of mobile phones across the project area which is fully covered compared to land lines and emails which are restricted to major business centres. Sending letters through PSV vehicles is also quite common. The household interviews indicated that mobile phones were the commonest mode of communication (73.2%) followed by letters (8.7%) and community phones (8.1%). Other communication means included landline phones and emails.
Kathonzweni and Kalawa markets are the nearest points to the project site that are served with electricity. Most parts of Makueni district are served with electricity as the basic source of energy supplemented with firewood, charcoal and oil fuels (diesel, kerosene and petrol). Firewood and kerosene are the most used sources of energy cooking and lighting respectively in both the damsite and up/downstream areas, they account for 98% and 97% respectively out of the other sources. Charcoal is also used for cooking but in few cases. Statistically electricity does not appear to be effectively covered but there is electricity at Kathonzweni which is within the market but not at the villages. Solar and gas energy are rarely used in the project area.

3. Institutions and Development Agencies in the Project Area

There are various institutions and development agencies (local and outside) within Mavindini, Katithi, Kathulumbi, Syotuvali and Syomunyu sub-locations, most of which will benefit from and/or participate in development of the proposed Thwake Multi-purpose Dam project. These institutions and their roles are tabulated in Table 3.2:

Table 4: Institutions and Development Agencies within the Project Area

<table>
<thead>
<tr>
<th>Type of Institution</th>
<th>Names of Institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Markets</td>
<td>Mavindini, Katithi, Miziki, Kathulumbi, Syotuvali, Syomunyu and Kanyangi</td>
</tr>
<tr>
<td>Churches</td>
<td>Seventh Day Adventist, Catholic church, Africa Inland Church and Redeemed</td>
</tr>
<tr>
<td>Schools</td>
<td>Secondary schools: Mavindini, Katithi, Mutembuku, Kitoto, Kathulumbi, St. Stephen- Kanyonga, Kanyangi and Syomunyu, Primary Schools: Ilumani, Miangen, Mavindini Kanyonga, Mumbeen, Miksi, Mathangathini, Kitambai, Katithi, Kathulumbi, Unyeeyo,</td>
</tr>
<tr>
<td>Development agencies</td>
<td>Kenya Rural Enterprise Program, Kenya Women Finance Trust, ACT – Now (branch of German Agro Action), Arid Land Resource Management Project (ALRMP II), ICRISAT, Inades Formation, Makeueni Ginneries, World Vision, World Food Programme, UCCS and Red Cross</td>
</tr>
</tbody>
</table>

In addition, there exist numerous CBOs (as well as local merry-go-rounds (“chamas”)) and local community societies in the project area. In recent times, an international NGO, Worldvision, has been assisting farmers in the project area through funding for terrace digging in proponent farms.

4. Service Areas
The proposed Thwake Multi-purpose dam once fully completed is earmarked to produce hydropower and water for domestic and irrigation. The service area to be served with water for either irrigation or domestic is not already determined but would include fully or partially the areas presented in Table 3.3.

Table 5: The Project Service Areas

<table>
<thead>
<tr>
<th>District</th>
<th>Division</th>
<th>Area (Km²)</th>
<th>Percent of total district area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mtito Andei</td>
<td>931.2</td>
<td>Kibwezi</td>
<td>817.7</td>
</tr>
<tr>
<td>Machinery</td>
<td>127.1</td>
<td>Makindu</td>
<td>880.2</td>
</tr>
<tr>
<td>Wote</td>
<td>400.6</td>
<td>Kathonzweni</td>
<td>183.4</td>
</tr>
<tr>
<td>Kithuki</td>
<td>148.7</td>
<td>Kitise</td>
<td>291.5</td>
</tr>
<tr>
<td>Mavindini</td>
<td>257.1</td>
<td>Mbooni</td>
<td>330</td>
</tr>
<tr>
<td>Nzaui</td>
<td>350.3</td>
<td>Nguu</td>
<td>24.8</td>
</tr>
<tr>
<td>Total 4</td>
<td>11</td>
<td>4,717.8</td>
<td>51.2</td>
</tr>
</tbody>
</table>

Source: District Commissioners’ Offices Makueni and Kibwezi, 2008

The table above indicates that Thwake dam will approximately serve an area of 4,717.8 Km², which in essence account for 51.2% of the total size of the districts’ areas. This implies that the proposed project will have major impacts in over 50% of the administrative districts units. The project’s service area includes covering parts of three districts namely Kibwezi, Mbooni and Makueni districts.

5. Land Ownership And Settlement Patterns

The project area was part of government initiated and supported Makueni settlement scheme which started in 1948 for purposes of settling retired Akamba soldiers. The other category of people settled in this area included the landless citizens from areas with high population zones that experienced land degradation around Machakos district. The average sizes of land parcels owned by individual households were found to range between 0.8 to 16.0 hectares.
All land in the project area, except Katumbua hill – trust land, is individually and privately owned. Land in Mavindini and Kalawa divisions has been registered and title deeds issued while in Kanyangi (Yatta division), land is yet to be surveyed and registered. However, discussions indicated that the highest number of the landowners hold title deeds of the first generation while their offspring do not possess the title deed but own shares from the first generation title deeds. According to the baseline study, land adjudication and registration is in two forms:

1. Land surveyed, registered and title deeds issued as is the case in Mavindini and Kalawa divisions
2. Land not surveyed nor registered and thus not titled as is the case of Syomunyu in Yatta division

The land to be acquired for the proposed project was found to be complicated by other aspects including pending disputes cases, arising from the “come we shelter” policy among the local tribe and unclear demarcations, as well as “squatters”. As far as land is concerned in the area, two main categories of “those affected” were identified.

1. Category A: Residents losing all their land to the main dam or buffer area.
2. Category B: Residents losing parts of their land to the main dam or buffer area.

1. Land Use

Land in the area is used for residential buildings, business/market centres, crop cultivation (growing maize, beans, peas, cotton and green among others), grazing and extracting construction materials (quarrying) – see as illustrated below:
There are many farms in the project area which however have no clear pattern of distribution of the farms as each resident establishes his/her farm on the basis of land ownership, slope and

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Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

potentiality. These farms stretch right up to the banks of the rivers Athi and Thwake and while some are terraced, others are not and soil erosion is common. As farming is restricted by the availability of water, it is practiced commonly around the perennial Athi River. The price of farms vary depending on their proximity to the rivers, with the farms found located next to Athi River difficult to get as any being sold fetches a price of KShs. 100,000, while those farther from the river bank are being sold at an average of KShs. 60,000 per acre.

Settlement in the project area has taken place at different periods over the last fifty years. Settlement in Kalawa division occurred in late 1950’s and early 1960’s while those in Mavindini division settled in the early 1960’s. The settlers in both divisions originated from different areas including Mbooni, Kisau, Iuani, Muthetheni, Kilungu and as far as Mwala among other areas. Settlement in Kanyangi division’s project area occurred in the 1980’s with many of the settlers coming from Makueni district and Kalawa divisions as well as other parts of Kitui district due to population pressure while others came from areas recorded earlier.

Settlement patterns have no defined sequence as one settles next to the fathers homestead, on inherited land or a distance on purchased/inherited land parcels. Most of the houses in Mavindini, Kalawa and Kanyangi areas are brick walled (80%), roofed with corrugated iron sheet (76%) mostly due to grass scarcity and earth/clay floored (75%).

2. Agricultural Activities Around The Project Area

Agriculture in the project area is determined by rainfall which is bimodal with the short rains falling between October and December while the long rains fall between March and May. The project lays in an agro-pastoral zone APLZ I & APLZ I comprising of the lower extremely arid zone and is classified under ecological zones LM4/5 which is characterized by frequent dry spells and inadequate proper green vegetation.

The project area fall within the marginal Agro-Pastoral Livelihoods zones where short rains account for about 85% annual harvest. Due to the arid conditions, the area experiences recurrent shocks in form of poor long rains, low prices of livestock (as low as between 15.8% and 34.4%), and higher prices of food commodities mostly Maize and beans. The area is faced with a high magnitude of cyclical food deficiency, depending on rainfall, forcing majority of the population to rely on food aid. For example, a historical profile exercise in the area revealed that between 1955 and 1999, there were six major famines including “Yua ya Ndeke-1955, Yua ya Atta – 1964/65, Yua ya Longos1974/75, Nikwa Ngwete – 1980/81, Yua ya Ndukambikwaye – 1984 and Yua ya Ngatata – 1993/94”. Some of these famines have been so severe that residents have been forced to return back to the ancestral land they migrated from.
Subsistence farming is dominant in the area with most farmers growing food crops namely maize, sorghum, beans and green grams among others. Maize is the main food crop and is intercropped with beans while cow peas are the main legumes grown in the area. Other crops grown include beans, cow peas, Sorghum, Millet, Cassava, Sweet Potatoes, pigeon peas and black green grams. Sorghum production is not popular, but has experienced increasing growth in the total acreage. Lately, some farmers have started growing fruits including mangoes, paw paws and citrus as well as cotton for commercial purposes. However, cotton production in the area is gradually decreasing. There is minimal use of inputs including certified seeds and fertilizer mostly by those doing irrigation. However, there is average increase of pesticides for control of diseases and pests. Farm management level is low and this may be responsible for low crop yields per acre. The main crops grown and production levels in Mavindini division is presented in Table 3.4.

Table 6: Statistics for Food and Cash Crops for Mavindini Division

<table>
<thead>
<tr>
<th>Name of crop</th>
<th>Hectare</th>
<th>Potential Yield Per Hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>800</td>
<td>5 bags</td>
</tr>
<tr>
<td>Sorghum</td>
<td>300</td>
<td>4 bags</td>
</tr>
<tr>
<td>Beans</td>
<td>280</td>
<td>3 bags</td>
</tr>
<tr>
<td>Pigeon peas</td>
<td>400</td>
<td>5 bags</td>
</tr>
<tr>
<td>Cow peas</td>
<td>500</td>
<td>4 bags</td>
</tr>
<tr>
<td>Cassava</td>
<td>40</td>
<td>5 bags</td>
</tr>
<tr>
<td>Millets</td>
<td>20</td>
<td>4 bags</td>
</tr>
<tr>
<td>Green grams</td>
<td>500</td>
<td>4 bags</td>
</tr>
<tr>
<td>Cotton</td>
<td>600</td>
<td>850 Kgs</td>
</tr>
</tbody>
</table>


Crop farming in the area is faced with major pests and diseases including Aphids, Mites, Scale and Ball Worms, weevil, Pod, Caterpillar, Powdery Mildew and Wilt among others. With the arid climatic conditions and crop diseases, the project area to a large extend depends on import and relief of agricultural products.

3. Livestock

The mean population of households rearing livestock in the project districts is 88% as the project area is generally suitable for livestock keeping. The main livestock kept include cattle, sheep, goats,
donkeys, poultry, rabbits and bees among others. The livestock kept are mainly indigenous breeds that can withstand the harsh environmental conditions. Animals in the area provide the following benefits: cash income from the sale or hire of animals, or their products; source of power for cropping, transport and manure for soil fertility maintenance; a source of food, transport, fuel, access to social support networks, cultural wellbeing and a variety of other functions.

Oxen are used for ploughing while donkeys are used for fetching water and for those who own none, they chiefly borrow them after working for the wealthy and middle class to fetch their water and plough their land. Due to inadequate grass, cattle are illegally moved into restricted grazing areas like forests and in KARI Farms. Table 3.5 presents livestock statistics in Mavindini location in the project area

Table 7: Livestock Statistics for Mavindini Division

<table>
<thead>
<tr>
<th>Livestock Type</th>
<th>Breeds</th>
<th>Population</th>
<th>Average Per Household</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle (beef and dairy)</td>
<td>Zebu and Crosses</td>
<td>4,000</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Friesian, Jersey,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat goats</td>
<td>Local and Galla</td>
<td>7,000</td>
<td>8</td>
</tr>
<tr>
<td>Sheep</td>
<td>Local and Doper</td>
<td>400</td>
<td>3</td>
</tr>
<tr>
<td>Donkeys</td>
<td>Local</td>
<td>150</td>
<td>1</td>
</tr>
<tr>
<td>Rabbits</td>
<td>Crosses</td>
<td>200</td>
<td>2</td>
</tr>
<tr>
<td>Poultry</td>
<td>Local</td>
<td>7,500</td>
<td>10</td>
</tr>
<tr>
<td>Bee keeping</td>
<td>Log type: lags troth</td>
<td>900:26</td>
<td>3</td>
</tr>
</tbody>
</table>


The main livestock products include beef, chevon/mutton, offal, eggs, milk, hides and skins, manure and crude honey. Livestock rearing is however complicated by abnormal movements of family members to towns in search of employment opportunities. There are also common livestock diseases in the area including CBPP, Black Quarter, Trypanosomiasis, Anaplasmosis, worms, Fowl Pox and Coccideiosis among others.

4.  Poverty And Income Levels

The government of Kenya’s Review Poverty: Volume 1 (1997) ranked the greater Makueni district (which comprised of all the project districts) as one of the poorest districts in Kenya. Currently, absolute poverty in the project districts is 64.3% and contributes 3.8% to national poverty. Poverty in the rural areas (where 66% of the population is poor)is high as compared to 34% of the urban population in these districts. Food poverty is more rampant accounting for 57.2%. Increased cases of diseases resulting from poor hygiene and sanitation as relates to water are among the problems associated with poverty in the district.
Rural poverty levels in the area are however higher as 63% of the population lives below the poverty line. Incomes are generally low and farmland unproductive due to inadequate pasture and water. It is estimated that 40% of households’ income is spent on food alone.

5. Education

Education is considered an important tool in Makueni District in the alleviation of poverty, and is also key in determining the quality of the available labor force which is useful in all other sectors of the local economy. In Makueni and Mbooni East districts, literacy levels are medium, with an average of 75.3% (79.6% for men and 70.9% for female). In the district, as per the 2009 census, the gross enrollment rate in schools is 48.3% while dropout rate is 2% and completion rate is 94.4%. Of the total schooling population around the project site, 46.9% were girls while 53.1% were boys.

Literacy levels in the project districts are high at 85%. However literacy levels for women is lower (77.7%) than for men (92.3%). The project site location has many schools as tabulated in Table 7.

Table 8: Institutional Presence around the Project Area

<table>
<thead>
<tr>
<th>Location</th>
<th>ECD Centers and Primary Schools</th>
<th>Secondary Schools</th>
<th>Polytechnics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mavindini</td>
<td>Ilumani, Miangeni, Mavindini</td>
<td>Mavindini, Katithi and St. Stephen-Kanyonga</td>
<td>Mavindini</td>
</tr>
<tr>
<td></td>
<td>Kanyonga, Mumbeeni, Miksi, Mathangathini, Kitumbai and Katithi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kathulumbi</td>
<td>Kathulumbi, Unyeeyo, Kamutonye, Kitoto, Syongungi, Mutembuku, Muaani, Kathamba Ngii, Kakuli and Mukelenzu</td>
<td>Kathulumbi, Kitoto and Mutembuku</td>
<td>Mutembuku</td>
</tr>
</tbody>
</table>

The numerous schools in the district will help alleviate the problem of student transfer when the Resettlement Action Plan displaces some schools that will cover the dam area. However the remaining schools will need to be expanded to accommodate the higher population transferring.

According to information from the divisional Education Officers, the area is endowed with many educational institutions including early childhood development (pre-primary) centers, primary and secondary schools, and polytechnics. However, there are no higher learning institutions. In Mavindini and Kalawa areas, household interviews indicated that 9.4% had never attended school, 12.8% had not completed primary, 36.2% had completed primary, 25.5% had not completed secondary, 4% had completed secondary, 11.4% had attained college education and 0.7% had
attained university level of education. This implies that majority of the population had attained primary level of education. The high population of primary education level will provide adequate unskilled labour during and after dam construction. However, there will be need to “import” trained labourforce for the dam construction and maintenance. Further, there is need to institute a training collage as a social responsibility being part of the dams effort to improve training levels in the area.

6. Labour Force And Economic Occupation

The project districts have a total labourforce (those with 15 – 64 years) of 117,601 persons. This provides a pool of workers for the proposed construction of Thwake dam. The agricultural sector is the main employed occupying 78% of the population compared to rural self-employment (8%), wage employment (10%) and urban self-employment (4%).

The household survey in the project area indicated that 40% of the population is self-employed while 33% are unemployed. Those in self-employment mainly own small businesses in the respective markets within the target areas and are mostly younger generation. Of the 17% in formal employment, a bigger number were teachers and government leaders while 10% of the respondents were engaged in casual labour which fluctuates based on seasonal activities.

Studies undertaken revealed that the average wage rate for unskilled labour in the project area is rated at a cost of Kshs. 250 per day per labourer, while skilled labour is also available in the form of trained masons, electricians, plumbers and carpenters.

7. Health

Health Institutions serving people within the project area include Mavindini, Kanyangi and Kalawa Health Centres, as well as Kathulumbi and Mumbeeni Dispensaries. In addition there are some mobile clinics which usually attend the people at different destination markets.

The commonest diseases in the project districts are Malaria/fever (51.1%), Diarrhea (2.5%), Stomach-ache (5%) and Respiratory Diseases including Upper (1.1%), lower (2.2%) and Flu (12.7%). Household interviews further that Malaria, Colds and Amoeba were the commonest diseases in the project area accounting for 57.7% of the morbidity occurrences. The high incidence of diseases is attributed to high temperatures that encourage breeding of mosquitoes. It is closely followed by general flu associated with dust and climatic fluctuations which comprises of about...
Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

12.7% of the morbidity occurrences. Other diseases in the area are associated with poor hygiene and sanitation relating to water quality and adequacy include typhoid fever, diarrhea, worms, skin infections and eye related problems among others.

34% of the household surveyed revealed that they did not treat water for drinking and hence were prone to contraction of water bone diseases such typhoid and cholera. 32% of the households interviewed indicated that they treated drinking water by boiling and an equal number used chemicals while the rest used filtering.

The common preventive measures used within the proposed project area include sleeping under mosquito nets, boiling water, wearing warm and long sleeved clothes. Other mitigative measures include among others eating a balance diet, maintaining high hygiene standards, using insecticides and bush clearing.

8. Sanitation

Sanitation coverage in the project area districts is well over 86%. This is closely related to the high coverage’s in the project site where 94.6% of the people from the up/downstream use pit latrine and 0.7% have VIP Latrines. The rest of the population (4.7%) use open defecation/bush which accounts for poor sanitation in the area. Despite the high (95.3%) coverage, most of the pit latrines are poorly maintained, i.e. they are shallow, not roofed, mud walled and have no permanent doors. 99% of the population in the dam site and up/downstream bathe and wash at home while the rest, majority being men, bathe at the water sources.
2. Cross Cutting Issues

1. Gender

The 1999 population census indicated that the ratio of men to women in the district was 24:25 while at the project levels it was 12:13. This is attributed to the fact that most men migrate to the big towns in search of employment and other income opportunities. In the project districts, women are more than men accounting for 54% of the total population. Gender disparities are also found between the rural and urban population where 54.9% of all urban population were women while they accounted for 54.5% of the rural population. This indicates that the project sub-locations had an average of more men than women as the former tend to move to urban areas in search of employment.

In the project districts, women literacy levels are lower (77.7%) than for men (92.3%). Further, there are more boys than girls (46.9% girls and 53.1% boys) enrolled in schools in the dam site. 65.8% of the households in the districts are headed by men while women headed households are 34.1%. However, in the project area, the household survey established that majority (90%) of the households are male headed where only 8.7% are female headed and the rest are child-headed as tabulated in Table 3.7.

### Table 9: Household Headship in the Project Area

<table>
<thead>
<tr>
<th>Area</th>
<th>Household headship by percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>Dam site (Mavindini)</td>
<td>90.7</td>
</tr>
<tr>
<td>Up-stream (Kalawa)</td>
<td>85.1</td>
</tr>
<tr>
<td>Downstream (Kathonzweni and Kitise)</td>
<td>90.9</td>
</tr>
<tr>
<td>Total</td>
<td>88.9</td>
</tr>
</tbody>
</table>

*Source: Household Survey, 2008*

Ownership and access to productive resources mainly benefit the man. This is seen for example where all land and beef cattle are owned and controlled by man while the rest of the livestock that are of less value including chicken are owned and managed by both man and woman but all are managed by both gender. A daily activity profile drawn for the area reveal that women undertake eighteen activities compared to men’s fourteen. In addition, women undertake almost all water related activities including fetching water, washing utensils, house and clothes, cooking and bathing children.
Gender Mainstreaming:

Women as well as men will benefit equally from the employment opportunities that will be created and from convenient and safe access drinking water. Women often run shops and bars in the area and during the construction period, it is anticipated that there will be further income generating activities for women such as food catering/restaurants for workers on the construction sites, more bars, and the selling of local products to construction camp workers. These activities will benefit mainly women who are very often the sole supporters of their families. It is also recommended for the contractor to give equal employment opportunities to women as well as men within the project skills requirements, and to maximize the procurement of local products and services.

The resultant safe drinking water, reduced distance to water will profoundly benefit women and create more time for them to engage in other productive activities. As women are culturally regarded as “responsible” for household chores, they have to travel long distances in search of water. This could be changed by provision of water to the rural area. In addition, both women and men will benefit from the employment opportunities that will be created from convenient and safe access to water. More women will be engaged in income-generating activities, by running shops, restaurants, bars and selling local products to construction camp workers.

2. Cultural Issues

All the project service areas are mainly occupied by the Akamba community which forms approximately 99% of the total population. However there is still a substantive percentage of people from other communities especially in the major towns of Wote, Kalawa, Makindu, Kibwezi and Mtito Andei among others. The Akamba consists of various clans including Atwii, Aombe, Akitondo, Atangwa, Akikui and Atwii among others. These have elaborate cultural practices including strong kinship linkages with organizations spanning from localized merry go – rounds to strong clan relations and burial societies as well as social interactions mainly during religious ceremonies. They have strong beliefs in traditions including witchcraft, the state and relationship with their departed ancestors. It is expected that more members from non-Kamba communities will immigrate into the project area during and after completion of the proposed dam to exploit the emerging opportunities in fishing, farming and transport.

3. HIV/ Aids And Other Communicable Diseases
Makueni District is basically rural and most of the inhabitants are non-residents. Social interactions and the related implications are, therefore, expected to be relatively low. Influence of major towns including Machakos and Nairobi in terms of HIV/AIDS (and other social diseases) could be significant. The reported HIV/AIDS prevalence rate for the district in 2006 stands at 3.2%, with women levels at 5.3% against that of men at 1.3%, but it is expected to be on a downward trend.

The main groups dealing with HIV/AIDS management in Makueni District are Community Based Organization (CBOs), Self Help Groups, Women Groups and numerous other community initiatives around the District. The National Council on HIV and AIDS also plays a leading role in this regard.

4. Climate Change Concern:

The construction and operation of Thwake multipurpose dam should be seen within the context of global climate change which might significantly affect physical environment of the project. Climate change could affect project operation through, for example, higher temperatures and therefore higher water demands, or more intense rainfall and therefore more intense floods, or reduced rainfall and lower water availability. However, the project itself will greatly increase the security of water supply to farmers and improve flood control, thereby militating against the potential impacts of climate change.
Environmental Impact Assessment is a tool for ensuring new projects and programmes incorporate appropriate measures to mitigate adverse impacts to the environment and peoples' health and safety as well as enhancing sustainable operations with respect to environmental resources and co-existence with other socio-economic activities in their neighbourhood. Recent GOK efforts aimed at formulating a clear policy strategy has culminated in the enactment of a new legislation on water management. The Water Act 2002 is aimed at harmonising and streamlining the management of water resources, water supply and sanitation services (see outline and sample extracts in annex IV). Necessary policies and legislation that ensures annual environmental audits (EA) are carried out on every running project, activity or programme and a report submitted to National Environmental Management Authority (NEMA) for approval and issuance of relevant certificates.

According to the Kenya National Environment Action Plan (NEAP, 1994) the Government recognized the negative impacts on ecosystems emanating from industrial, economic and social development programmes that disregarded environmental sustainability. Following on this, establishment of appropriate policies and legal guidelines as well as harmonization of the existing ones have been accomplished and/or are in the process of development. The NEAP process introduced environmental assessments in the country with among the key stakeholders being industrialists, business community and local authorities. This culminated into the development of the Policy on Environment and Development under the Sessional Paper No. 6 of 1999.


1. National Environment Action Plan (NEAP)

According to the Kenya National Environment Action Plan (NEAP, 1994) the Government recognized the negative impacts on ecosystems emanating from economic and social development programmes that disregarded environmental sustainability. In this regard, establishment of appropriate policies and legal guidelines as well as harmonization of the existing ones have been accomplished and/or are in the process of development. Under the NEAP process EIA was introduced and among the key participants identified were the District Development Committees.

2. National Policy on Water Resources Management and Development

The National Policy on Water Resources Management and Development (Sessional Paper No. 1 of 1999) was established with an objective to preserve, conserve and protect available water resources.
Environmental and Social Impact Assessment (Study report)

Proposed Multipurpose Thwake Dam

resources and allocate it in a sustainable rational and economic way. It also desires to supply water of good quality and in sufficient quantities to meet the various water needs while ensuring safe disposal of wastewater and environmental protection. The policy focuses on streamlining provision of water for domestic use, agriculture, livestock development and industrial utilization with a view to realizing the goals of the Millennium Development Goals (MDGs) as well as Vision 2030. To achieve these goals, water supply (through increased household connections and developing other sources) and improved sanitation is required in addition to interventions in capacity building and institutional reforms.

While the National Policy on Water Resources Management and Development (1999) enhances a systematic development of water facilities in all sectors for promotion of the country's socio-economic progress, it also recognizes the by-products of this process as waste water. It, therefore, calls for development of appropriate sanitation systems to protect people's health and water resources from institutional pollution. Development projects, therefore, should be accompanied by corresponding waste management systems to handle the waste water and other waste emanating there from. The same policy requires that such projects should also undergo comprehensive EIAs that will provide suitable measures to be taken to ensure environmental resources and people's health in the immediate neighbourhood and further downstream are not negatively impacted by the wastes.

In addition, the policy provides for charging levies on waste water on quantity and quality (similar to polluter-pays-principle) in which case those contaminating water are required to meet the appropriate cost on remediation, though the necessary mechanisms for the implementation of this principle have not been fully established under the relevant Acts. However, the policy provides for establishment of standards to protect the water bodies receiving wastewater, a process that is ongoing.

3. Sessional Paper No. 6 of 1999 on Environment and Sustainable Development

Among the key objectives of the Sessional Paper No. 6 of 1999 on Environment and Sustainable Development (1993) are:

1. To ensure that from the onset, all development policies, programmes and projects take environmental considerations into account,

2. To ensure that an independent environmental impact assessment (EIA) report is prepared for any development before implementation,
3. To ensure that effluent treatment standards which will conform to acceptable health standards?

Under this paper, broad categories of development issues have been covered that require sustainable approach. These issues include the waste management and human settlement sectors. The policy recommends the need for enhanced re-use/recycling of residues including wastewater and increased public awareness raising and appreciation of clean environment as well as the participation of stakeholders in the management of wastes within their localities. Regarding human settlement, the paper encourages better planning in both rural and urban areas and provision of basic needs such as water, drainage and waste disposal facilities among others for decent housing of every family.

1. Legal Framework

Applications of national statutes and regulations on environmental conservation suggest that TAWSB will have a legal duty and social responsibilities to ensure the proposed plant development is carried out without compromising the status of the natural resources in the area, public privacy, health and safety. This position enhances the importance of this environmental impact assessment for the proposed site to provide a benchmark for its sustainable operation. The key national laws that govern the management of environmental resources in the country have been briefly discussed below. It is noteworthy that wherever any of the laws contradict each other, the Environmental Management and Co-ordination Act 1999 prevails.