An Integrated Appraisal of an Irrigation Project in Zimbabwe

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Abstract

This study is an instructive tool in the preparation and appraisal of Irrigation projects, supplements the Public Investment Management Guidelines (PIM Guidelines) and the Public Investment Management Manual (PIM Manual). It is designed to aid public officials working within the irrigation sector especially those responsible for the planning, appraisal, development, selection, budgeting, and implementation of Irrigation projects. The irrigation project manual (IPAM) provides guidance on the methodology and best practices employed in the appraisal of Irrigation projects.

Keywords: Cost Benefit Analysis, Irrigation, Public Investment, Zimbabwe

JEL Classification: D61, I38, O55, Q25

1. INTRODUCTION

1.1. Purpose of the Manual and its Relationship with the PIM Guidelines

This manual, an instructive tool in the preparation and appraisal of Irrigation projects, supplements the Public Investment Management Guidelines (PIM Guidelines) and the Public Investment Management Manual (PIM Manual). It is designed to aid public officials working within the irrigation sector especially those responsible for the planning, appraisal, development, selection, budgeting, and implementation of Irrigation projects.

The Irrigation Projects Appraisal Manual (IPAM) is aimed at strengthening the institutional and technical capacity of Contracting Authorities' (CAs) such as the Ministry of Lands, Agriculture, Water, Climate, and Rural Resettlement (MoLAWCRR) in preparing and appraising Irrigation projects.

The IPAM provides guidance on the methodology and best practices employed in the appraisal of Irrigation projects. It outlines the procedural stages required to conduct a robust appraisal, starting with project conception through the development of a Project Concept Note (PCN). The IPAM then successively expounds on the two stages of the appraisal process that come after the PCN, which are the Pre-Feasibility Study (PFS) and Feasibility Study (FS).

The analytical tools provided in this manual will assist CAs to efficiently and effectively develop and implement Irrigation projects that will lead to the enhancement of Zimbabwe's agriculture sector.

1.2. Cost Benefit Analysis and its Role in the Manual

Resources are finite and, as such, should be employed efficiently. Cost-Benefit Analysis (CBA) serves the purpose of scrutinizing whether the benefits that accrue from a given Irrigation project outweigh the costs incurred. There is an opportunity cost in the use of resources in one project over another. CBA ensures that resources are put to their best use, given that the same resources can be allocated to alternative uses. CBA is useful in identifying and quantifying the contribution of Irrigation projects to the overall welfare of society. This manual outlines the application of CBA in the appraisal and evaluation of Irrigation projects.

2. PROJECT CONCEPT NOTE (PCN)

2.1. Introduction

A Project Concept Note (PCN) entails the transformation of a project idea/proposal into a business case that can be considered for implementation. The objective of the PCN is to present justification of the worthwhileness of a proposed project, as well as to assess its consistency with the Government's strategic goals. A PCN is a presentation drawn up to outline why a proposed project such as an irrigation development project should be undertaken and if it is to be funded through the Government's budget why this project over all other projects should be allocated financial resources.

2.2. Preamble on Irrigation Projects

Water is an extremely precious commodity. It is a vital input for various social and economic activities. Irrigation involves controlled water supplied through pipes, ditches and other means. It is a reliable source of water during the dry season, which enables agricultural crop production all year round and results in significant socio-economic benefits. Maximizing the benefits derived from projects requires that they are well planned, appraised and are well executed to ensure that water and capital resources are efficiently utilized given that both have the opportunity costs of employing them in a particular project versus another.

What is important at the PCN stage is to plan and design irrigation projects that are centred around meeting the needs or addressing the problems faced by the society that would benefit from the project. The appraisal of a proposed project with respect to the feasibility, viability, and sustainability is addressed at the Pre-Feasibility and Feasibility Study stages of the project development cycle. Hence the subsequent sections in this chapter of the manual focus on how to plan for and design an irrigation project.

2.3. Developing Irrigation Projects using the Logical Framework Approach

As public investment projects aim to address socio-economic problems. The first step in preparing an irrigation project is the identification of the prevailing needs or challenges faced by society as a whole or a specific group within society. Problem identification should include an assessment of who is affected by the prevailing problem, how they are affected and what kind of impact the project will have in its quest to improve the beneficiaries' socio-economic conditions.

Such an analysis enables project planners and developers to design various strategies for addressing the identified problems or needs. Furthermore, it is the basis upon which project objectives, outcomes and outputs are set.

To this end, the Logical Framework Approach (LFA) is the analytical process that is used for formulating and planning projects. The LFA enables project planners and developers to identify and analyse prevailing problems as well as to design interventions that should be undertaken to resolve them.

The LFA analytical process is undertaken in two phases, namely:

i. **Problem Identification Phase:** during which the existing situation is analysed to develop a vision of the 'future desired situation'. This phase covers problem analysis, stakeholder analysis, and objectives analysis.

ii. **Project Formulation Phase:** during which various strategies/options for addressing the identified problems will be developed and assessed in operational detail. This phase covers the design and analysis of project alternatives, the development of the logical framework matrix, and activity and resource scheduling.

2.3.1 Problem Identification Phase

Clearly understanding the prevailing problems and challenges faced by farmers, with respect to accessing and utilizing water for various agricultural activities, is critical in the planning and design of a water supply project. Therefore, a CA must, first of all, clearly identify the problems that give rise to the idea of a proposed project.

The problem identification phase consists of three sequential steps:

i. **Problem analysis:** this involves the identification of the main problems faced by project beneficiaries, as well as the establishment of the cause and effect relationships of the identified problems.

ii. **Stakeholder analysis:** once the prevailing problems are identified, further consideration is given to whom these problems impact most and what are the roles and interests of various parties in addressing the issues identified.

iii. **Analysis of Objectives:** builds an image of an improved situation after project implementation. Furthermore, the analysis is aimed at defining the anticipated impact, outcomes and outputs of the project.

To illustrate how to conduct both the problem identification and project formulation phases using the LFA, an illustrative case study will be used. This case study will also be utilized throughout the manual as an aide to explain other useful tools used in the planning, development, and appraisal of Irrigation projects.

Box 1. Introduction to the Illustrative Case Study[1]

Prevailing Problem

In the Matabeleland region, animals are not only a sign of wealth but a source of livelihoods; they are sold or exchanged for grain, especially corn, which is used to prepare Zimbabwe's main staple dish, sadza or isitshwala. Crops usually fail due to low rains, so farmers' safety net are domestic animals such as cattle, small ruminants and poultry. However, due to a drought that has plagued the region, farmers are finding it hard to produce crops and to rear their livestock due to a shortage of water. The farmers depend on the rains for water to produce crops and rear their livestock.

Proposed Project

The government is proposing to construct an irrigation scheme in the area. The proposed project will include a dam with a capacity of 56 million m3, irrigation infrastructure such as pumps, pipes and control devices, and a drainage system. The irrigation scheme will service an area of 2,500 Ha.

Project Name: Gatsheni- Matopo Irrigation Project

2.3.1.1. Problem Analysis

Problem analysis involves identifying project beneficiaries, the problems they face, and determining the "cause and effect" relationships. Problem analysis includes the following steps:

A. Identification of the beneficiaries who will be impacted by the project and the problems they face. An illustrative example is shown in Table 1.

B. The development of a problem tree to establish the causes and effects of the problems.

2.3.1.2. Identification of Project Beneficiaries and Existing Problems

An analysis of farmers' access to and use of water enables for the identification of the key problems, challenges and constraints that they face. An assessment of the issues faced by the project beneficiaries should be made along the following lines:

a. Firstly, it should be determined for what purpose do the beneficiaries use water and whether the current means of access to water is adequate for their requirements and intended use (both in terms of quantity and quality of water). Farmers mainly use water from irrigation projects for the following purposes:

[1] This case study is for illustrative purposes only, it does not in any way represent an actual project. It has been developed to provide readers with a better understanding of the concepts and tools of planning, developing and appraising irrigation projects.

i. **Water for Livestock rearing**: water of a quality suitable for the rearing of livestock is key to ensuring the production of animals that are free from disease and safe for human consumption.

ii. **Water for crop production:** water suitable for the type of agricultural activities being undertaken is essential to successful crop production.

iii. **Household activities:** Water from an irrigation project may also be utilized for purposes other than irrigation, especially by women, to carry out their day to day household activities like cooking, cleaning, and caring for children. Such uses will largely depend on the quality and suitability of the water for household needs. When applicable these benefits should be quantified and added to the irrigation benefits for crop and livestock production.

b. Secondly, in addressing the identified problems, challenges or constraints, the project should provide water services that are of a superior level to those "without" the project. In other words, since the only way to address problems faced by water users is to provide water of improved quality and, or quantity, it is important to assess whether the resulting output (water) that will be supplied by the project will be incremental or non-incremental. From the water users' perspective, an incremental output refers to the additional water that is produced by a project over and above what would have been available to them without the project. Whereas, a non-incremental output is the water produced by the project that displaces an existing water supply because the prevailing water has high coping costs or is unreliable.

Therefore, when assessing the problems, challenges and constraints faced by the project's beneficiaries, the assessment should be made, taking into consideration whether the project will address:

i. The provision of water for livestock and, or crop production,

ii. Whether the project's output (water) will displace or increase the existing water sources; and,

iii. Whether the project will generate any secondary benefits such as the utilization of water for other purposes such as household chores.

The matrix shown in Table 1 can be used to identify the problems faced by the irrigation project's beneficiaries. Each matrix consists of a number of quadrants, each listing the common problems faced by the beneficiaries taking into account the purposes that they use water for and the kind of output that the project would generate to address their particular problem(s). It should be noted that a project may lie in one or all of the quadrants depending on the nature and scope of the project in relation to the problems it is trying to ameliorate.

Table 1: Project Identification Matrix: Irrigation Projects

	Common Problems Addressed by Irrigation Projects	
	Water for livestock	**Water for crops**
Incremental Output	**Lack of access to safe water for livestock:** i. Prevalence of waterborne diseases ii. Increase in time spent collecting water iii. High cost of purchasing water from vendors iv. High cost of water treatment at the individual household level	**Lack of access to water for crop production:** i. Single cultivation cycle ii. Subsistence farming iii. Low yields iv. High-risk agriculture (i.e. crop failure)
Non-incremental Output	**Dilapidation of Irrigation Infrastructure:** i. The high cost of maintaining existing infrastructure ii. The high cost of operating existing infrastructure iii. High water losses	

Table 2: Illustrative example of the Gatsheni- Matopo Irrigation Project

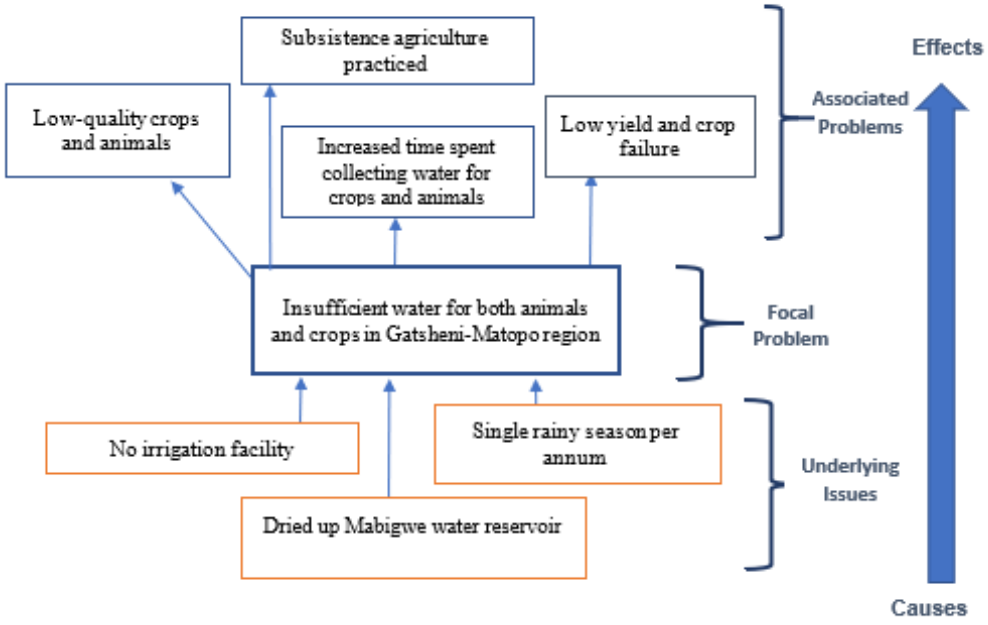
	Problems to be Addressed by Gatsheni- Matopo Irrigation Project	
	Water for livestock	**Water for crops**
Incremental Output		**Lack of access to water for crop production:** i. Single cultivation cycle ii. Subsistence farming iii. Low yields iv. High-risk agriculture (i.e. crop failure)
Non-incremental Output	**Lack of access to safe water for livestock:** i. Prevalence of waterborne diseases ii. Increase in time spent collecting water iii. High cost of water treatment at the individual household level	

Note: When implemented, the project is likely to replace water for livestock with a cheaper water supply (lower coping costs), therefore representing a non-incremental output. On the crops side, however, the project will allow farmers to have two cultivation seasons and potentially switch to high-value crops; this represents an incremental project output.

2.3.1.3. Identification of the Causes and Effects of a Problem

Once the problems to be addressed by the project have been identified, the next step of the problem analysis stage is the identification of all the causes of the problem and their likely effects. The identification is carried out by constructing a problem tree. A problem tree is simply a representation of the problem, its causes and likely effects set out in hierarchical order as shown in Figure 1.

Figure 1: Illustration of a problem tree for Gatsheni-Matopo Irrigation Project



The steps of creating a problem tree are as follows:

a. Start by defining the focal problem faced by project beneficiaries; this should be a negative statement as shown in Figure 1.

b. Identify all of the issues associated with the focal problem (i.e., the effects of the focal problem), as shown in Figure 1.

c. Identify what are the causes of the focal and associated problems faced by the project beneficiaries, as shown in Figure 1.

2.3.1.4. Stakeholder Analysis

Stakeholders are the people who will benefit from the project. However, stakeholders also refer to the people or institutions that are directly involved in the implementation of the project or are likely to be affected by the project in some way (both positively and negatively). Lastly, stakeholders are people or institutions who can influence/affect the outcome of the project. Stakeholder analysis is the process of identifying the project's stakeholders, assessing their interests, and determining their role within the project. The process includes an assessment of

each stakeholder's level of interest in the project and their ability or power to either positively or negatively influence the success of the project.

Stakeholder analysis is undertaken as follows:

a. Identify project stakeholders.

b. Determine the relative interest and influence of each stakeholder.

c. Profile each of the stakeholders in terms of what is important to the stakeholder, how could the stakeholder contribute to the project, how could the stakeholder jeopardize the project and what strategy can be used to engage the stakeholder.

The first step of stakeholder analysis is to establish who your stakeholders are. For example, in assessing the individuals, groups of people, organizations or firms that are affected by the Gatsheni- Mapoto Irrigation scheme, a stakeholder matrix could be used, such as the one presented in Table 3.

The identification of project stakeholders should be followed by an assessment of each stakeholder's level of interest in the resolution of the prevailing problem(s) and their potential to influence the project. The assessment serves as a basis for determining the kind of engagement to be adopted for each stakeholder. Table 3. Illustrates how stakeholders could be profiled depending on their interests and level of influence on the project and the possible methods of engagement that could be adopted to ensure smooth project implementation and delivery.

Table 3: Illustrative Stakeholder Matrix for the Gatsheni- Matopo Irrigation Project

Stakeholder Name	Impact *How much does the project impact them? (Low, Medium, High)*	Influence *How much influence do they have over the project? (Low, Medium, High)*	What is important to the Stakeholder?	How could the stakeholder contribute to the project?	How could the stakeholder jeopardize the project or individual component of the project?	Strategy for engaging the stakeholder
Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement	Low	High	Increase in livestock and crop production.	Develop a ring-fence scheme to secure adequate financing for the maintenance of the water reservoir and irrigation infrastructure	Failure to maintain the water reservoir and irrigation facility	As the sponsoring agency; it will engage other stakeholders
Female Farmers	High	Low	Ability to access affordable water for crop production and livestock rearing	Active participation in trainings and sharing knowledge with other farmers	Reluctance to apply modern crop production practices	Meetings and capacity building
Male Farmers	Medium	High	Increased access to water for livestock rearing and crop production	Active participation in trainings and sharing knowledge regarding livestock and crop production with other farmers	Failure to save part of the proceeds from livestock rearing to invest in commercial inputs for the next season. Reluctance to apply modern agricultural practices to improve the quality of the crops and animals produced.	Meetings and capacity building
Local Authorities	Medium	High	Production of enough food for the community	Organising farmers to work together with other stakeholders	Failure to work together with the other stakeholders	Meeting with the local authorities
Non- government Organisation	Medium	High	Alignment of the project with their strategic vision and framework	Deliver the capacity building component of the project	Failure to provide funding for capacity building or failure to provide adequate capacity building.	Meetings with the MoLAWCRR and capacity building programs with farmers

2.3.1.5. Objectives Analysis

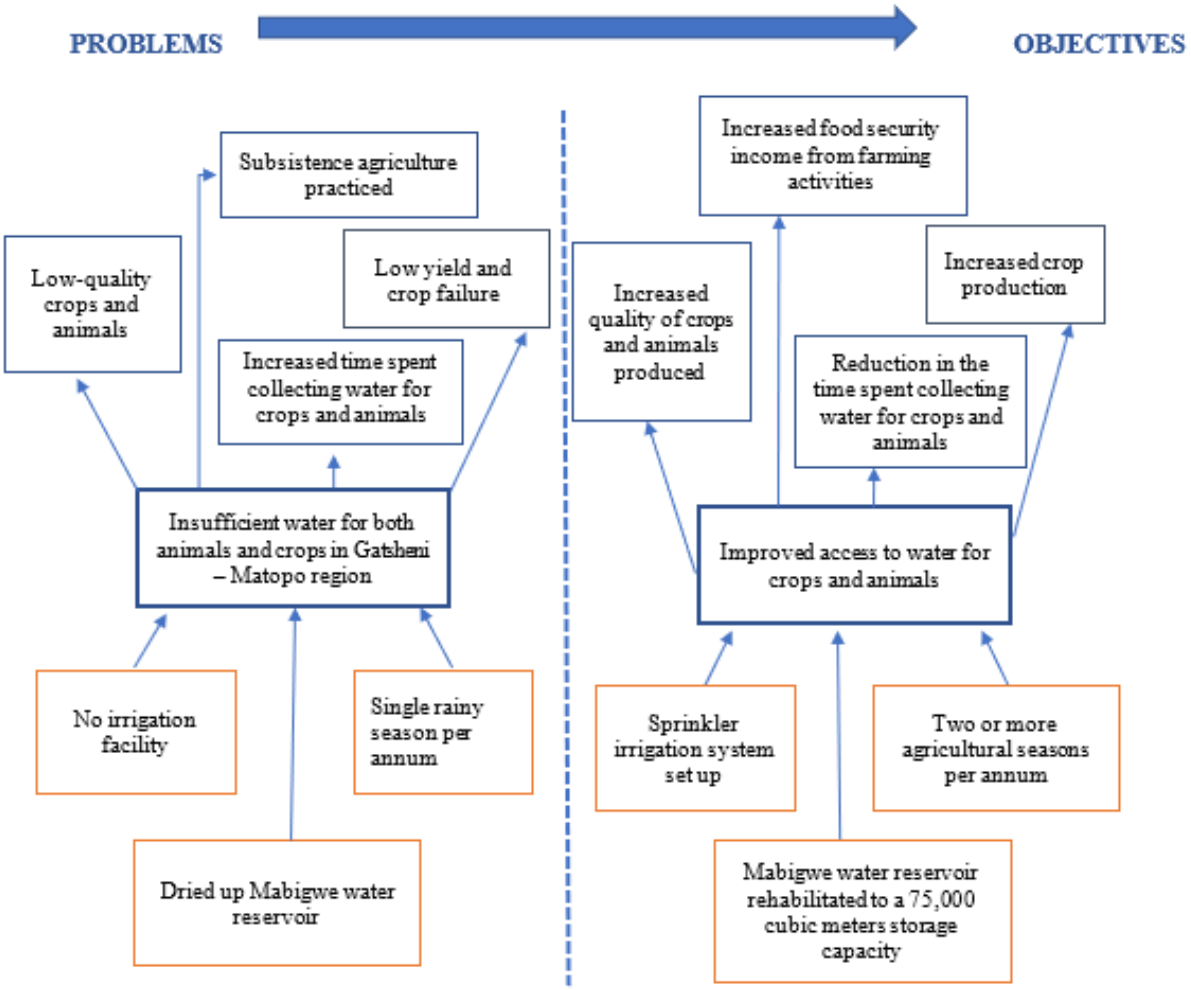
Once the stakeholders and the problems that affect them (which the project seeks to eliminate) have been identified, an objectives tree should be developed. While the problem analysis looks at the negative aspects of the prevailing situation, objectives analysis looks at the positive aspects of the desired future situation. This involves the reformulation of problems into objectives by translating a problem tree into an objectives tree. The objectives tree can, therefore, be conceptualized as the positive mirror image of the problem tree, and the "cause and effect" relationships become "means to ends" relationships.

The construction of an objectives tree involves the following steps:

a. Reformulate all negative situations of the problem analysis into positive situations that are desirable and realistically achievable.

b. The causes and effects of the problem tree are transformed into means and ends, while the focal problem is transformed into the overall goal the project must accomplish. In this way, the project's objectives are established.

Figure 2. Illustration of an Objectives Tree

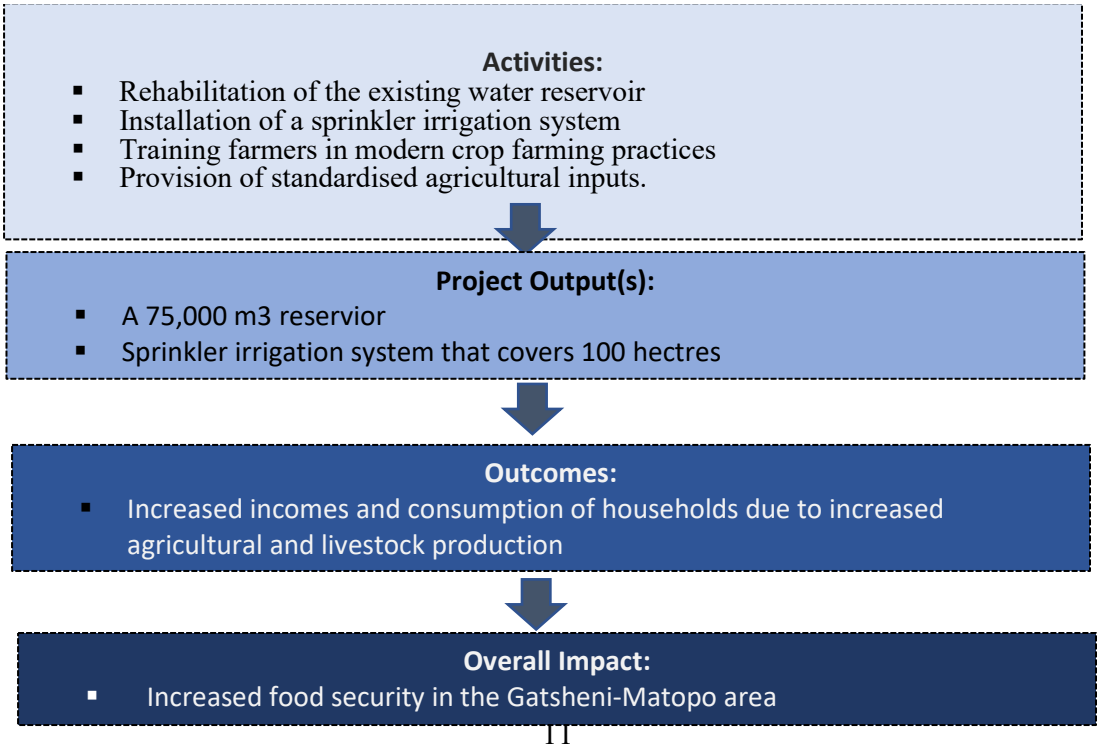


Once the objectives of the project have been identified, the next step is to outline the activities that will be undertaken by the project pursuant to the delivery of the project's output and the achievement of its objectives. Furthermore, the expected outcome that will be generated as a result of the project's outputs should be defined together with the overall impact on stakeholders. It should be noted that during the project design stage, it is essential to identify and address the impacts(s) the project will have on farmers, the community and the environment. For example, how will farmers located downstream be affected by the irrigation scheme that dams water upstream? Such a project can result in reduced river flow and a reduced risk of flooding. The former will imply an additional cost will be imposed on the downstream farmers. Such costs should be estimated and included in the analysis. Whenever possible project design should incorporate an approach to provide adequate level of compensation to the downstream farmers. The latter will imply an additional benefit of the project that also needs to be incorporated in the analysis.

The project design should take into account the water rights of both upstream and downstream users as well as equity in accessing water resources for both women and men. Irrigation projects should not simply reallocate water from one group of stakeholders to another but should instead ensure equitable access to all water users. A well-designed project will result in improved access to water for agricultural activities, the efficient use of water resources, a reduction in the risk of the negative impacts of extreme weather conditions such as droughts and flooding, improved agricultural production and increases in the incomes and food security for farmers. The analysis of the expected impact(s) of an irrigation project on different stakeholders should be presented in the PCN.

The project's impact, outcome and outputs are derived by reformulating the objectives tree. An illustrative example of the Gatsheni- matopo Irrigation scheme Project's activities, outputs, outcomes and impact are presented in Figure 3.

Figure 3. Illustration of the Impact, Outcomes, Outputs and Activities for the Gatsheni- Matopo irrigation project



2.3.2. Project Formulation Phase

The project formulation phase consists of four sequential steps:

1. Designing and assessing project alternatives.
2. Assessment of preliminary costs and sources of funds.
3. Development of the Logical Framework Matrix.
4. Development of an Implementation Plan.

2.3.2.1. Designing and Assessing Project Alternatives

A number of different project interventions can be designed through which the identified problems will be addressed. The project interventions should be modelled around finding the best method of delivering the project's output (water) to the farmers, as well as attaining the project's impact and the desired outcome. Key considerations when designing project alternatives that can be used to address the prevailing problems are:

i. Appropriateness of technology to be used as well as the cost of each alternative (the aim is to find the least cost alternative of addressing the problem);

ii. Advantages and disadvantages of each intervention; and,

iii. The demand for the project's output which will guide the scale and scope of the project.

iv. In certain instances, the full scope of the project's impact and outcomes can only be realized if the project's interventions are blended with non-water supply specific interventions such as training farmers on how to utilize modern farming practices and technologies to increase agricultural productivity.

At the PCN stage a qualitative assessment of each of the project alternatives should be made. The analysis is used to assess and compare the identified project alternatives and ensure the best end-users is adopted pursuant to the objectives of the project. It is advised that no more than five project alternatives should be assessed at the PCN stage to avoid complexity.

Irrigation project alternatives can be broadly categorized into two main classes; construction of new irrigation infrastructure and rehabilitation of existing irrigation infrastructure.

i. Construction of new irrigation infrastructure: New infrastructure is mostly aimed at meeting the growing demand for water by farmers. For example, a growth in the demand for water for agricultural activities may be due to climatic changes in the area which results in for example, water scarcity. An irrigation project, therefore, will enable the availability of water throughout the year which will enable increased agricultural production requirements.

ii. The rehabilitation of existing irrigation infrastructure: The objective of these kinds of projects is to partially or entirely replace existing irrigation infrastructure. Such projects are necessary when infrastructure systems/components have reached the end of their service life and must be replaced. If the old infrastructure is not replaced, water services would be provided at suboptimal levels as the irrigation

system will not work effectively and efficiently due to the bottlenecks that may result from old and faulty components. The rehabilitation of existing infrastructure can also entail the improvement of service quality through, for example, an intervention to decrease physical losses by addressing infrastructure problems such as leaking pipes. This will also reduce the operating and maintenance costs of the irrigation infrastructure.

2.3.2.2. Assessment of Preliminary Costs and Sources of Funds

Once the project alternatives have been designed, the next step is to outline the costs of undertaking each of the alternatives. As at the PCN stage, the project is still in its infancy, the cost estimates should be preliminary and can be based on proxies of projects of a similar nature and scope constructed in the recent past. The cost estimates should include capital costs and operating and maintenance costs. In cases where proxy costs are used, an adjustment should be made to reflect the real and inflationary changes in the project alternative's costs over time. An important aspect to consider is how the project costs will be financed. An outline of the proposed sources of funding should be included along with the project's cost estimates. Funding for capital expenditure can be garnered from various sources such as the national or local budget, equity, debt, development partners and, or private sector parties. An example of the preliminary cost estimates of the Gatsheni- Matopo Irrigation Scheme Project and the proposed source of funds is presented in Figure 4.

Figure 4. Preliminary cost and source of funds for the Gatsheni- Mapoto

Capital Expenditure:

The irrigation infrastructure, including the dam, pumps, pipes and control devices is expected to cost $32 million.

O&M Expenditure:

The annual O&M expenditure is estimated to be $1.6 million; this includes the cost of energy to pump the water from the dam to the farmlands.

Potential Sources of Funds:

- The government of Zimbabwe and foreign donors.
- O&M costs of the irrigation system will be incurred by the farmers who will pay an annual contribution towards a maintenance fund.

2.3.2.3. Development of the Logical Framework Matrix

The Logical Framework Matrix (LFM) is used to summarize the key elements of a project, such as a project's impact, outcomes, outputs, and activities, as well as the proposed budget based on the project's outputs. Good practice in project planning and preparation indicates that to keep the project simple and straightforward, the LFM should only have a few possible

impacts and a single outcome, if these components exceed these recommendations, the project sponsor should consider rethinking the project.

The LFM is also a useful tool to display and organize the project's concept. Columns of the matrix identify what the project intends to do and how, outlining the casual relationships and specifying the important assumptions, and how the inputs and outputs of the project will be monitored and evaluated. Rows of the Matrix relate to the measurement of the effects of and resources used by the project, through the specification of key indicators of measurement, and the means by which the indicators will be verified. Table 4 presents an illustrative example of the LFM for the Gatsheni- Matopo Irrigation project.

Developing the LFM is a three-stage process. The first stage consists of the following steps:

a. Copy the impact of the project from the objectives tree to the impact section of the LFM.

b. Copy the outcomes of the project from the objectives tree to the outcomes section of the LFM.

c. List the project's outputs and specify how they are linked to the achievement of the project's outcome.

d. List all the activities or tasks that are needed to deliver the project's outputs. There may be several activities for each output.

The second stage consists of the following steps:

a. SMART Indicators: Specific, Measurable, Achievable, Relevant, and Time-bound (SMART) indicators. Starting from the top to the bottom of the LFM (Impact – Outcome – Outputs - Activities), identify the SMART Indicators for measuring the progress in terms of quantity, quality and timeline for each of the components of the LFM.

b. Means of Verification: the source of verification should be considered and specified at the same time as the formulation of the indicators. This will help to test whether or not the indicators can be realistically measured at the expense of a reasonable amount of time, money and effort.

c. Risks: Identify and list the main risks that may jeopardize the expected outputs or outcome of the project.

The third and final stage consists of the following step:

a. Assumptions: are factors that have the potential to influence (or even determine) the success or failure of a project and may lie outside the direct control of project management. Assumptions are usually identified during the analysis phase. The analysis of stakeholders, problems, objectives, and strategies will have highlighted a number of issues (i.e. policy, institutional, technical, social and, or economic issues) that will impact the project's environment', but over which the project may not have direct control.

Table 4: Illustration of the Logical Framework Matrix for Option 2

Narrative Summary	Performance Indicators				Means of Verification	Assumptions	Risks
	Baseline 2018/19	Target 2019/20 (SMART)	Target 2020/21 (SMART)	Target 2021/22 (SMART)			
Impact: Increased food security in the Gatsheni-Matopo area	Approximately 20,000 people are food insecure	Reduce the number of food-insecure people to 10,000	Reduce the number of food-insecure people to 5,000	Reduce number of food-insecure people to 2,500	Provincial quarterly agricultural reports	Irrigation facilities and water reservoir will be maintained and serviced	Farmers failure to adopt new farming practices
Outcome: Increase in households' incomes and consumption							
O1: Increase in agricultural production	Crop production increases by 10% (5% of which is a contribution by female farmers)	Crop production increases by 15% (7.5% of which is a contribution by female farmers)	Crop production increases by 20% (10% of which is a contribution by female farmers)	Crop production increases by 30% (15% of which is a contribution by female farmers)	Department of Agriculture Technical and Extension Services Annual report	A variety of crops are grown on the farmlands benefiting from sprinkler irrigation	Climatic conditions
O2: Increase in livestock production	Livestock production increases by 2.5%	Livestock production increases by 5%	Livestock production increases by 7.5%	Livestock production increases by 10%	Department of Agriculture Extension Services Annual report	Different breeds of livestock are obtained and are well looked after	Failure of farmers to use good livestock rearing practices
Outputs							
O1: Water reservoir constructed	Dried up reservoir	Reservoir with a storage capacity of 75,000 cubic meters of water is constructed	-	-	Project progress reports, M&E reports	Funding is available	Delays in budget release
O2: Sprinkler Irrigation System installed	No Irrigation facility in place	50 ha of land are irrigated using the sprinkler irrigation system	-75 ha of land are irrigated using the sprinkler irrigation system	-100 ha of land are irrigated using the sprinkler irrigation system	Project progress reports, M&E reports	Farmer's wiliness to provide land for where the irrigation system will pass	Some farmers are opposed to having the irrigation system installed on their farmland

Activities to achieve the outputs	**Resource Considerations**
O1	**Main implementation Components**
1.1 Identification of sites 1.2 Tender for reservoir equipment 1.3 Civil works	1. Procurement of irrigation and dam equipment 2. Installation of equipment 3. Training programs

O2		Summary budget for at least 3 years (in USD mill)				
1.1 Identification of sites to install the irrigation system 1.2 Tender for irrigation equipment installation		Output	To date	FY18/19	FY19/20	FY2020/21
		Dam construction	0	11.2	11.2	-
1.3. Training of farmers 1.4. Improving access to agricultural inputs		Irrigation system	0	4.8	4.8	-

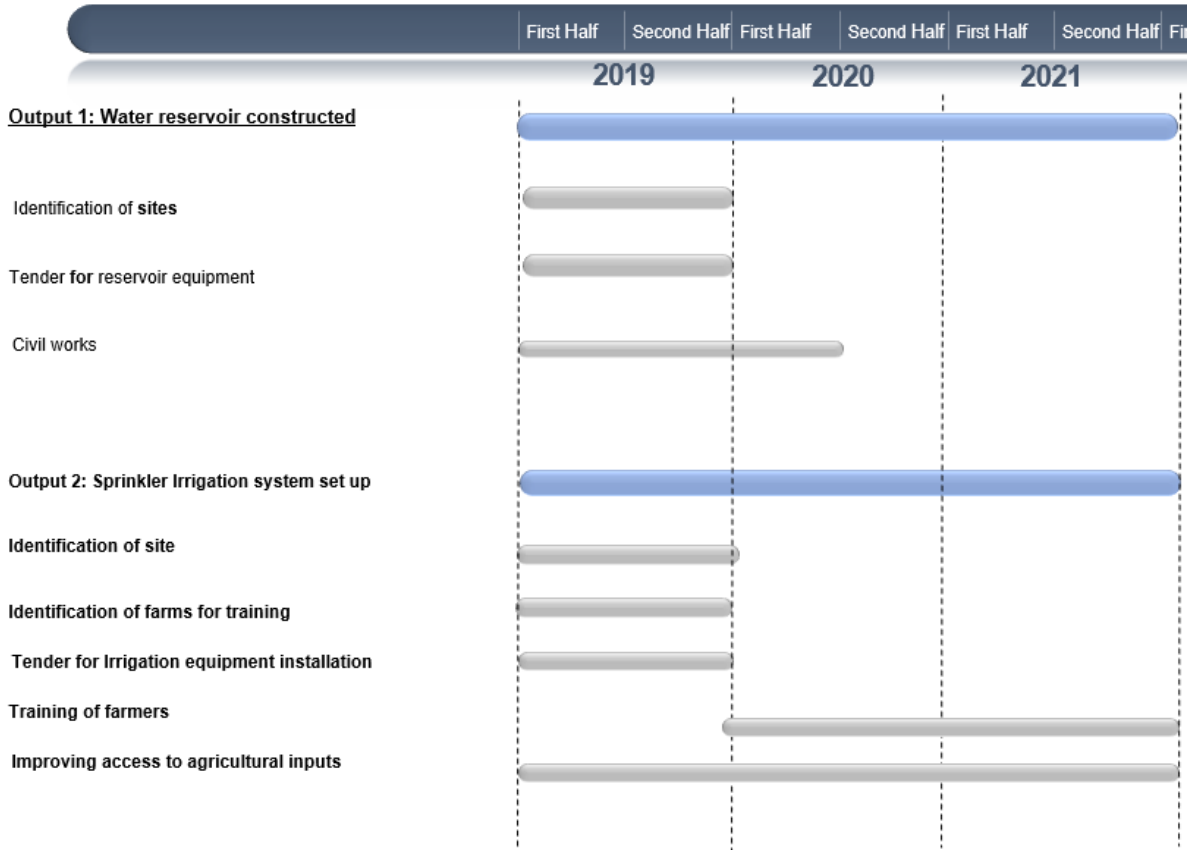
2.3.2.4. Development of an Implementation Plan

At the PCN stage, the project implementation plan should be indicative and propose an implementation strategy that is reasonable given the information available, timing, scale, and scope of the project. The various activities required to successfully implement and deliver the project should be scheduled using a Gantt chart, showing the timing, sequencing, and inter-dependencies among activities. Each of the activities to be carried out under the implementation plan should include the following components:

i. Activity name,
ii. Activity scope,
iii. A list of all the activities that must be completed before the initiation of the next activity,
iv. The commencement and completion date of each activity,
v. The cost of undertaking each activity; and,
vi. The institution or entity that is likely to have responsibility for implementing the project.

The resources required for the successful execution of each activity, including human resources, financial resources, physical resources and other resources, should be identified, and their procurement should be included as part of the implementation plan. An illustrative example of a project implementation plan for the Gatsheni- Matopo Irrigation Project is presented in Figure 5.

Figure 5. Illustration of the Gantt Chart of Project Activities



Activity Name	Activity Summary and Scope	Precedent Activities	Activity Duration	Activity Expenses
Procurement of Irrigation system and Dam equipment	The necessary equipment is purchased such as; pipes, pumps and other complementary equipment.	Identification of site where the Dam will be constructed and where the irrigation system is to be installed	Jan – Dec 2019	USD 8.96 million
Civil works	Civil works required for the dam and irrigation system.	Procurement of the Irrigation System and dam equipment.	Jan 2019 – Dec 2020	USD 12.24 million
Capacity Building	Training farmers on how to apply modern farming practices and technologies	Completion of the rehabilitation of the reservoir and installation of the irrigation system	Jan2020 – Dec 2020	UDS 1.2 million
Operation and Maintenance of the Irrigation system and dam	The dam and Irrigation system will be repaired and maintained to keep it in good working order.	Completion of the construction of the dam and installation of the irrigation system	Jan 2021 – onwards	Annual operating and maintenance costs: USD 1.6 million

2.4. Assessing the Effectiveness of the Proposed Project

Once a project aimed at addressing the problems faced by stakeholders has been designed, the next step is to assess the project's effectiveness in addressing those problems. At the PCN stage a qualitative assessment should be made of the project's financial and socio-economic effectiveness; furthermore, an indicative environmental and social impact assessment should be undertaken.

2.4.1. Financial Effectiveness

In the case where an irrigation project does not charge the end-users for water delivered, the financial effectiveness of the project will be negative, as there are no revenues to offset or recoup the investment, operating and maintenance costs over the expected life of the project. Hence, a financing gap analysis should be undertaken with respect to how much will be required to operate and maintain the project so that funds to sustain the project can be sourced from the central budget or from other sources. Without funding for operations and maintenance, the project will not be able to deliver its output or attain its outcomes and overall objectives.

In the case where the project does generate revenues, its financial performance should be gauged using profitability indicators such as the Net Present Value (NPV) and the Internal Rate of Return (IRR). However, at the PCN stage, the information required to derive the profitability indicators may not be available. In this case, the project's financial effectiveness shall be discussed in the context of the least-cost alternative of delivering water to farmers.

2.4.2 Socio-Economic Effectiveness

List key/direct economic costs and benefits accruing to the government and society. Consider the impacts on Zimbabwean citizens over the entire lifecycle of the assets that will be created. The main socio-economic benefits of irrigation projects are;

i. Increased agricultural production and productivity due to the substantial reduction in the risks associated with rainfed agriculture,
ii. Improved quality of agricultural produce,
iii. Change in the time of sales and production,
iv. Production of a variety of agricultural produce including commercial crops,
v. Labour savings especially for women,
vi. Stability in yields produced,
vii. Increase of cultivation on sub-marginal lands; and
viii. Reduced production costs.

When applicable list and discuss the broader indirect effects of the proposed irrigation project on the economy and society, specifying if these indirect effects will result in quantifiable impacts, such as environmental costs. For example, the impacts of a dam that is built to provide irrigation water may result in downstream farmers experiencing a reduction in water flow while also benefiting from smoothed water flow and the reduced risk of flooding. Depending on the climatic conditions, the marginal cost of water to farmers downstream will differ. In the case of a drought, farmers will incur increased cost of accessing water as they have to go upstream to get access to water; while in periods were there is no drought their marginal cost would reduce. In any case, it is the marginal cost of accessing water that should be carefully assessed. Only the net impact of the project on farmers access to water should be included in the socio-economic analysis. Overall, the net impact may be positive or negative depending on whether the positive effects outweigh the negatives or vice versa. In addition, mitigation measures such as maintaining adequate water flow downstream that do not disrupt farming and other water use activities should be proposed and outlined together with the project's impacts.

Indicate and discuss the distributional impacts of the project. List all the stakeholders and specify if they are expected to gain or lose because of the project. Specify if the project is likely to result in different impacts based on demographics such as age, gender, ethnicity, or level of income.

The socio-economic effectiveness of the project should be focused on a comparison of the economic costs and benefits. While a CBA is only required from the PFS onwards, an estimation of the socio-economic benefits of the project weighed against the anticipated cost of resources required to implement the project is useful in making a preliminary assessment of the viability of the proposed project.

Box 2. Illustration of the Social-Economic Effectiveness of the Gatsheni- Matopo Irrigation Project

The 56 million m3 dam and irrigation system will result in the provision of sufficient water for both livestock and crop production which will result in increased agricultural productivity and food security in the region. The farmers' livelihoods will be greatly impacted due to increased incomes from agricultural production.

2.4.3. Environmental and Social Impact Assessment

2.4.3.1. Environmental Impacts

An Environmental Impact Assessment (EIA) is required for irrigation projects at the PFS and FS stages of the project appraisal process. However, the project's impacts on the environment are an important component of the decision-making process. In the PCN, the CA should highlight the potential environmental impacts that will result if the project is implemented, as well as proposed measures for mitigating any adverse effects.

2.4.3.2. Social Impacts

The CA may highlight any social impacts that may arise from the project; this may include increased agricultural productivity, production of a variety of crops including commercial crops and poverty reduction as a result of increased access to improved water supply from irrigation projects.

2.4.3.3. Gender Analysis

An irrigation project will impact men, women and children in a different manner; hence, a project's benefits should not be aggregated; instead, they should be disaggregated by gender. Assessing the roles of men, women and children "without" and "with" the project provides a starting point for estimating and distributing the project's benefits to each gender group. In agricultural projects, both men and women participate in different activities. Men mostly participate in land preparation, ploughing and pest control, while women are engaged in activities like planting, fertilizing, weeding, harvesting and fetching water for both crop production and home consumption. Women and girls constitute 45.5% of the labour force in the Zimbabwean agricultural sector. It is women and girls who bear the task of fetching water for agricultural activities such as crop production, spending an estimated 49% of their day to daytime on this activity. Hence, when it comes to crop production, an irrigation project's time savings benefits are likely to primarily accrue to women and girls rather than men and boys. On the other hand, men and boys are in charge of livestock rearing and have to fetch water for their livestock or herd them to the nearest watering point (river, dam or well). If an irrigation project brings water in close proximity to livestock farms, the time savings benefits would primarily accrue to men and boys as opposed to women.

Wherever possible the PCN should provide a starting point for gender analysis and discuss the socially constructed roles of men and women without the project and how with the project any social inequities will be addressed or how the project will improve the coping mechanisms of those marginalized by social constructs given the project's outputs and outcome.

2.4.4. Risk Analysis

Several factors can affect the project's performance and its intended outcomes. CA's should outline the project's key risks and their direct and indirect impact(s) on the project and its beneficiaries. In particular, CA's should assess how climate change may impact the project.

Irrigation projects that tackle climate change risk and its related impacts can be grouped into two categories:

a. **Adaptation Projects:** include climate-proofing components designed to reduce or minimize the physical and socio-economic impacts of anticipated climate change over a project's economic life. For instance, an irrigation project exposed to the risk of reduced precipitation or drought can be climate proofed by incorporating additional water storage capacity to meet demand when water resources decline, thereby reducing the socio-economic impacts of insufficient water resources.

b. **Climate Resilience Projects:** their objective is to ensure that communities' can withstand current and future climatic conditions. An example is a project catering to farmers' needs in rainfed, drought-prone agricultural areas by providing them with irrigation infrastructure and drought-resistant crop varieties and capacity building to improve water use efficiency and soil moisture management techniques.

c. **Mitigation Projects:** projects with a primary objective or secondary benefits of reducing emissions that cause climate change, i.e., greenhouse gas emissions (GHGs). In the water sector such projects can include multipurpose dams that supply water for domestic, agricultural, and industrial needs as well as generate clean and renewable energy.

2.4.4.1. Climate Risk Screening

As with any other projects, irrigation projects are prone to exposure and vulnerability to climate change. Changing weather conditions and patterns can adversely affect irrigation projects and their beneficiaries. For instance, increasingly higher temperatures and warmer conditions may deplete surface water resources and reduce the water supply available to satisfy demand. Additionally, climate change can lead to irrigation infrastructure damage due to climatic events such as floods or cyclones. Table 5 highlights some of the known impacts on irrigation projects associated with climate change.

Table 5. Potential Impacts of Climate Change on Irrigation Infrastructure and Operations[2]

Changes in Climate	Impacts of Climate Change
Warmer temperatures	• Increased evapotranspiration, which may lower water resources especially in dry regions. • Changes in crop water requirements, which can affect crop productivity (i.e., quantity and quality).
Reduction in precipitation and more frequent and severe droughts	• Reduced water sources (ground and surface water), leading to increased water competition amongst different uses. • Increased demand for irrigation leading to depletion of water resources. • Crop losses and crop failure.
Increased precipitation and more frequent and severe floods and cyclones	• Damage to crops and irrigation infrastructure. • Damage to drainage systems due to flooding, which will lead to increased waterlogging and an inability to cultivate farmlands. • Blockage of canals and pipes due to increased extent and intensity of erosion and waterlogging, leading to lower volume of water reaching farmlands.

Climate change does not only pose a risk to the damage of irrigation infrastructure and the disruption of water supply for agricultural purposes; it also impacts the quantity and quality of water available. Hence, CAs should screen projects for climate change related risks. Screening projects for climate risk at the PCN stage is a critical foundational step in managing climate risk. Climate risk screening entails answering the following questions:

a. Does climate change impose a high degree of risk to the project? For example, do rising temperatures significantly impact the project's output/service or the useful life of the project's infrastructure?
b. Is the project located in an area prone to climate change-related events? Do climate change scenarios suggest that these events' frequency and/or severity are likely to increases?
c. What will be the implications, including the cost of infrastructure rehabilitation, cost of service disruptions both to the project and service users?

In conducting climate risk screening, it is essential to determine how climatic conditions will possibly change in the area where the project will be located; this requires the expertise of a climate specialist and involves;

[2] Sources:
a. Asian Development Bank, Guidelines for Climate Proofing Investment in Agriculture, Rural Development, and Food Security Sector.
b. Global Alliance for Climate-Smart Agriculture: Compendium on Climate-Smart Irrigation.

a. Establishing a baseline of the existing climatic conditions in the project's locale using historical weather data.
b. Projecting how climatic conditions will evolve over the project's economic life using General Circulation Models (GCM), i.e., climate change models.
c. Determining which weather variable(s) and their expected change will impact the project and its stakeholders.
d. Constructing the most likely scenario of how climatic conditions will change and how they will impact the project.

Climate risk screening is a preliminary assessment intended to identify if the project is exposed to and vulnerable to climate change risk. Various tools are available that can be used to conduct climate risk screening.[3] Detailed climate risk assessments should be conducted at the PFS stage for projects anticipated to be significantly impacted by climate change over their economic life, as indicated by the results of the climate risk screening conducted at the PCN stage. If a detailed climate risk assessment will be undertaken at the PFS stage, CAs should draw up Terms of Reference (ToRs) for such an assessment, and its cost should be included as part of the cost of the PFS preparation.

[3] Some the most widely use climate risk screening tools are:

a. The World Bank's Climate Change Knowledge Portal (CCKP). The CCKP is an online platform which provides global climate data and analytics. https://climateknowledgeportal.worldbank.org/

b. Acclimatize Aware is another online platform providing climate risk date sets and analytics. http://www.acclimatise.uk.com/analytics/applications/

Box 3. Illustrative Example of Preliminary Climate Risk Screening

Project Summary:

- The Department of Irrigation (DoI) is planning on implementing an irrigation scheme in Gatsheni-Matopo area to provide farmers with a reliable water supply. The famers have long relied on rain for the water they require to cultivate crops and rear livestock. Rainfall patterns in the area are erratic and farmers do not always receive sufficient rainwaters to meet their needs.
- The irrigation scheme will cover an area 2,500 hectares of farmland.

Climate Change Risk:

- Gatsheni-Matopo is located in an area that is susceptible to droughts.
- Historical data shows that the chances of the occurrence of a drought are once every 10 years, i.e., 10%. Furthermore, each drought event leads to a decline in water resources. It is estimated that on average the farmers lose about 20% of their water resources during a drought.
- According to climate change models developed by climate specialists, the frequency of droughts in the area is likely to increase. It is anticipated that the probability of having a drought will increase to 15%, i.e., the risk of a drought will increase from once every 10 years to 1.5 times every 10 years. In addition, the severity of a drought is expected to increase, with farmers losing on average about 25% of their water resources in the event of a drought. Hence, the annual water resources in the area are likely to decreased by 3.75% per annum.

Anticipated Lose in Water Resources as a Result of a Drought			
Average Annual Quantity of Water Required for Crop Production "without a drought" (million m3) A	Probability of a Drought Occurring over the life of the Project (%) B	Proportion of Water Resources lost as result of a Drought (%) C	Decline in Annual Water Resources in the Area (million m3) D = A * B * C
55.50	**15%**	**25%**	**2.08**

- A more detailed assessment of the project's exposure and vulnerability to climate change should be undertaken at the PFS stage

2.5. Presentation of the Project Idea using a PCN Form

Once the project idea has been formulated it should be converted into a "business case", which is known as the Project Concept Note (PCN). The PCN provides vital information about the project, as well as justification for the project and its alignment with the Government's strategic objectives. The PCN should be presented in a structured format using a PCN form. The structure, format and data requirements of the PCN form are outlined on pages 40-56 of the PIM Guidelines. An illustrative example of the PCN form for the Gatsheni- Matopo Irrigation Project is provided in Annex A.

2.6. Assessment of the PCN

The assessment of the PCN consists of two phases. The first phase entails an internal assessment of the PCN by the Line Ministry (MoLAWCRR). Once the PCN has passed the internal screening, it should be submitted to the MoFED for the second phase of the screening

process. It should be noted that PCN submissions are made in October, according to the Public Investment Management and Budgeting Calendar defined in Article 129 of the PIM Guidelines.

The external assessment of the PCN by the MoFED is a three-step process aimed at assessing the project's alignment with the Government's objectives and priorities. It also entails an evaluation of resource availability to fund the project with consideration of resource allocation to projects from other sectors vying for the same pool of resources. The three steps carried out in assessing the PCN are as follows:

i. The first stage is to determine the compliance of the CA with the submission process and other procedural requirements stipulated in the PIM Guidelines and this Manual. In exceptional cases, MoFED may accept PCN submissions earlier than or later than the stipulated deadline. Cas are required to submit PCNs in compliance with the PCN form outlined in the PIM Guidelines (PIM Guidelines, Article 173). In case of missing information, MoFED may postpone the PCN pending the submission of the complete information.
ii. At the second stage of the assessment, MoFED will assess the project's alignment with the National and Sectoral Strategic Objectives. Projects that are not in line with the National development strategies and sectoral development plans will get postponed. In exceptional cases, Cas may justify projects that are not directly aligned with the strategic development plans. Such cases, for instance, may include projects that are designed to mitigate force majeure situations, such as droughts, floods, earthquakes, Et cetera.
iii. The last stage involves MoFED assessing the affordability of the project as well as the likelihood of the expected economic benefits of the project exceeding the cost of resources.

Only projects whose PCNs pass both the internal assessment by the CA and the external assessment by the MoFED should be allowed to progress to the PFS stage.

3. PRE-FEASIBILITY STUDY (PFS)

3.2. Introduction

The Pre-feasibility Study (PFS) phase involves the refinement of all elements of the PCN stage described in the previous chapter by providing information on different aspects of a project in greater detail. Wherever possible, data from the PCN should be updated with more accurate estimates in preparing the PFS. The PFS emphasises the technical, financial and socio-economic viability of various options through which the project can be undertaken to identify the preferred option. Cas shall undertake a PFS of the proposed project or outsource the preparation of the PFS to a third party in cases where, for instance, the CA does not have the technical capacity to do so.

3.2 Methodology for Appraising a Proposed Project

3.2.1 Irrigation Projects Needs and Demand Analysis

The need and demand for a project's output (product or service) are two unique concepts. The need for a project's output has to do with peoples' requirements for the product or service provided by the project, such as the water required to carry out agricultural activities. On the other hand, the demand for the project's output refers to people's behavior patterns, how they respond to the provision of a product or service generated by the project.

The need and demand for a project's output do not always coincide. For example, all farmers require water as an input. However, if an irrigation project provides its output (water) at a fee, though farmers need the water, they may or may not utilize the water supplied by the project given its cost relative to other alternatives. Hence the utilization/demand for the project's output will depend on the value of the input (water for agricultural purposes) relative to the value of the output produced by the farmers (agricultural produce). Apart from the affordability of a project's output, many other factors will affect whether people will utilize the project's output, despite their need for it.

An appraisal of a project should, first of all, determine if there is a need for the project's output, this should be followed up with a demand assessment, which should take into account the factors that can positively or negatively affect the utilization of the project's output.

3.2.2. Identification of Alternative Irrigation Project Interventions/Options

The Integrated Investment Appraisal (IIA) methodology is used to evaluate both the financial and the socio-economic effectiveness of irrigation projects, estimating its impact from various perspectives. The investment appraisal begins with an evaluation of the profitability of the investment project (Financial module). The analysis shall be conducted on an incremental basis as a difference between "with irrigation scenario" and "without irrigation project scenario.'' The socio-economic assessment (Economic module) builds on the Financial, substantially reducing the time and resources usually required for such studies. The economic effectiveness is assessed using typical investment project efficiency indicators, such as Economic Net

Present Value (ENPV), analogous to Financial Net Present Value (FNPV), and Economic Rate of Return (ERR), similar to Internal Rate of Return (IRR).

Stakeholder analysis is also carried out to determine the key stakeholders who gain and lose as a result of the project. In addition, risk analysis is carried out to determine the key risks in the irrigation project and how they can be mitigated.

3.2.2.1. Project Appraisal using Cost-Benefit Analysis

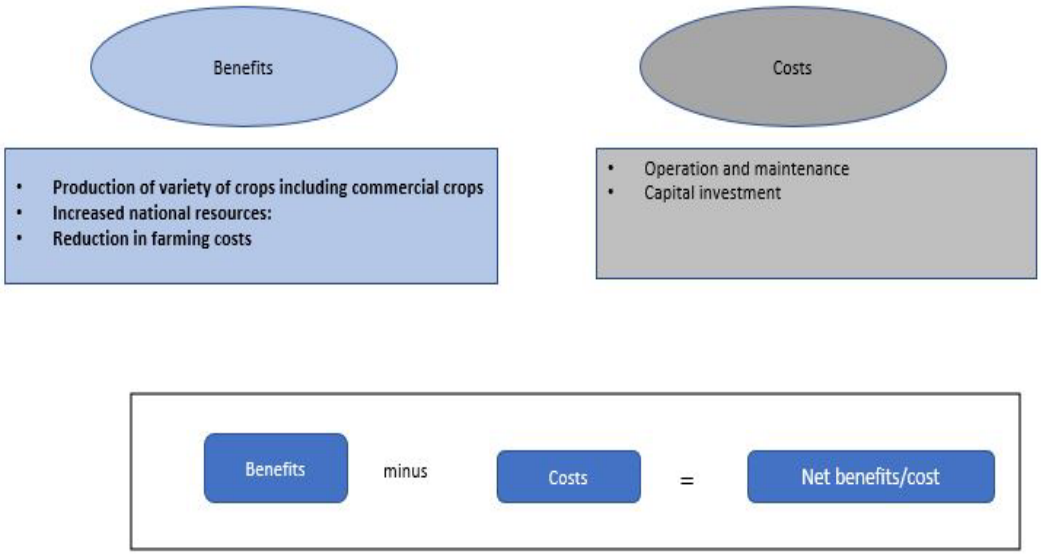
The objective of CBA is to assist decision-makers in undertaking an informed decision on public investment projects based on quantitative evidence of the financial and economic returns of the project; this is consistent with the concept of efficiency in the allocation of public resources.

The efficient allocation of resources occurs when the most highly valued set of outputs is created, given the use of the least cost of inputs. Hence, the core principle of CBA is to accept projects for which the net social benefits are positive (subject to budget and other constraints). Therefore, for the efficient management of the public resources, the guiding principle is to invest scarce resources only in projects where economic benefits are more than the economic costs. Hence CBA entails;

i. The identification and valuation of the project's costs and benefits; and,
ii. A comparison of the costs versus the benefits of a given project (allowing for the determination of whether the project's benefits outweigh the costs or the costs outweigh the benefits).

Figure 6 presents an illustrative example of how to undertake a CBA for an irrigation project.

Figure 6. Example of how to undertake the CBA for an Irrigation Project



3.2.2.3. Incremental Project Analysis

A project's benefits and costs should be measured on an incremental basis. When appraising a project, two scenarios should be assessed, one that includes the project (that is the "with" project scenario) and one that does not include the project (the "without" project scenario). An incremental analysis of a project entails the computation of the net benefits that are generated by the project over and above those that would have occurred in the absence of the project. The incremental net benefits of a project are computed by subtracting the benefits and costs of a project in the "without project" scenario from those in the "with project" scenario. Incremental project analysis allows for the identification of the benefits and costs that are generated as a result of the project in question.

An essential element of incremental analysis is to ensure that the "without project" scenario is properly defined. The "without project" scenario needs to be optimized to ensure that it is comparable to the "with project" scenario. In principle, the "without project" scenario is not static. It should be a dynamic projection of how the situation in the absence of the project would naturally evolve, with correct measures being taken, such as the maintenance of existing infrastructure to maintain and meet service requirements and standards. A simple "before" and "after" comparison of the project is not appropriate as these two scenarios represent static scenarios whose circumstances do not change to reflect measures that would be taken most notably in the case were the project is not implemented.

In the case of an irrigation project for instance, optimization of the existing irrigation system ("without project scenario") includes accounting for the following activities that are likely to be undertaken to keep the system functioning optimally:

i. Incorporation of scheduled maintenance of the exiting irrigation system;
ii. Execution of marginal investments that provide for adequate operation of the existing facility;
iii. Application of modern farming methods by the farmers;

In the agriculture sector, the optimization of the performance of the existing infrastructure may prove to be the least costly solution to the current problem.

3.2.2.4. Analysis of Project Alternatives (Options Analysis)

The appraisal of a proposed irrigation project should include an assessment of the alternative means through which the projects output can be delivered. For irrigation projects, this comprises of determining the various approaches that water for agricultural purposes can be delivered to farmlands. The various types of irrigation projects and technologies that can be used to deliver water for agricultural activities are outlined in Annex D, while the process of developing and irrigation project alternative is detailed in Annex E.

The analysis of project alternatives is used to assess and compare the identified project alternatives to ensure that the best strategy is adopted pursuant to the objectives of the project and that the resources expanded are used efficiently and effectively.

The number of project alternatives assessed should not exceed five to avoid complicating the analysis. In assessing project alternatives, each alternative should be clearly described together

with a summary of its associated advantages and disadvantages and a quantification of the preliminary costs and benefits relative to the objectives of the project.

A summary should also be given, which states the preferred option and explains how the preferred option meets the objectives more effectively than other options, and how it provides the best value for money.

CBA shall be conducted for all of the project alternatives that are being considered, and the preferred alternative shall be selected based on among other criteria discussed above its CBA indicators in comparison with those of the other alternatives.

3.2.2.5. Project Model and its Role in Undertaking a Project Appraisal

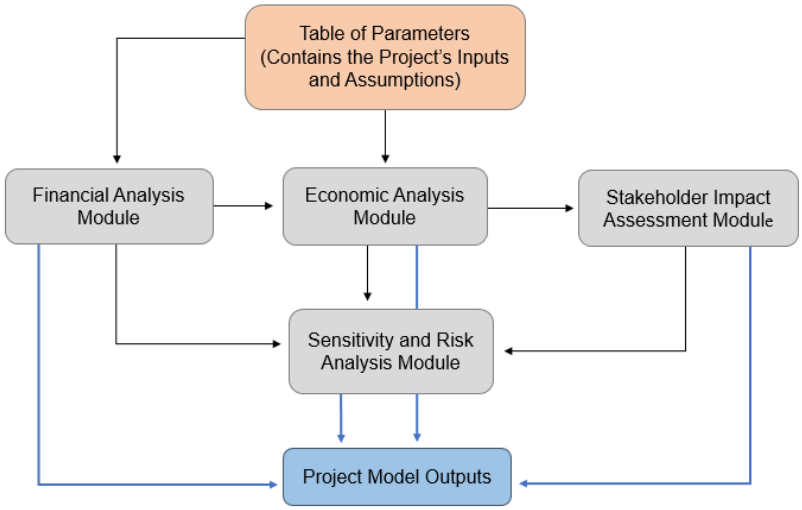
Conducting an appraisal of an irrigation project requires that the expected costs and benefits of the proposed project be forecasted into the future. Forecasting costs and benefits into future periods requires modelling what the value of the project's costs (capital, operating, and maintenance expenditures, etc.) and the benefits (increased agricultural production, change in the time of sale, time savings, etc.) will be in each successive period. A project model is therefore constructed to evaluate a proposed project based on the projections of how it is expected to perform in the future given various assumptions about how the costs and benefits are likely to turn out over the project's operational life. The project model is used to compute the key decision metrics that will be used to assess the project's financial and economic viability, as well as in assessing the social impacts and identifying the project's risks.

Model Structure

The project model should be created using Microsoft Excel. The model should follow a clear and logical structure. The components and structure of the model are presented in Figure 7. The model should be titled with a name that identifies the project under appraisal and should include the date when the model was constructed or last updated; this should consist of the year, month and day; for example, "Gatsheni-Matopo Irrigation Project 2019-05-20.xlsx".

The model should be constructed in such a way that it integrates the financial analysis, economic analysis, stakeholder impact assessment and the sensitivity and risk analysis modules. The inputs used to calculate the outputs in the financial, economic, and stakeholder impact modules should be linked to those inputted in the table of parameters. This integration allows for a dynamic model that can be subjected to a sensitivity and risk analysis as any changes in inputs will be reflected in the changes of the project's financial analysis, economic analysis and stakeholder impact assessment outputs in the sensitivity and risk analysis modules. The model should be constructed using a single time frame, such as annual, semi-annual, quarterly or monthly.

Figure 7. Structure of Project Model



Model Inputs and Assumptions

Various inputs and assumptions about the project's key parameters (costs and benefits) are required to construct a robust model that captures as accurately as possible the feasibility of undertaking the proposed project. At the PFS stage, if primary data is not available, it can be substituted with secondary data from a project that has been implemented, that is of a similar scale and, or scope. The required inputs and assumptions are listed below:

- Period of project commencement
- Period of project cessation
- Project evaluation period
- Assets to be constructed (e.g., a dam or reservoir) and their respective costs and useful lifespans.
- Assets to be acquired (e.g., water pumps, pipes, etc.) and their respective costs and useful lifespans.
- Quantity of water used to water plants, "without" and "with" the project (useful for estimating the incremental water savings/costs from the project)
- Agricultural input costs, "without" and "with" the project (useful for estimating the incremental savings/costs from the project)
- Labour costs, "without" and "with" the project (especially labour required for collecting and watering crops or animals, these parameters are useful for estimating the incremental labour savings/costs from the project). Where possible disaggregate the labour costs by gender given the fact that men and women undertake different labour activities when it comes to cultivating crops and rearing livestock
- Expenditure on human capital if applicable (engineers and technicians)

- Expected operating costs of the irrigation infrastructure (this should be categorized by item, i.e., fuel/pumping costs, labour costs, cost of chemicals, etc.); for the "without" and "with" project scenarios.
- Maintenance costs of the irrigation infrastructure (the frequency of these costs should reflect when maintenance is required; this can be on an annual basis or every five or ten years) for the "without" and "with" project scenarios.
- The capacity of the irrigation infrastructure for the "without" and "with" project scenarios.
- Number of beneficiaries expected to use the irrigation facility and the quality of water needed.
- Forecasted demand for water by the beneficiaries.
- Current practices of obtaining water and the associated costs such as time spent fetching water (note, if possible, this should be disaggregated along the lines of gender)
- The type of crops to be grown under the irrigation facility.
- Hydrological information such as available water sources and recovery rate
- Financial discount rate
- Economic discount rate
- Macroeconomic parameters (inflation rate, exchange rate, real change in prices and salaries)
- Taxes and other fiscal payments (if applicable)
- Sources of funds
- The gear ratio in the case of multiple sources of funds (debt financing, private sector financing etc.)
- Terms of debt financing if applicable (interest rate, loan repayment period, grace period etc.)

3.3 Conducting the Cost-Benefit Analysis of Irrigation Development Projects

Cost-Benefit Analysis (CBA) is the primary methodological approach used in the assessment of the financial and economic analysis of irrigation projects. Using CBA, one can assess whether the present value of the project's benefits exceed the present value of the project's costs. The cash-flow analysis is used for comparing the annual costs and benefits for both the without and with project situations.

The objective of CBA is to assist the decision-maker in deciding on a public investment project based on the quantitative evidence of the financial and economic returns of the project. The rule that social benefits must exceed social costs allows for those who gain from a project to share the benefits with those who lose as a result of the project, on the

basis that both parties are better off than they would be without the project. For the efficient management of public resources, therefore, the first principle is to invest scarce resources only in projects where the economic benefits are more than the economic costs. Second, use the quantitative analysis to design project-specific measures and more comprehensive policies (including tax policies) to address income inequality. CBA is also useful in assessing the project's impact on society, for instance, the project's ability to improve farmers' livelihoods and ensure food security, as well as the project's ability to address or reduce gender inequities.

CBA is conducted using a Discounted Cash Flow (DCF) Analysis, which compares the annual costs and benefits of the project in both the "without" and "with" project scenarios. The primary CBA criterion is the net present value (NPV) of the discounted incremental cash flows of the project. The NPV formula is shown below:

$$\text{NPV} = \sum \left(\frac{B-C}{(1+R)}\right) > 0$$

Where:

- B represents the benefits
- C represents the costs
- R represents the discount rate

Social and environmental benefits or costs that can be quantified in monetary terms should be included in the CBA; this is done by adding the present value of the net socio-environmental impacts to the net benefits of the project, as shown in the formula below:

$$\text{NPV} = \sum \left(\frac{B-C\mp E}{(1+R)}\right) > 0$$

Where:

- (B-C) represents the net benefits or net costs in the case where the project's costs outweigh the benefits
- E represents the net socio-environmental impacts
- R represents the discount rate

3.3.1 Costs of Irrigation Development Projects

Irrigation development costs can be categorized into three main categories, that is capital expenditures, operating and maintenance costs and other costs. The costs are discussed in the sections that follow.

3.3.1.1 Capital Expenditures

Capital expenditures refer to the expenses incurred in acquiring or improving the assets of the irrigation project, and they include:

- Irrigation infrastructure and property redevelopment: e.g., clearing land, ground preparation, surveys, designs, and the construction and installation of irrigation infrastructure (dams, pipes, pumps, and irrigation delivery system, e.g. center pivot)
- Acquisition of motor vehicles
- Any other capital investments required depending on the specific requirements of the project

3.3.1.2 Operating and Maintenance Expenditures

The operation and maintenance of irrigation schemes can be the responsibility of either the government, the irrigation agency, individual farmers or groups of farmers. It can also be a joint responsibility between groups of farmers and the government, depending on the size of the scheme.

With respect to large irrigation schemes or government-run schemes, the irrigation agency and the farmers often share the responsibility of operating and maintaining the irrigation infrastructure. In such cases, the operation and maintenance of the water delivery and storage systems usually is the responsibility of a government agency, while the farmers are responsible for maintaining field infrastructures such as canals and small hydraulic structures.

Irrigation systems have three main types of maintenance that can be undertaken to keep the infrastructure working as efficiently as possible. The three types of irrigation infrastructure maintenance are discussed below.

a) **Special Maintenance:** This maintenance involves work that is undertaken to repair the irrigation system in response to unforeseen damages, such as those caused by floods or earthquakes.
b) **Deferred Maintenance:** Deferred maintenance or rehabilitation includes any work that is undertaken to restore the capacity of the irrigation system. The system is allowed to deteriorate to a certain level, beyond which it would not operate efficiently before it is restored to its operational level. Maintenance and rehabilitation are usually deferred as a result of a lack of funds.
c) **Routine Maintenance:** This involves all the work that is undertaken on the irrigation system in order to keep the irrigation system operating satisfactorily. It is typically conducted on an annual basis.

O&M expenditures that are incurred in irrigation projects could include the following:

- Annual operating expenses incurred to deliver water to farmlands.
- Annual repairs and maintenance to buildings, structures and equipment
- Labor expenditures incurred in operating and maintaining the irrigation infrastructure.

- Property and social insurance
- Energy costs incurred in running the irrigation facilities and infrastructure.
- Professional services such as consultants or legal services
- Land lease costs were applicable.

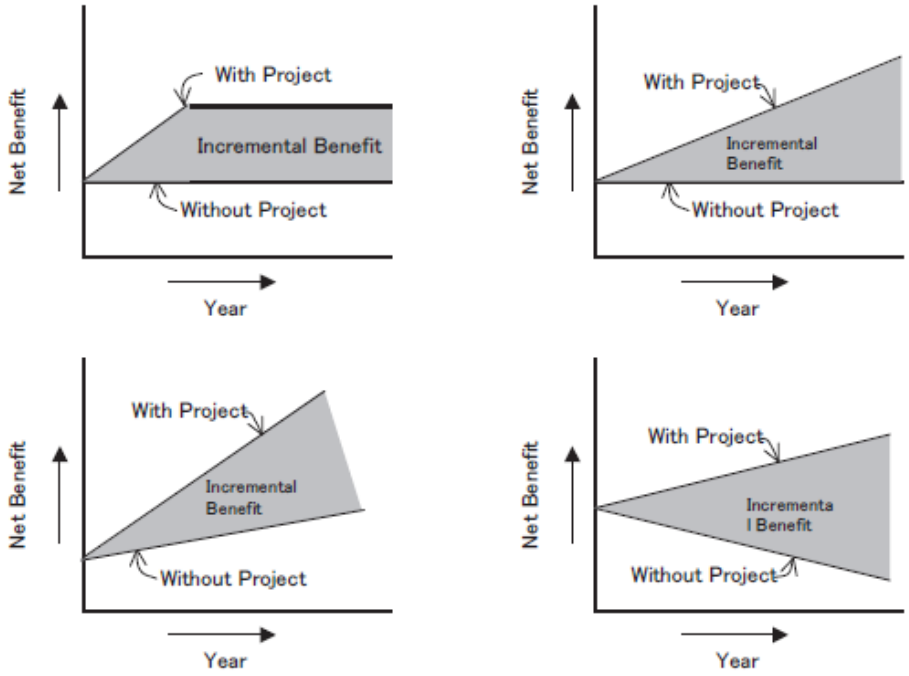
3.3.1.3 Other Costs

- Farm inputs for example fertilizers, pesticides etc., for the crops that are to be grown on the Scheme.
- Capacity building is a crucial part of irrigation projects, which is when upgrading or developing a new irrigation scheme with new technologies. The farmers and technical staff should be trained on the use of the irrigation system to be installed and as well as good farming practices.
- Taxes and duties: Duties and taxes on imported goods, especially equipment, to set up the irrigation scheme, should be included as part of either investment or operating and maintenance costs, whichever is applicable.
- Opportunity costs of water should be included in the analysis. The consumption of water by one user deprives another user. If one user has a higher value for water than another user, then an opportunity cost exists and should be viewed as a misallocation of resources.

3.3.2 Benefits of Irrigation Development Projects

The benefits of an irrigation development project can be evaluated by the comparing the benefits "without" the project and the benefits "with" the project. The incremental benefits (the benefits "with" the project less the benefits "without" the project) are crucial in showing how the project impacts its beneficiaries. An illustration of the incremental benefits of irrigation projects is presented in Figure 8. The benefits of irrigation projects can be categorized as quantifiable and non-quantifiable benefits.

Figure 8: Illustration of the Incremental Benefits of an Irrigation Project[4]



3.3.2.1 Quantifiable Benefits from the Rehabilitation of Irrigation Projects

The following quantifiable benefits can be derived from rehabilitation irrigation projects:

I. **Increased production[5]:** An irrigation is likely to increase the production of crops due to the continuous availability and supply of water that allows multiple production cycles in a year. Also, crop yields may increase substantially when irrigated compared to when no irrigation is utilized in the cultivation of crops. Hence, increased crop productivity can be as a result of:

   a. Additional cultivation season(s), and;
   b. Increased crop yields.

II. **Improved quality of agricultural produce:** An irrigation scheme may improve the quality of the crops produced due to an adequate water supply, so long as good agricultural practices are utilized.

III. **Price differential:** An irrigation project when implemented, will increase the number of cultivations seasons. It also enables farmers to produce crops off-season when the prices of such crops are usually at their peak.

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[4] Gittinger 1982

[5] Though water is one of the inputs for crop production, all other inputs must be provided in the right quantities and at the right time, additionally climatic conditions must be suitable in order for crop yields to be optimized, however, the provision of irrigation water does have a bearing on crop productivity and yields.

Production of a variety of crops including commercial crops: An irrigation project may enable the production of new crops that were not possible before due to a limited water supply. These crops may be commercial which increases households' incomes, or they may be staples consumed by farming households, which would increase food security and the standard of living. Depending on the household dynamics (i.e., whether a man or woman heads the household and whether it is men or women who have the authority over the allocation and uses of resources), the benefits of improved crop production may accrue either to men or to women. It is, therefore, essential to include the gender impacts of the project's benefits when assessing an irrigation project.

IV. **Change in operation and maintenance costs of irrigation facilities:** Irrigation infrastructure rehabilitation projects may result in savings in ongoing operating and maintaining costs of the existing infrastructure, for example, labor costs and expenditures on operating maintenance materials and equipment could be far lower once the existing infrastructure is rehabilitated.

V. **Labor saving:** Once irrigation systems are put in place, savings in labor costs will be realized on account of the time and effort saved, as farmers will no longer have to bear the cost of fetching water. Labor savings in the case of crop production are likely to accrue mostly to women and children as it is they who are mainly involved in collecting and carrying water for agricultural activities. In the case of livestock rearing, it is men and boys who bear the responsibility of watering the animals; hence any time savings would largely be attributed to them. The time saved can be utilized for other activities required to make farming more productive and profitable.

VI. **Stability in yields:** Irrigation schemes may result in the stability of crop yields, allowing farmers to achieve some income security, reduced crop insurance costs, and obtain greater assurance in meeting production targets and supply contracts.

3.3.2.2 Quantifiable Benefits of New Irrigation Development Projects

The following quantifiable benefits can be derived from new irrigation development projects:

I. **Commercialization of agriculture:** Irrigation projects enable intensive agricultural production suitable for the commercial marketing of crops to be undertaken. Irrigated land is considered ideal for the production of particular food items, which are needed in large amounts such as fruits and vegetables.

II. **Reduction of climatic risks:** Irrigation fed crops are less prone to hazards extreme climatic conditions such as droughts which can lead to crop failure. Irrigation projects lead to a reduction in crop failure.

III. **Replacement of inferior crops with superior crops and increased yield:** Development of a new irrigation project in an area increases the yields produced due to the availability of water in addition to the production of superior crops.

IV. **Increase of cultivation on sub-marginal land:** Irrigation enables agriculture to be practiced on land that was previously not suitable due to the lack of water.

V. **Reduction in farming costs:** Irrigation brings with it efficiencies in the use of water in the cultivation of crops and the rearing of livestock. Water is a key input; therefore, water use efficiencies result in reduced production costs.

VI. **Climate benefits:** The adoption of irrigation may result in climatic benefits. Due to the use of irrigation, agricultural production can lead to increased carbon dioxide removal as a result of increased organic soil matter. On the other hand, irrigation projects may contribute to additional GHG emissions through, for example, increased livestock production. Hence, when considering the GHG emissions, it is the net impact that is important. It should be assessed whether the net impact results in more or less GHG emissions. If the net impact is a reduction in GHG emissions, this should be included in the analysis of the project a benefit, while a net increase in GHG emissions would be included as a cost.

3.3.2.3 Non-Monetized Benefits of an Irrigation Scheme

An irrigation scheme may also result in several benefits that are difficult or costly to quantify or monetize. Such benefits may include for example, the improvement of the academic performance of the children especially girls, due to the reduced time spent on agricultural activities like collecting water. These benefits shall be presented and discussed qualitatively.

3.3.3 Financial Analysis

The financial analysis module is required to assess the financial viability and sustainability of the proposed project. Financial analysis is key to understanding the profitability of the project as well to assess if there are enough financial resources to operate and maintain the project over its operational life. Financial analysis can be used to estimate the amount of funds required to set up, operate and maintain the irrigation scheme; these estimates are useful in sourcing funds from the fiscal budget, as well as other sources such as donor agencies.

Projects that generate revenue through user fees require a financial analysis to determine if the fee revenue is sufficient to cover operations and maintenance expenditures, as well as recoup capital expenditures. The identification of shortfalls will allow the project developers to find funds to cover those shortfalls. In the case of Public-Private Partnerships (PPPs), financial analysis is key to assessing if the project presents a profitable undertaking on the part of the private sector. If the project does not yield a return in line with private sector expectations,

financial analysis can then be used by the public sector to measure the amount required to make the project attractive for the private investor.

The financial analysis involves the identification of all expenditures and revenues over the lifetime of the project with the view of assessing the ability of a project to achieve financial, sustainability and a satisfactory rate of return. It's aimed at determining the profitability of the project; it's sustainability and establishes a baseline for undertaking economic, distributional and risk analysis.

3.3.3.1 Construction of a Financial Cash Flow Statement

The financial analysis evaluates the expenditures and revenues generated by a project using the discounted cash flow (DCF) approach. This method requires the construction of a cash flow statement to carry out the financial analysis of a project. A typical cash flow statement is organized into two distinct sections. The first section is dedicated to summarizing all of the receipts generated by the project, whereas the second section is concerned with the project's expenditures. The main components of the two sections of the cash flow, receipts/revenues (inflows) and expenditures (outflows) are outlined below.

The cash inflows of a project typically consist of the following items:

i. Operational revenues
ii. Changes in accounts receivable
iii. Residual values of the project's assets if their economic life exceeds the analysis period

The cash outflows of a project typically consist of the following items:

iv. Capital expenditures
v. Operational expenditures (including income tax liabilities)
vi. Maintenance expenditures
vii. Changes in working capital (accounts payable and cash balances)

Following the cash flow structure outlined above, the financial analysis of a project requires that two cash flows be constructed: one for the "without" and the other for the "with" project scenario. Once these two respective cash flow statements are constructed, the incremental cash flow statement can be derived. It simply entails subtracting the cash inflow and outflow items of the "with" project scenario from the corresponding "without" project scenario.

The incremental cash flow statement is what is used to conduct financial analysis by calculating the net cash flow, which is simply the difference between the total inflows and outflows. When debt financing is part of the capital structure, the incremental cash flow should be constructed from two points of view;

a) **Total Investment Point of View:** This cash flow statement does not include debt and equity financing and the repayment of debt. Therefore, this cash flow is used to evaluate the project's ability to meet its debt service obligations (principal and interest), after it has settled all of its operational and maintenance expenditures. In order to assess the project's ability to cover its debt obligations, the Net Cash Flow Available for Debt Service (NCFADS) must be computed from which the debt service coverage metrics can be calculated.

b) **Famers Point of view:** This cash flow statement is constructed to evaluate the profitability of the project from the farmers' perspective as measured using the FNPV and FIRR metrics.

3.3.4. Economic Analysis

The economic analysis of an irrigation project is an essential component to determine the economic viability and sustainability of the proposed project. Unlike financial analysis which only assesses the benefits accruing to one entity, for example, the private sector in the case of a PPP, the economic analysis assesses the benefits accruing to society as a whole. An economic analysis is useful for evaluating if the economy's resources are being put to their best use if they are allocated to be invested in this particular project, given that resources are scarce and there are competing needs (alternative uses) for the resources that are allocated to any project. Hence, the main objective of economic analysis is to ensure that the country's resources are being used efficiently.

The net economic contribution of a project is measured by the present value of the project's incremental net economic benefits. The economic analysis aids decision-makers in allocating the available resources to those projects that maximize the present value of the net economic benefits created for the country, community or group of beneficiaries given the amount of resources invested.

3.3.4.1. Constructing an Economic Resource Flow Statement

To carry out the economic analysis of an irrigation project, Commodity Specific Conversion Factors (CSCFs) will be used to convert the cash flow statement into an economic resource flow statement.[6] The economic resource flow statement is utilized in undertaking the economic analysis of a project; it consists of two main sections; that is the project's benefits and the project's costs. The purpose is to weigh the project's benefits against its costs. In economic analysis distortions such as taxes and subsidies that are imposed by the government are not included as part of the CBA, as they are considered transfers from one economic actor to another; and as such do not represent costs or benefits but are rather externalities. Once the economic resource flow statement has been constructed, the project's viability can be assessed by utilizing the net resource flow (total benefits minus total costs) to estimate the economic net present value (ENPV) and the economic rate of return (ERR).

Below is the economic resource flow statement used to assess the economic viability and sustainability of the Gatsheni- Matopo irrigation project.

[6] A CSCF is the ratio of the economic price of a project input or output to its financial price. It can be used to convert the financial revenues and expenditures of a project to their equivalent economic benefits and costs.

Figure 8. Illustration of the Economic Resource Flow Statement

Project Benefits / Costs	Present Values (million USD)
Benefits	**80.83**
Incremental economic value of Maize	28.01
Incremental economic value of Vegetables	52.82
Costs	**46.02**
Capital expenditure	26.50
O& M costs	9.34
Cost of Production Inputs	10.19
ENPV	**34.81**
ERR	**28.54%**

Note: The different CSCF of the costs and benefits are used to obtain the economic values.

3.3.5 Distributive Analysis

The implementation of a project may result in both positive and negative impacts on various groups of society. These impacts can be both direct and indirect. The stakeholder impact assessment is used to identify and quantify the impacts that the proposed project is likely to have on the project's stakeholders. In other words, stakeholder analysis is used to identify who stands to gain or lose as a result of the project and by how much. In the case where the project poses adverse impacts on society, measures of mitigation should be found to ameliorate these negative impacts.

The stakeholder analysis of an irrigation project is crucial to the identification of a project's impact on gender equality. As highlighted throughout the manual already, men and women have different roles and responsibilities when it comes to sourcing and utilizing water for irrigation purposes. Hence the benefits generated by a project must be disaggregated and distributed along the lines of gender wherever possible. The project's gender impacts can be broken down by applying sex-disaggregated statistics to the distributive analysis of the project's benefits. The distributive impacts of the project may also be disaggregated based on other relevant groupings such as income groups within the population of beneficiaries in order to show how the project impacts low-income households.

The distributive analysis is based on the project's financial and economic analysis. It is conducted by estimating the externalities generated by the project. Project externalities are derived by finding the difference between the financial and economic values of the project's inflows and outflows. The externalities generated across various social groups, either directly or indirectly by the project, represent the costs or benefits accruing to each group of stakeholders. Distributive analysis excludes the equity holders and lenders as their interests are financial and are assessed in the financial analysis module.

The distributive analysis is composed of the following steps:

1. Identification of project stakeholders and externalities.
2. Estimation of the magnitude of the project's externalities, measured by taking the difference between the economic value of a project's inflows or outflows and the financial value of the same inflow and outflow items.

3. Computing the present values (PVs) of the project's externalities over the life of the project using the EOCK.
4. Reconciliation of the financial, economic, and stakeholder analysis modules.[7]
5. Allocation of the PV of externalities among the project's stakeholders.

3.3.6. Risk Analysis

A CBA would not be complete without taking into account project risk. As the benefits and costs of a water project are projected into future periods, uncertainty exists with regards to their realization and, in turn, the attainment of the required financial and economic returns as well as the intended outcomes set out for the project. The financial and economic variables that pose a risk to the project's overall financial and economic performance should be identified and their impacts assessed at the PFS stage using sensitivity analysis. For example, the yields produced and production costs are crucial in the financial and economic analysis; deviations in any of these two parameters should be tested to measure their impact on the project's outputs such as FNPV and ENPV. The identification of project risk variables and their financial and economic impacts can be used as the basis for formulating measures to reallocate or mitigate such risks to make the project viable and or sustainable.

Sensitivity analysis is used to assess the impact of changes in key project assumptions on the results of financial and economic forecasts (NPVs, IRRs). However, other methods such as break-even analysis, scenario analysis and Monte Carlo simulations can also be utilized to assess the various risks of the proposed project.

Key sensitivity factors include the assumptions (initial data/inputs) of the financial and economic model, the actual values of which during the project implementation may deviate significantly from the values embedded in the model; due to an inability to accurately forecast them during project appraisal or as a result of their inherent volatility. Typical sensitivity factors include investment costs of the irrigation project, operating and maintenance expenditures of the project, user fees, and agricultural productivity (crop yields). The results of the sensitivity analysis should be reported using the "Sensitivity Analysis Forms,". an example of which is illustrated in Table 6.

[7] When conducting reconciliation, the analyst should ensure that the following relationship holds:

$$NPV_e^{EOCK} = NPV_f^{EOCK} + PV^{EOCK} \sum Ext_i$$

Where: NPV_e^{EOCK} is the net present value of net economic benefits

NPV_f^{EOCK} is the net present value of the net financial cash flow

$PV^{EOCK} \sum Ext_i$ is the sum of the present value of all externalities generated by the project

Table 6: Illustrative Example of a Sensitivity Analysis Form

	Financial incremental		Economic incremental	
Investment Cost Overrun	FNPV	IRR	ENPV	ERR
-10%				
-5%				
0%				
5%				
10%				

3.4. Preliminary Environmental and Social Impact Assessment[8]

As stipulated in Articles 298 and 299 of the PIM Guidelines, the appraisal of a water project at the PFS stage should include an Environmental and Social Impact Assessment (ESIA), which is used to determine the impact the proposed project will have on the environment and society either directly or indirectly. ESIAs are regulated under the Environmental Management Act (EMA)[9], which stipulates the requirements and procedures of preparing an ESIA report. According to EMA, An ESIA is required for irrigation projects. The CA should, therefore, seek guidance from the Environmental Management Agency (EMA) which is the regulatory authority charged with protecting the environment.

3.4.1. Environmental Impact Assessment

An Environmental Impact Assessment (EIA) is useful in identifying and where possible to quantify the potential environmental impacts of a proposed irrigation project. Irrigation projects can have various adverse effects on the environment within the area/region where they are located. Irrigation projects pose a threat downstream and upstream to land use patterns, the natural flow of rivers and lakes and the depletion and pollution of surface and groundwater sources. Irrigation schemes are notorious for increasing soil salinity, waterlogging and for increasing the incidence of malaria and other waterborne diseases. Efforts have been made to design and construct free–drainage structures that would facilitate the easy flow of water and reduce the incidence of water-related diseases. However, such structures have not been widely implemented. There has also been an attempt to raise local awareness about the management of water catchments to minimize project impacts such as siltation in dams.

Apart from identifying the environmental impacts resulting from an irrigation project, the EIA should also outline the appropriate measures that can be taken to mitigate or manage such effects.

[8] For more information regarding the ESIA the reader should refer to section 4.3. of the PIM Manual on page 17

[9] Environmental Management Act 13 of 2002

3.4.2. Social Impact Assessment

A Social Impact Assessment (SIA) is necessary for identifying the direct and indirect, short or long-term impacts that a project will have on the society in the project's area of influence. Irrigation projects can have numerous impacts on society. Some of the examples of the impacts are listed below:

i. Improving the livelihoods of farmers and alleviating poverty.
ii. Improving food security and wellbeing (more balanced nutrition, resulting in better health)
iii. Displacement and relocation of people.
iv. In the case of an irrigation project that is complemented by dam infrastructure, the risk of flooding may be reduced; however, communities downstream may face adverse effects of damming such as reduced water flow.

These are just a few of the positive and negative impacts that may arise as a result of an irrigation project. It should be noted that the project's impacts should be disaggregated along the lines of gender, income groups and other relevant demographics such as the age and sex of the head of the household. The SIA should outline appropriate measures that can be taken to mitigate or manage the social impacts that may result from the project.

3.5. Climate Risk Assessment

The climate risk assessment is a continuation of the climate risk screening conducted at PCN. However, climate risk assessment is an in-depth analysis of how climate change impacts the project and its performance. The impacts are quantified and expressed as economic costs. Furthermore, climate risk assessment leads to the development of adaptation measures that can be utilized to climate-proof the project if it is adversely affected by climate change. The benefits of each climate-proofing option are then assessed to determine the best alternative to mitigate the impacts of climate change on the project.

Climate risk assessment at the PFS stage consists of four steps, that is;

i. The assessment of the economic viability of a regular infrastructure investment project,
ii. Estimating the benefits of climate proofing the project and assessing options to climate-proof the project.
iii. The assessment of the economic viability of climate-proofing, and,
iv. Decision making.

3.5.1. Assessment of the Economic Viability of a Regular Infrastructure Investment Project

A regular infrastructure investment project should be quantitatively assessed with respect to its technical, financial, and socio-economic feasibility and viability. It should be assessed based on the following considerations:

a. Financial viability based on financial metrics such as the financial net present value (FNPV) or the internal rate of return (IRR).
b. Socio-economic viability based on economic project performance metrics such as the economic net present value (ENPV) or the economic rate of return (ERR).

Box 4 provides a summary of the socio-economic analysis of the Gatsheni-Matopo Irrigation project.

Box 4. Illustrative Example of the Economic Viability of a Regular Infrastructure Investment Project

Based on technical studies and the engineering design conducted at PFS, the irrigation project is expected to have a capital cost of $ 35 million and annual O&M costs of $ 2 million. The project is anticipated to produce benefits of $ 10.94 million per annum, which consist of improved productivity of crop production.

Assessment Criteria	Million USD
Economic Net Present Value - ENPV	$ 34.81

The conclusion that can be drawn from the economic analysis is that the project is economically viable, as the project's ENPV is positive, i.e., the ENPV>0. However, the project must be assessed for climate risk before it is implemented to determine if any climate-proof interventions are necessary.

3.5.2. Estimating the Benefits of Climate Proofing the Project

The determination of whether a project should be climate proofed, as well as the assessment of the benefits of climate-proofing it, should only be done if the 'Regular Infrastructure Investment Project' is deemed to be economically viable; in other words, the project should exhibit an ENPV > 0, as outlined in section 3.5.1.

To determine if a project should be climate-proofed, a detailed quantitative climate risk assessment should be conducted. The climate risk assessment, which is a continuation of the climate risk screening conducted at PCN, is conducted to determine the benefits of climate-proofing the project. The benefits of climate-proofing are the avoided impacts that climate change would cause if the project were not climate-proofed (i.e., the cost of repairing damaged infrastructure and the associated economic losses) if a climactic event such as a drought occurs. Box 5 provides an illustrative example. The benefits of climate-proofing a project should be

estimated based on the most likely climate change scenario, i.e., extreme scenarios such as highly pessimistic or optimistic should be disregarded. A common base case scenario should be developed based on the most likely evolution of climate change over a given period. This base case, climate change scenario, should be utilized consistently amongst projects from all sectors.

Box 5. Illustrative Example of Estimating the Benefits of Climate Proofing a Project

Climatic Change Risk:

- Gatsheni-Matopo is located in an area that is susceptible to droughts.
- Historical data shows that the chances of the occurrence of a drought are once every 10 years, i.e., 10%. Furthermore, each drought event leads to a decline in water resources. It is estimated that on average the farmers lose about 20% of their water resources during a drought.
- According to climate change models developed by climate specialists, the frequency of droughts in the area is likely to increase. It is anticipated that the probability of having a drought will increase to 15%, i.e., the risk of a drought will increase from once every 10 years to 1.5 times every 10 years. In addition, the severity of a drought is expected to increase, with farmers losing on average about 25% of their water resources in the event of a drought. Hence, the annual water resources in the area are likely to decreased by 3.75% per annum.

NPV of a Regular Project ($ million) (W)	NPV of a Regular Project Adjusted for the Impacts of Climate Change Risk ($ million) (Y)	PV of the Benefits of Averting Climate Change Impacts on the Project ($ million) (Z) = (W) – (Y)
ENPV = 34.81	ENPV = 26.93	ENPV = 7.88

Note:

a. All values in the table are expressed in real terms and discounted using an economic opportunity cost of capital (EOCK) of 12%.

Should Climate Proofing Options be explored?

Yes, climate proofing the project should be explored as the anticipated drought has negative impacts on the project. The benefits of climate-proofing the project are the averted impacts of climate change on the project. The project should be climate proofed if feasible and viable options are available.

3.5.3. Assessment of Options to Climate Proof a Project

The term 'Climate-Proofing' refers to the component or intervention added to the project to enable it to withstand a climate change related event. When it has been determined that climatic change has adverse impacts on the project, CAs should consider what can be done to reduce or minimize those impacts. A key consideration is the cost-effectiveness of various options to climate-proof the project. It should be noted that the benefits that will be derived from climate-proofing the project are unlikely to be technically and economically efficient to mitigate all the climatic risk (i.e., 100% of the risk) that the project is exposed to. Hence, in deciding which climate-proofing option effectively addresses the impacts of climate change on the project, CAs should ensure that the cost of any climate-proofing option does not exceed the benefits

that will be derived by adopting measures that alleviate the impacts associated with climate change.

Numerous interventions can be employed to climate-proof a water supply project; however, they can be group into two broad categories, that is;

a. Infrastructure interventions, and,
b. Non-Infrastructure interventions.

Box 6. Climate Proofing Irrigation Projects

- Changes in climate especially changes in rainfall patterns may impact irrigation infrastructure and disrupt agricultural water delivery services. Irrigation infrastructure comprises of an ecosystem of multiple components, such as water adduction, pumping stations, storage (e.g., reservoirs and dams), and water conveyance and distribution systems. Climate change may have an impact on one component, multiple components, or the entire system. Hence, one of the key elements of assessing the options of climate proofing an irrigation project is to determine which components of the water supply system are vulnerable to the expected changes in climate over the projects life.
- It is crucial to take into consideration agricultural activities and water demand growth into the assessment of climate proofing options. As the agricultural activity in the project area grows, demand for water will increase. Hence, climate proofing options will only be effective if they account for both the variability in weather patterns as well as water demand.
- Climate proofing measures should be developed in consultation with project beneficiaries to ensure that they are relevant and suitable enough for them to adapt to changes in climate.

Some examples of various types of infrastructure and non-infrastructure interventions are outlined in Table 7.

The technical design and cost of climate-proofing options should be obtained from engineers. They should be based on the likelihood and magnitude of climate change forecasted by climate experts during the project's economic life.

Climate-proofing the project will not eliminate all the impacts of climate change. In other words, the benefits of climate proofing the project should be adjusted to consider any unmitigated risk of climate change. After the project has been climate-proofed, the remaining impacts of a climatic change event are referred to as the "residual risk" of climate change. The residual risk is estimated based on the anticipated effectiveness of the climate-proofing options, as shown in the illustrative example below. The effectiveness of climate-proofing is determined by an engineer, given the most likely climate change scenario expected to occur over the project's economic life.

Table 7. Irrigation Climate Proofing Interventions

Climate Change Risk	Vulnerability to Climate Change	Climate Change Impact	Infrastructure Climate Proofing Options	Non-Infrastructure Climate Proofing Options
Increased precipitation, flooding, and cyclones	Damage to infrastructure	Potential failure of storage infrastructure such dams and reservoirs, which can lead to flooding of fields and settlements downstream.	• Adopt a higher design standard for infrastructure to take more frequent extreme weather events into consideration. • Design or adapt reservoir overflows and spillways to cope with larger flows and prevent failure.	• Update and disseminate evacuation procedures. • Increase the frequency with which emergency procedures are practised.
	Siltation of canals, pipes, and other water distribution infrastructure due to soil erosion	Reduced flow and uneven distribution of water in the area under irrigation.	• Construction of silt traps at strategic point to lower the amount of sediment in the distribution network.	• Educating framers not to cultivate crops close to canal and riverbanks. • Planting shrubs and other plants that hold soils together close to canals and riverbanks.
	Water logging	Potential damage and loss of crops.	• Build drainage systems on irrigated plots of land.	
Drought	Insufficient water to meet demand from farmers. Decreased water flow may lower levels in reservoirs and damage infrastructure or restrict use.	Water shortages and potential for water rationing and crop losses. Intermittent water supplies and pressure changes in the distribution network may damage irrigation infrastructure.	• Increase water storage capacity to provide supply over extended dry periods. • Invest in alternative water sources where possible, e.g., desalination, water harvesting and reuse infrastructure.	• Demand-side water management interventions to decrease water demand. These could include educating farmers on using water more efficiently or raising awareness of drainage and wastewater reuse.
	Fluctuating surface and groundwater levels may cause problems for infrastructure	Water intakes may be left exposed as water levels fall.	• Design water intake to accommodate varying water levels (for example, floating booms). River intakes strengthened to withstand more turbulent flows.	• Water resource monitoring and management of water abstraction to maintain water resources.

Box 7. Illustrative Example of Assessing Options to Climate Proof a Project

Climatic Change Risk:

- A drought especially a severe one will lead to insufficient water resources to meet the requirements for crop production.
- To climate-proof the Gatsheni-Matopo Irrigation Project an infrastructure intervention will be utilized. To ensure that there is enough water to meet the requirements for crop production all year round. Various dam storage capacities will be explored to identify the optimal water storage required to climate-proof the project from dry period as well as droughts.
- The table below shows the estimated costs and benefits of climate-proofing the project using the various dam storage capacities.

Climate Proofing Option	**PV Costs of Climate Proofing the Project ($ million)**	**PV Benefits of Climate Proofing the Project - *with no adjustments for residual risk* ($ million)** **(A)**	**Anticipated Effectiveness of each Climate Proofing Option in Mitigating Climate Change Risk (%)** **(B)**	**PV Benefits of Climate Proofing the Project - *adjusted for residual risk* ($ million)** **(C) = (A) * (B)**
Raising the height of the dam to provide an additional 2.5 million m3 of water	1.08	7.88	70%	5.51
Raising the height of the dam to provide an additional 5 million m3 of water	1.95	7.88	90%	7.09
Raising the height of the dam to provide an additional 7.5 million m3 of water	3.08	7.88	100%	7.88

Note: All values in the table are expressed in real terms and discounted using an economic opportunity cost of capital (EOCK) of 12%.

Additional Climate Proofing Measures?

In addition to the raising the height of the dam, the following non-infrastructure climate-proofing options to manage demand, when water resources are greatly impacted by a climate change event such as severe drought are:

a. Water resource monitoring and management of water abstraction to maintain water resources.
b. Education on efficient water use and reuse of drainage water.

3.5.4. Assessment of the Economic Viability of Climate Proofing a Project

The climate-proofed project's costs should be weighed against the residual risk-adjusted benefits to determine the economic feasibility and viability of climate-proofing a project. ENPV is used to measure the economic efficiency of Project B in addressing the impacts of climate change.

In determining the preferred climate-proofing option to implement, CAs should also take into consideration:

a. Technical feasibility,
b. Financial affordability,
c. Capacity and experience of the CA to implement the option,
d. Environmental impacts,
e. Legal implications.

Box 8. Illustrative Example of Assessing the Economic Viability of Climate Proofing a Project

Climate Proofing Option	PV Costs of Climate Proofing the Project ($ million) (A)	PV Benefits of Climate Proofing the Project - *adjusted for residual risk* ($ million) (B)	NPV of Climate Proofing Option ($ million) (C) = (B) – (A)
Raising the height of the dam to provide an additional 2.5 million m3 of water	1.08	5.51	4.44
Raising the height of the dam to provide an additional 5 million m3 of water	1.95	7.09	5.14
Raising the height of the dam to provide an additional 7.5 million m3 of water	3.08	7.88	4.79

Note: All values in the table are expressed in real terms discounted using an economic opportunity cost of capital (EOCK) of 12%.

3.5.5. Decision Making

As highlighted in the preceding sections, it is important to determine if both Project A (a regular infrastructure project "without" climate-proofing) and Project B (the climate-proofing option) are economically viable. When making decisions about projects based on the CBA methodology, the rule of thumb is that only projects that have a positive ENPV should be chosen as they are the ones that will add to the socio-economic welfare of a country. Even though tackling climate change is crucial to socio-economic welfare, climate-proofed projects should not be approved based on development objectives and political imperatives alone. They should be given the green light based on their economic efficiency in achieving targeted outcomes such as fostering socio-economic adaptation and resilience and mitigating climate change.

When there are multiple options to climate-proof the project, the preferred option should be the most effective and efficient in climate-proofing the project against climate change over its economic life. In other words, it should be the option that maximizes the ENPV of climate-

proofing. The decision criteria in the context of project exposed to and vulnerable to climate change are outlined in Box 9, and an illustrative example is provided in Box 10.

Box 9. Criteria for Decision Making in the Context of Climate Change

1. If **ENPV Project A < 0, do not proceed with the project.** In such a case, climate-proofing will not be explored as the project will not be implemented given that it is not economically viable.

2. If **ENPV Project A > 0**, and **ENPV Project B < 0, proceed with project A and not project B.** In such a case, climate-proofing is not a viable option as there are no technically and economically efficient climate-proofing options available. Therefore, the best course of action is to implement a regular infrastructure project that is not climate-proofed and deal with the impacts of climate change if and when they occur.

3. If **ENPV Project A > 0**, and **ENPV Project B > 0, proceed with project A and B**. In such a case, climate-proofing the project is a viable undertaking. Hence, the regular infrastructure project should be implemented with a climate-proofing component.

   Note:

   a. Project A refers to a regular infrastructure project that does not include a climate-proofing component.

   b. Project B refers to the climate-proofing option that will enable the project to withstand climate change impacts to a certain degree.

Box 10. Illustrative Example of Project Decision Making

NPV of a Regular Project – "without" climate proofing ($ million)	NPV of the Preferred Climate Proofing Option ($ million)	NPV of a Regular Project that is Climate Proofed ($ million)
26.93	**5.14**	**32.06**

Note: All values in the table are expressed in real terms discounted using an economic opportunity cost of capital (EOCK) of 12%.

Decision on the Project

- As **ENPV Project A > 0** and **ENPV Project B > 0,** the CA should proceed with Project A and B, as climate proofing the project is an economically viable undertaking.

Note:
a. Project A refers to a regular infrastructure project that does not include a climate-proofing component.
b. Project B refers to the climate-proofing option that will enable the project to withstand climate change impacts to a certain degree.

3.6. PFS Form for presenting the Preliminary Feasibility of a Project

Once the project's Pre-Feasibility Study has been conducted, it should be presented in a structured format using the PFS form. The structure, format, and data requirements of the PFS form are outlined in Annex C.

3.7. Assessment of PFS

The assessment of the PFS involves checking the robustness and effectiveness of the proposed project according to its ability to meet financial and socio-economic outcomes while adhering to national and sectoral objectives and goals in addressing the identified problem.

The assessment of the PFS consists of two phases. The first phase entails an internal assessment of the PFS by the Line Ministry. The internal assessment shall attempt to answer three questions:

1. Is the project consistent with National and Sectoral development strategies?
2. Out of a number of project alternatives, what is the preferred project alternative, and why is this the best strategy of addressing the identified problems?
3. Do the expected socio-economic benefits of the project exceed its economic costs?

Once the PFS has passed the internal screening, it should be submitted to the IMC through the MoFED for the second phase of the screening process. It should be noted that PFS submissions are made between March and April, according to the Public Investment Management and Budgeting Calendar defined in Article 129 of the PIM Guidelines.

The external assessment of the PFS by the IMC is a three-step process aimed at assessing the project's alignment with the Government's objectives and priorities. It also entails an evaluation of resource availability to fund the project with consideration of resource allocation to projects from other sectors vying for the same pool of resources. The three steps carried out in assessing the PFS are as follows:

i. The first stage is to assess the compliance of the CA with the submission process and other procedural requirements stipulated in the PIM Guidelines and this Manual. CAs are required to submit PFSs in compliance with the PFS form outlined in the PIM Guidelines (PIM Guidelines, Article 254). In case of missing information, the IMC may postpone the PFS pending the submission of complete information.
ii. At the second stage of the assessment, the IMC will assess the project's alignment with the National and Sectoral Strategic Objectives. Projects that are not in line with the National development strategies and sectoral development plans will get postponed. In exceptional cases, CAs may justify projects that are not directly aligned with the strategic development plans. Such cases, for instance, may include projects that are designed to mitigate force majeure situations, such as droughts, floods, earthquakes, Et cetera.
iii. The last stage involves the IMC assessing the affordability of the project as well as the likelihood of the expected economic benefits of the project exceeding the cost of resources.

The IMC's decisions on PFSs shall be issued in May-June. Only projects whose PFSs pass both the internal assessment by the CA and the external assessment by the IMC should be allowed to progress to the FS stage. PFSs approved by the IMC are valid for a period of three (3) years. Once a project's PFS expires, the project should be reappraised and resubmitted to the IMC for consideration following the internal and external screening processes described above.

4. FEASIBILITY STUDY (FS)

The Feasibility Study (FS) builds on a project's information developed at the PCN and PFS stages by providing information on different aspects of the project in greater detail. To provide insight into the project's feasibility, the FS should make use of primary data and where such data is not available studies should be undertaken to obtain accurate information about the project's costs and benefits. This data should replace the secondary and, or proxy data used to conduct the PFS. The FS should form a more accurate picture of the project's technical, financial and socio-economic prospects to aid decision-makers in allocating resources efficiently. The FS shall be undertaken by the project sponsor or outsourced to a third party in the case where, for example, the project sponsor lacks the technical capacity to do so.

4.1. Financial Modality of Public Investment

Article 364 of the PIM Guidelines stipulates three modalities of investment projects, such as Public Investment, Joint Venture, and Private-Sector Financing. The assessment of the financial modality of an investment project shall be made in line with Articles 388 and 389 of PIM Guidelines. Projects proposed as JVs shall follow the provisions of the JV Act and corresponding regulations.

4.2. Environmental and Social Impact Assessment

The FS of a water supply project should include an Environmental and Social Impact Assessment (ESIA) study, which should identify and quantify the potential environmental and social impacts of a proposed project. This should be done by updating the preliminary ESIA conducted at the PFS stage with the changes made to the FS based on new and more accurate project data.

4.2.1. Environmental Impact Assessment

Environment Management Act (EMA), 13 of 2002, exists to provide for the sustainable management of natural resources and protection of the environment. It also provides a guide regarding what the Environmental Impact Assessment (EIA) is and how it should be conducted. The EMA defines EIA as an evaluation of a project to determine its impact on the environment and human health and to set out the required environmental monitoring and management procedures and plans.

According to the EMA, a project's EIA report should:

1. Give a detailed description of the project and the activities to be undertaken in implementing it,
2. State the reasons for selecting the proposed site of the project,
3. Give a detailed description of the likely impact the project may have on the environment or any segment thereof, covering the direct, indirect, cumulative, short-term and long-term effects of the project,

4. Specify the measures proposed for eliminating, reducing or mitigating any anticipated adverse effects the project may have on the environment, identifying ways of monitoring and managing the environmental effects of the project,
5. Indicate whether the environment of any other country is likely to be affected by the project and any measures to be taken to minimize any damage to that environment,
6. Have an analysis of the biodiversity impacts of the project, land tenure system, soil, as well as hydrology, and;
7. Attachments of soil, hydrological and topographical maps, and make an analysis of the impacts of the project to the current environmental baseline.

When conducting an EIA, public consultations should be made with LMs, certain departments at Local, District, Provincial and National level. These consultations should also include other institutions related to the project as well as neighbouring land users.

An Environmental Management Plan, which outlines how the project will manage and mitigate any adverse impacts the project may have on the environment, should be submitted to the Treasury during the FS stage. Table 8 below displays how the plan should be presented.

Table 8. Biophysical Environment Management Plan (Sample)

Impact Statement	Process/Activity responsible for impact	Proposed Mitigation on impact	Monitoring and Management Agency	Management and Monitoring activities	Time frame	Budget

An EIA certificate for the project should be obtained from the Director-General at the FS stage. The certificate should be attached as an annex to the submission of the FS. It is important to note that this certificate is valid for only two years with the possibility of an extension if deemed necessary; otherwise, the whole EIA process will have to be redone.

4.2.2. Social Impact Assessment

The social impact assessment (SIA) is carried out to understand the possible social and cultural impacts of the proposed project. The SIA should disaggregate the impacts to reflect how certain groups within society are affected. Impacts should be disaggregated along the lines of gender, income groups and other relevant demographics such as age and sex of the head of the household.

SIA is the process of managing the social issues associated with a project. Unlike the EIA, the SIA focuses on social considerations rather than biophysical issues. Social impacts start even before the construction of a project. The following steps are taken during an SIA:

1. Understanding the issues:

    a. Forecasting the social changes that may result from the project,

b. Stakeholder consultations, and;
c. Community assets and aspirations scoping.

2. Predicting and assessing likely impacts:

    a. Collaborative selection of sustainability and impact indicators,
    b. Baseline indicator data collection,
    c. Impact significance determination,
    d. Social and economic development opportunities assessment,
    e. Establishing the significance of the predicted changes and determining how the various affected groups and communities will likely respond, and;
    f. Identifying ways to mitigate negative impacts and capitalize on the positive impacts.

3. Developing monitoring and mitigation strategies:

    a. For the negative impacts, develop mitigation strategies, and;
    b. Monitor in case new unpredictable impacts arise.

4.3. Climate Risk Assessment

The assessment of projects at the FS stage of the project cycle consists of three steps.

i. The reassessment of a regular Infrastructure investment project's economic viability using primary data and detailed cost estimates.
ii. The reassessment of the economic viability of the preferred climate-proofing option.
iii. Decision making.

4.3.1. Reassessment of the Economic Viability of a Regular Infrastructure Investment Project

Box 11. Illustrative Example – Reassessment of the Economic Viability of a Regular Infrastructure Investment Project

Based on technical studies and a final design conducted at FS, the irrigation project is expected to have a capital cost of $ 35 million and annual O&M costs of $ 2 million. The project is anticipated to produce benefits of $ 10.94 million per annum, which consist of improved productivity of crop production.

NPV of a Regular Project "without" climate proofing ($ million)
(Y)
ENPV = 26.93

Note: All values in the table are expressed in real terms discounted using an economic opportunity cost of capital (EOCK) of 12%.

Only projects that exhibit a positive ENPV after reassessment based on updated cost and benefits should be considered for climate proofing.

4.3.2. The Reassessment of the Economic Viability of the Preferred Climate-Proofing Option

Box 12. Illustrative Example – Reassessment of the Economic Viability of the Preferred Climate Proofing Option

- The preferred climate proofing option identified at the PFS stage is reassessed at FS based on updated climate change models and cost and benefit estimates of climate proofing the project.
- Final technical studies and designs conducted at FS indicate that while the benefits of climate-proofing the project will not change, its cost is 10% greater than anticipated at the PFS stage. Hence instead of costing $ 1.95 million, climate proofing the project will require, $ 2.15 million.

Preferred Climate Proofing Option	**PV Costs of Climate Proofing the Project ($ million)** **(A)**	**PV Benefits of Climate Proofing the Project – with no *adjustment for residual risk* ($ million)** **(B)**	**Anticipated Effectiveness of the Preferred Climate Proofing Option in Mitigating Climate Change Risk** **(C)**	**PV Benefits of Climate Proofing the Project – *adjusted for residual risk* ($ million)** **(D) = (B) * (C)**	**NPV of the Preferred Climate Proofing Option ($ million)** **(E) = (D) – (A)**
Raising the height of the dam to provide an additional 5 million m3 of water	**2.14**	**7.88**	**90%**	**7.09**	**4.95**

Note: All values in the table are expressed in real terms discounted using an economic opportunity cost of capital (EOCK) of 12%.

4.3.3. Decision Making

Once Project A and B have been reassessed at the FS stage using updated cost and benefit data, a decision should be made on whether to implement the project based on the criteria outlined in Box 13.

Box 13. Illustrative Example of Project Decision Making

NPV of a Regular Project "without" climate proofing ($ million)	NPV of the Preferred Climate Proofing Option ($ million)	NPV of a Regular Project that is Climate Proofed ($ million)
26.93	**4.95**	**31.88**

Note: All values in the table are expressed in real terms discounted using an economic opportunity cost of capital (EOCK) of 12%.

Decision on the Project

- As **ENPV Project A > 0** and **ENPV Project B > 0,** the CA should proceed with Project A and B, as climate proofing the project is an economically viable undertaking.
- **Note:**
- a. Project A refers to a regular infrastructure project that does not include a climate-proofing component.
- b. Project B refers to the climate-proofing option that will enable the project to withstand climate change impacts to a certain degree.

4.4. Monitoring, Review, Reporting, and Action Plan

4.3.1. Monitoring, Review, and Reporting

As stipulated by the National Monitoring and Evaluation (M&E) Policy[10], it is the role of the Line Ministries, local authorities and public entities to develop and implement Monitoring Plans and to disseminate periodic reports. The Line Ministry must specify the frequency of the monitoring and reporting cycle. The PIM Guidelines outline the need for well-designed and realistic key performance indicators (KPIs), as agreed by all key stakeholders. These indicators should clarify the project's intentions and should aid in the assessment of achievements.

The LM should use Monitoring Plans to keep track of how the project is aligned to and achieves its objectives; a monitoring plan is a key instrument during the project's implementation stage. Its purpose is to determine if the outcome and outputs have been realized so that action can be taken to correct any failures or delays as quickly as possible.

It is important to develop an M&E plan before beginning any monitoring activities so that there is a clear plan for what questions about the project are to be answered. It will help the program staff decide how they are going to collect data to track KPIs, how monitoring data will be

[10] Government of Zimbabwe. (2015). *National Monitoring and Evaluation Policy.* Harare

analysed, and how the results of data collection will be disseminated to various stakeholders. The M&E plan will help make sure that data is being used efficiently to make programs as effective as possible and to be able to report on results at the end of the program.

Steps to develop an M&E Plan include:

1. Identify project goals and objectives.
2. Determine what KPIs to track, some of the most important and useful KPIs are:

    a. Process indicators: are used to track the progress of the project. They help to answer the question, “Are the project’s activities being implemented as planned?”
    b. Outcome indicators: are used to track how successful the project activities have been in terms of achieving the project’s objectives. They help to answer questions like, “Have project activities made a difference to the beneficiaries? Are farmers' livelihoods improved? , Are rural households food secure? Are gender inequality issues addressed? The outcome indicators should be specific, and wherever possible, they should be disaggregated by gender, income groups, ethnic groups and other groups within the socio-economic context.

3. Define data collection methods and timelines: After creating monitoring indicators, it is time to decide on the methods for gathering data and how often various data will be recorded to track the project’s KPIs. Project KPIs should be determined based on discussions between program staff and various stakeholders. These discussions will have significant implications for what data collection methods will be used and how the results will be reported.

4. Identify M&E roles and responsibilities: Line Ministries should identify stakeholders responsible for monitoring the delivery of project outputs. It is important to decide from the early planning stages the parties responsible for collecting the data for each indicator. Data management roles should be decided with input from the key stakeholders so that all parties are on the same page and know which indicators they are assigned.

5. Plan for Report Dissemination: The last element of the M&E plan describes how often and to whom data will be disseminated. Line Ministries must spell this out guided by the National M&E Policy

4.3.2. Action

The Monitoring, Review, Reporting, and Action Plan should also include a section that lists the steps needed to achieve the project’s goals and objectives. It should clarify and break down the resources and timeline for each activity required to reach the project’s goals and objectives. An action plan makes it possible to monitor the project’s progress and take each activity step-

by-step, therefore allowing for efficient project handling. The advantage of doing this is to enable the LM to execute a structured plan for the end goal that they intend to achieve. Moreover, it provides the team with appropriate foundations, therefore prioritising the amount of time to be spent on each activity. An action plan will also help redirect the project when it deviates from its intended targets during the implementation stage.

The action plan section should also include a list of actions or changes to be brought about in the community. Each action or change to be sought should consist of the following information:

- **What** actions or changes will occur?
- **Who** will carry out these changes?
- **By when** they will they take place, and for how long?
- **What** resources (i.e., funds, personnel) are needed to carry out these changes?
- **Communication**, who should know what?

4.4. Project Governance Structure Plan

The project governance structure is the framework through which the project is managed. Good project governance sets the direction the project will take and ensures that the correct decisions are taken pursuant to the project's goals and objectives.

To ensure the success of the project, a comprehensive assessment of the project's organizational structure should be made that includes the following key components;

a. Project management: who will have overall accountability and responsibility for managing the project? The project's officers and team, as well as their allocated roles within the project, should be outlined,
b. Human resource requirements: the capacity and skills of the project team as well as technical advisors is a key consideration in ensuring the project is successfully delivered, and;
c. Project management strategies during the investment and post-investment phases of the project.

Furthermore, issues of gender should be addressed with regards to the overall gender balance of the project team as well as in key decision-making processes.

A description of the project's main participants should also be assessed, taking into consideration the following issues:

a. The scope of interaction amongst project participants,
b. The role, function and responsibility of each of the project participants (as illustrated in Table 9), and;
c. The distribution of benefits and costs between project beneficiaries and other stakeholders.

Table 9. Project's Institutional Scheme

#	Project Participant	Information about the project participant	Functions of the project participant	Responsibility of the project participant
1.	Line Ministry			
2.	Contracting Authority			
3.	Project Assets' Holder			
4.	Project Operator			
5.	Project Participant			

4.5. Project Implementation Plan

As part of the FS, a proposal that outlines how the project will be implemented should be included. The implementation plan should delineate the scheduled timing of the activities within each phase of the project's implementation plan and should be accompanied by the relevant cost schedules. The successful implementation of the project is subject to the availability of resources required to undertake the project. Therefore, the implementation plan should ensure that the financial, human and input resources required to execute the project are adequately available. Consideration should be given to contractual structures such as supply contracts and forward and futures contracts to secure key inputs. Additionally, secondary sources of all resources must be identified to guard against the inability of primary sources to meet the project's needs. The implementation plan should also outline how the implementation process will be managed by assigning responsibilities to the parties most suitable to carry out the given role. Lastly, a proposal must be provided on how the project's progress will be monitored and evaluated; this should include the KPIs that will be used to measure performance and overall progress against a set of objectives and targets.

4.6 FS Form for presenting the Feasibility of a Project

Once the project's Feasibility Study has been conducted, it should be presented in a structured format using the FS form. The structure, format, and data requirements of the FS form are outlined in Annex C.

4.7 Assessment of FS

The assessment of the FS involves checking the robustness and effectiveness of the proposed project according to its ability to meet financial and socio-economic outcomes while adhering to national and sectoral objectives and goals in addressing the identified problem.

The assessment of the FS consists of two phases. The first phase entails an internal assessment of the FS by the Line Ministry. The internal assessment shall attempt to answer three questions:

1. Is the project consistent with National and Sectoral development strategies?

2. Is the proposed solution technically optimized?
3. Do the expected socio-economic benefits of the project exceed its economic costs?

Once the FS has passed the internal screening, it should be submitted to the IMC through the MoFED for the second phase of the screening process. It should be noted that FS submissions are made in July, according to the Public Investment Management and Budgeting Calendar defined in Article 129 of the PIM Guidelines.

The external assessment of the FS by the IMC is a three-step process aimed at assessing the project's alignment with the Government's objectives and priorities. It also entails an evaluation of resource availability to fund the project with consideration of resource requirements from projects in other sectors vying for the same pool of resources. The three steps carried out in assessing the FS are as follows:

i. The first stage is to determine the compliance of the CA with the submission process and other procedural requirements stipulated in the PIM Guidelines and this Manual. CAs are required to submit FSs in compliance with the FS form outlined in the PIM Guidelines (PIM Guidelines, Article 322). In case of missing information, the IMC may postpone the FS pending the submission of complete information.

ii. At the second stage of the assessment, the IMC will assess the project's alignment with the National and Sectoral Strategic Objectives. Projects that are not in line with the National development strategies and sectoral development plans will get postponed. In exceptional cases, CAs may justify projects that are not directly aligned with the strategic development plans. Such cases, for instance, may include projects that are designed to mitigate force majeure situations, such as droughts, floods, earthquakes, Et cetera.

iii. The last stage involves the IMC assessing the technical feasibility of the project, the affordability of the project as well as the likelihood of the expected economic benefits of the project exceeding the cost of resources.

The IMC's decisions on FSs shall be issued between August and September. Only projects whose FSs pass both the internal assessment by the CA and the external assessment by the IMC should be selected for inclusion in the National Budget. FSs approved by the IMC are valid for a period of three (3) years. Once a project's FS expires, the project should be reappraised and resubmitted to the IMC for consideration following the internal and external screening processes described above.

ANNEX A: PROJECT CONCEPT NOTE FORM

Item	Project Information Required
Project Identification (ID)	Insert the project identification number. The identification number should be unique and should include up to 5 alphabetic letters to identify the Contracting Authority, followed by a numerical sequence.
Line Ministry	Insert the Line Ministry functionally responsible for the project.
Contracting Authority	Insert Contracting Authority responsible for the project.
Project Title	Provide a short and succinct project title, capturing the essence of the project.
Location	Provide the project location including the Province and District .
Project Objective	Provide clear sentence to describe the direct benefit of implementing the project. Think of the fundamental reason the project is being proposed — examining immediate change or overall result. **Do not** provide project details here that can be described elsewhere on the Form.
Status before Project	**Briefly** describe the current situation (that is, without the project), using concrete and factual data.
Status after Project	**Briefly**, describe how the current situation will be affected if the project is implemented. Use specific and accurate data.
Justification	Justify the reason for undertaking the project in less than 250 words. Justification is done by comparing anticipated results and expected costs.
Alignment with National Development Strategies	Results-based management requires Ministries to agree on policy objectives and key result areas, which are then included in the Budget. How is the project aligned with Government policy objectives? Which Government strategic objectives does the project address, and how does it do so?
Alignment with Sector Strategies	Provide a detailed description of how the project links to and supports key sector policy objectives and key Ministry Strategic policy objectives.
Alignment with Provincial and District Development Plan Objectives supported by the Project	Will the project have an impact at the provincial and district levels? If so, what consultations have taken place with provincial and district stakeholders?
Alignment with Climate Change Objectives	Highlight how the project is expected to contribute to climate change adaptation, resilience or mitigation objectives outlined in the national development plans and strategies as well as the NDCs.
Other Strategic Considerations	Does the project fit with national security considerations? Could it prevent or mitigate a national disaster (for example an epidemic)?
Total Capital Cost	Include the preliminary estimates of the project's total capital costs.
Operations and Maintenance Cost	Include anticipated annual operations/maintenance expenditures.
Sources of Project Funds	Indicate the internal project promoter funds, Government budget funds, private sector funds and borrowing.
Funds required to conduct Pre-Feasibility Analysis	Indicate the funding required to complete the Pre-Feasibility analysis of the project.

Item	Project Information Required
Outcomes (expected)	List all **expected outcomes** resulting from the project. Outcomes should be a direct result of the project outputs.
Outputs (expected)	List all **expected outputs** to be directly delivered by the project (that is, the direct result of project activities. See below). Outputs should be within or just within the Government agency's control. List all **anticipated results** (that is, those that will remain once the project has ended).
Main Activities	List the main project activities associated with the delivery of outputs. Activities should be listed **in a logical order** and **numerically linked** to outputs to facilitate an assessment of whether the proposed activities can realistically produce the expected outputs.
Implementation Plan:	Provide a technically optimum implementation plan. The construction schedule should also specify funds required for each phase and propose sources of funding.
Financial Effectiveness	Indicate if the project is expected to result in financial revenues.
Socio-economic Effectiveness	Provide an initial demand forecast. A clear linkage should be made to the project justification as well as to the output and outcomes sections.
Preliminary Environmental and Social Impact Assessment	Not Applicable
Risk Analysis	Outline the project's key risks and their direct or indirect impact(s) on the project and its beneficiaries and were possible outline measures to mitigate or manage those risks.
Climate Risk Screening	Does climate change impose a high degree of risk to the project? Is the project located in an area prone to climate change related events? Do climate change scenarios suggest that these events' frequency and/or severity is likely to increase? What will be the implications, including the cost of infrastructure rehabilitation, cost of service disruptions both to the project and the service users?
Other Studies	Not Applicable
Sources of Information	List primary sources of information used to derive alignment with strategic policies, preliminary project costs, demand projections and other information used in the preparation of Project Concept Note Form. Provide references to support key assumptions.

ANNEX B: PREFEASIBILITY STUDY FORM

Item	Project Information Required
Project ID	Insert project identification number. The identification number should be unique and should include up to 5 alphabetic letters to identify the Contracting Authority followed by a numerical sequence.
Line Ministry	Insert Line Ministry functionally responsible for the project.
Contracting Authority	Insert Contracting Authority responsible for the project.
Project Title	Provide a short and succinct project title, capturing the essence of the project.
Location	Provide the project location including the Province and District.
Project Concept Decision and Date	Insert the decision number for the project concept. Enter the project concept decision date.
Project Objective	Describe the direct benefit of implementing the project. Think of the fundamental reason the project is being proposed — examining immediate change or overall result. **Do not** provide project details here that can be described elsewhere on the Form.
Status before Project	**Briefly** describe the current situation (that is, without the project), using specific and factual data.
Status after Project	**Briefly**, describe how the current situation will be affected if the project is implemented. Use specific and factual data.
Justification	Justify the reason for undertaking the project in less than 250 words. The project should comply with all regulations and have positive socio-economic returns.
Alignment with National Development Strategies	Results-based management requires Ministries to agree on policy objectives and key result areas, which are then included in the Budget. How is the project aligned with Government policy objectives? Which Government strategic objectives does the project address, and how does it do so?
Alignment with Sector Strategies	Provide a detailed description of how the project links to and supports key sector policy and Ministry strategic policy objectives (see Ministerial preambles in the Estimates of Expenditure Book).
Alignment with Provincial and District Development Plan Objectives Supported by the Project	Will the project have an impact at the provincial anddistrict levels? If so, what consultations has taken place with provincial and district stakeholders?
Alignment with Climate Change Objectives	Highlight how the project is expected to contribute to climate change adaptation, resilience or mitigation objectives outlined in the national development plans and strategies as well as the NDCs.
Other Strategic Considerations	Does the project align with national security considerations? Could it prevent or mitigate a national disaster (for example, a drought or an epidemic)?
Total Capital Costs	Update estimates to the project's total capital costs. The estimates of the project's total capital cost should be **as accurate as possible**. Please provide the source of information and justification for the amount stated.
Operating and Maintenance Cost	Anticipated annual operating and maintenance expenses.
Sources of Project Funds	Indicate funding source such as project promoter funds, Government budget funds, private sector, borrowing.

Item	Project Information Required
Funds Required to Conduct Feasibility Study	Indicate the funding needed to complete the feasibility analysis of the project. A compelling case should be made if the funding requirement exceeds 3 percent of the total capital cost.
Outcomes (expected)	List all **expected outcomes** resulting from the project. Outcomes should be a direct result of the project outputs.
Outputs (expected)	List all **expected outputs** to be directly delivered by the project (that is, the direct result of project activities. (See below). Outputs should be within or just within the Government agency's control. List all **anticipated results** (that is, those that will remain once the project has ended).
Main Activities	List the main project activities associated with the delivery of outputs. Activities should be listed **in a logical order** and **numerically linked** to outputs to facilitate an assessment of whether the proposed activities can realistically produce the outputs expected.
Implementation Plan	Provide a technically optimal project implementation plan. The implementation plan should also specify funds required for each phase and propose sources of funding. Provide output and activity schedule (Gantt chart) indicating the timing, sequencing, and dependencies for all activities.
Financial Effectiveness	Indicate the financial rate of return and the financial net present value.
Socio-economic Effective- ness	Indicate the economic rate of return and the economic net present value.
Fiscal Effectiveness	Indicate the annual nominal net fiscal impact and the present value of net fiscal impact over the project's life.
Risk Analysis	Outline the project's key risks and their direct or indirect impact(s) on the project and its beneficiaries and were possible outline measures to mitigate or manage those risks.
Results of Preliminary Environmental and Social Impact Assessment	Provide a summary (less than 500 words) of the results of the Environmental and Social Impact Assessment.
Climate Risk Assessment	Provide a summary (no more than 500 words) outlining the results of the climate risk assessment. The assessment should provide an indication of whether the project should be climate proofed.
Climate Proofing	Provide a summary of the proposed climate proofing option(s) including: a. The estimated capital cost of each option. b. The benefits of each option with respect to reducing the impacts of climate change. c. A summary of the socio-economic viability of the option(s). d. Indication and justification of the preferred climate proofing option.
Procurement Plan	Draft project procurement methods — open tender, closed tender, direct purchases — for all project goods and services (with due attention to any Government thresholds). Include a schedule (Gantt chart) detailing principal procurement deadlines.
Other Studies Conducted	List and provide a summary of results of other studies carried out with regards to the project.
Sources of Information	List primary sources of information used to derive alignment with strategic policies, preliminary project costs, demand projections and other information used in the preparation of Project Concept Note Form. Provide references to support key assumptions.

ANNEX C: FEASIBILITY STUDY NOTE FORM

Item	Project Information Required
Project ID	Insert the project identification number. The identification number should be unique and should include up to 5 alphabetic letters to identify the Contracting Authority, followed by a numerical sequence.
Line Ministry	Indicate the Line Ministry functionally responsible for the project.
Contracting Authority	Indicate the Contracting Authority responsible for the project.
Project Title	Provide a short, succinct title, capturing the essence of the project.
Location	Provide project location including the Province and District.
Project Pre- feasibility Study Decision and Date	Insert decision number for the project Pre-Feasibility Study. Enter project PFS decision date.
Feasibility Analysis Completion Date	Indicate the completion date, day/month/year (dd/mm/yyyy)
Project Objective	Describe the direct benefit of implementing the project. Think of the fundamental reason the project is being proposed — examining immediate change or overall result. **Do not** provide project details here that can be described elsewhere on the Form.
Status before Project	Describe the current situation (that is, without the project), using specific and factual data.
Status after Project	Describe how the current situation will be affected if the project is implemented. Use specific and factual data.
Justification	Justify the reason for undertaking project. The project should comply with all regulations and have positive socio-economic returns.
Alignment with National Development Strategies	Results-based management requires Ministries to agree on policy objectives and key result areas, which are then included in the Budget. How is the project aligned with Government policy objectives? Which Government strategic objectives does the project address, and how does it do so?
Alignment with Sector Strategies	Provide a detailed description of how the project links to and supports key sector policy and Ministry strategic policy objectives (see Ministerial preambles in the Estimates of Expenditure Book).
Alignment with Provincial and District Development Plan Objectives Supported by the Project	Will the project have an impact at the provincial and district levels? If so, what consultations has taken place with provincial and district stakeholders?
Alignment with Climate Change Objectives	Highlight how the project is expected to contribute to climate change adaptation, resilience or mitigation objectives outlined in the national development plans and strategies as well as the NDCs.
Other Strategic Considerations	Does the project align with national security considerations? Could it prevent or mitigate a national disaster (for example, a drought or an epidemic)?
Total Capital Costs	Provide final estimates of the project's total capital costs. The estimates of the project's capital costs should be **as accurate as possible**. Copies of engineering drawings and costing should also be submitted.
Operating and Maintenance Cost	Indicate the optimal annual operations and maintenance expenditures.
Sources of Project Funds	Indicate sources of project funding such as internal Contracting Authority funds, Government budget funds, the private sector and borrowing among others.
Outcomes (expected)	List all **expected outcomes** resulting from the project. Outcomes should be a direct result of the project outputs.

Item	Project Information Required
Outputs (expected)	List all **expected outputs** to be directly delivered by the project (that is, the direct result of project activities. See below). Outputs should be within or just within the Government agency's control. List all **anticipated results** (that is, those that will remain once the project has ended).
Main Activities	List the main project activities associated with the delivery of outputs. Activities should be listed **in a logical order** and **numerically linked** to outputs to facilitate an assessment of whether the proposed activities can realistically produce the expected outputs.
Implementation Plan	Provide a technically optimal project implementation plan. The implementation plan should also specify funds required for each phase and propose sources of funding. Provide output and activity schedule (Gantt chart) indicating the timing, sequencing, and dependencies for all activities.
Financial Effectiveness	Indicate financial rate of return and financial net present value.
Economic Effectiveness	Indicate economic rate of return and economic net present value.
Fiscal Effectiveness	Annual nominal net fiscal impact. Present value of net fiscal impact over the project's life.
Risk Analysis	A comprehensive risk analysis shall be conducted at this stage. Whenever possible additional data should be collected to better measure the risk. At this stage implementing agencies are encouraged to use entire range of techniques, such as, sensitivity analysis, decision trees, and risk simulation software.
Proposed Financing Modality of Public Investment	Specify the financing mode, for example public investment project or joint venture.
Environmental and Social Impact Assessment	Provide a summary (less than 500 words) of the results of Environmental and Social Impact Assessment including the Environmental and Social Management Plan.
Climate Risk Assessment	Provide a summary (no more than 500 words) outlining the results of the climate risk assessment. The assessment should provide a climate risk mitigation/management plan.
Climate Proofing	Provide a summary of the preferred climate-proofing option, including: a. The final cost estimates. b. The final estimation of the benefits of climate-proofing the project. c. The socio-economic viability of the climate-proofing option.
Procurement Plan	Indicate project procurement methods — open tender, closed tender, direct purchases — for all project goods and services (with due attention to any Government thresholds). Include a schedule (Gantt chart) detailing principal procurement deadlines.
Monitoring, Review, Action and Reporting Plan	The Line Ministry shall identify stakeholders responsible for monitoring outputs delivery and specify the frequency of the monitoring and reporting cycle. Outline the roles and responsibilities of the ministerial project board, project manager and executing agency. Consider developing a monitoring framework, including indicators of project progress/success, as agreed by all parties.
Project Governance Structure Plan	Provide details of the party responsible for project management within the applicant line ministry/department/agency. (If there will be a project steering committee, provide details of the proposed membership.)
Other Studies	List and provide a summary of results of other studies carried out with regard to the project.

ANNEX D: TYPES OF IRRIGATION PROJECTS AND TECHNOLOGIES

D1: Types of Irrigation Projects

Small Scale Irrigation Projects

Small irrigation schemes are designed for small communities, and they benefit smallholder and subsistence farmers. The area under irrigation in the case of small irrigation projects is below 2,000 Ha, and the source of water is either groundwater, wells, or surface water. The water is delivered to farmlands using pumps or gravity flow in the case where the water is stored in tanks. Small scale irrigation projects are usually managed a water users' group, who oversee the operation and maintenance activities of the irrigation scheme.

Medium Scale Irrigation Projects

Medium-scale irrigation projects cover a Culturable Command Area (CCA) of between 2,000 and 10,000 hectares. They usually consist of a multipurpose surface water storage facilities such as a reservoir, flow diversion and distribution network system such as canals or pipes.

Large Scale Irrigation Projects

Large scale irrigation projects cover a CCA of more than 10,000 hectares. They usually consist of large irrigation systems with formal management structures. Large scale irrigation projects are typically accompanied by a large reservoir, flow diversion structures such as a dam and an extensive distribution network such as canals and pipes. The reservoir or dam are usually multipurpose and can be used for various purposes such as flood control or the generation of electricity. However, large scale irrigation projects also come with a host of socio-environmental issues such as the displacement of communities, siltation, erosion and, in some instances flooding.

Although large scale irrigation projects have high costs, they usually have a high return per hectare of irrigated land and provide numerous benefits such as an extensive water supply and distribution networks, increased agricultural productivity as well as the ability to generate energy.

D2: Types of Irrigation Technologies

Sprinkler Irrigation Systems

Sprinkler irrigation is a type of irrigation system where the water is applied to the soil in a form similar to rain. Sprinkler irrigation systems use rotating sprinklers, with each sprinkler applying water to a given area depending on the size of the sprinkler and nozzle as well as the water pressure. Sprinkler irrigation systems are particularly suitable for water-scarce areas, hilly slopes, and easily erodible soils. There are two main types of sprinkler irrigation systems, namely a rotating head system and a perforated pipe system. The rotating head system consists of small-sized nozzles placed on riser pipes fixed at uniform intervals along the length of lateral pipes. The nozzle of the sprinkler rotates due to a small mechanical arrangement which utilizes the thrust of flowing water. The perforated pipe system consists of holes perforated in the lateral irrigation pipes in a specially designed pattern to distribute water uniformly. The spray emanating from the perforations is directed on both sides of the pipe and can cover a strip of land from 6 m to 15 m wide.

Benefits of Sprinkler Irrigation Systems

- Water-savings, water is applied to a specific area, eliminating losses
- Suitable for varying sizes of land (both small and big size)
- Ability to administer fertilizers and chemicals through the system for even distribution
- Labour savings, less labour is required during operation and maintenance as compared to other irrigation systems
- Suitable for all types of topography

Costs of Sprinkler Irrigation Systems

- Investment costs, i.e., equipment and associated infrastructure
- Operation and Maintenance expenditures
- Labour costs
- Power costs
- Capacity building costs these include the training of farmers on how to use the sprinkler to ensure the efficiency of the system

Surface Irrigation Systems

Surface irrigation systems move water across the farmlands. Surface irrigation systems can be sub-divided into three types; furrow, border and flood or basin irrigation systems.

Furrow irrigation is the type of irrigation where the water is funnelled into small furrows between rows of crops. The water is absorbed into the bottom and sides of the furrows to wet the soil.

Border Irrigation is the type of irrigation where the water is allowed to flow down a gentle slope. The water flows down until there is enough in one area of land and the water flow tips over the border that divides the bottom of one piece of land and the top end of the other. The water flow is stopped once the desired amount of water has been delivered.

Basin Irrigation is a type of irrigation system were an area of land is irrigated by surrounding the land with embarkments to form a basin, which is then flooded with water. The water in a basin continues to percolate into the soil even after the stream water has been turned off. An irrigation basin usually has a length of 50 meters and width, ranging from 7 to 50 meters depending on the soil texture and size of the field.

Benefits of Surface Irrigation Systems

- Requires less manual labour as compared to hose spraying or shifting hose sprinklers
- Covers a large plot of land in a shorter amount of time
- Not as negatively influenced by winds or sediments as other irrigation systems

Costs of Surface Irrigation System

- Labour costs

- Operation and maintenance costs
- Supervision costs
- Cost of the equipment

Drip Irrigation Systems

Drip irrigation systems apply water directly to the root system of the plant. Pipes with perforated holes are buried just below the surface, and a dripper lets out a drop of water at a time. A drip irrigation system comprises of the following elements; mainline, sub-mains, laterals, valves which control the flow of water, drippers that ensure the supply of water directly to the soils, pressure gauges, water meters, filters, pumps, and pressure regulators. It is broadly divided into two components; the water acquisition component which acquires water from the source and delivers it to the field and the water distribution component which controls the supply and distribution of water within the fields as well as its application to the plants.

Benefits of Drip Irrigation Systems

- Saves water by eliminating surface water evaporation in hot and arid conditions as water is applied directly to the roots of the plants
- Reduces weed growth because water is only delivered where it's needed
- Helps to prevent fungal diseases by minimizing water contact with the leaves, stems and fruits of the plants
- Input cost savings. The use of Drip irrigation can reduce pumping costs due to the low water pressure and volume of water required and the reduced losses of chemicals and fertilizers
- Saves time, money, and labour costs since the system is so efficient

Costs of Drip Irrigation System.

- Labour costs
- Operation and maintenance costs

D3: Selecting an Irrigation System

When selecting an irrigation system, consideration should be given to the following issues; the source of water (ground or surface water), the topography of the area where the irrigation system will be set up, the type of soil, climate, types of crops to be grown, the investment and operating and maintenance expenditures and the irrigation system's socio-economic and environmental impacts. An assessment of the factors listed above would ensure that the appropriate irrigation system would be chosen, one that is appropriate to the farmers' needs as well as one that is financial and economically viable and sustainable.

D4: Water Sources for Irrigation

Water sources for an irrigation system are; surface water and ground water. Surface water includes rivers, streams, ponds and lakes, while groundwater includes aquifers, springs and wells.

Despite the source of water the irrigation scheme in question, an assessment should be made with respect to the quality of the water (its suitability for crop production and livestock rearing) and the quantity of that water (to determine if there is enough water to meet the demand for a prolonged period). Additionally, an assessment should also be made with respect to water rights and availability during peak irrigation seasons.

D5: Construction of Dams and Reservoirs for Use Irrigation Projects

Use Cases for Dams and Reservoirs

Dams provide a range of economic, environmental and social benefits. Dams and Reservoirs are primarily used to serve four functions specific function as outlined below;

a) **Flood Control**: In addition to helping farmers, dams help prevent the loss of life and property caused by flooding. Dams and reservoirs are effective flood protection mechanism and can be used to maintain water levels in a river.

b) **Water Storage**: Dams create reservoirs that supply water for various purposes, including industrial, municipal, and agricultural activities.

c) **Irrigation**: The withdrawal and use of water from reservoirs to meet the needs and requirements for crop production and livestock rearing is essential in sustaining livelihoods and growing economies.

d) **Energy Generation**: Dams are used to generate hydroelectricity, which improves the living standards of the community and allows businesses and industries to be productive.

Costs of Dam and Reservoir Construction for Irrigation

- Capital costs: these include the costs that will be incurred in planning, designing, and constructing irrigation infrastructure, as well as purchasing any necessary equipment
- Apart from capital costs, the irrigation scheme will bring with it recurrent operating and maintenance costs

Advantages of Dams and Reservoirs

- Reservoirs store water, especially during periods of prolonged or heavy rain which reduces flooding
- The stored water can be tap during the dry season and can be utilized for a number of activities such as irrigation, energy generation and recreation.

Disadvantages of Dams and Reservoirs

- Dams are costly to build
- Creating a reservoir can flood existing settlements
- Daming water changes the natural course of rivers and may negatively affect communities and farmers downstream

ANNEX E: DEVELOPING IRRIGATION PROJECT ALTERNATIVES

In developing an irrigation project, the first thing is to outline the existing situation in the area where the irrigation project will be developed; this may include the farming methods currently used such as hoes or machines, the crops that are cultivated, existing water sources and the institutional and policy framework for instance, water user associations.

The second thing is to outline the situation once the irrigation project has been developed.

In the case of an irrigation project that will construct an entirely new infrastructure, the following information should be obtained and assessed carefully in the PFS;

- Any reports prepared by local or international consulting firms including outlines or preliminary designs and cost estimates for the proposed irrigation project
- Local and site-specific climate data
- Relevant time series data on surface water resources
- Groundwater and well inventory data
- Aerial and topographic maps
- Soil and irrigation suitability mapping
- Details of the current land use, land tenure and water rights.
- Local agricultural and livestock production systems, including crop yields of rainfed and irrigated crops
- Assessment of the market for agricultural output including demand for products and their prices

In case of an existing irrigation project that will be rehabilitated or upgraded, the following information should be obtained and assessed carefully in the PFS;

- The current state of the infrastructure and an indication of the rehabilitation requirements
- A record of the operating and maintenance arrangements and costs
- The environmental impacts of the existing irrigation including, sedimentation, waterlogging, salinisation, pollution etc.
- The social impacts of the existing irrigation scheme including, resettlement, treatment of outsee and conflict resolution, as well as the degree of access to irrigated land, farming technologies, inputs and credit by women and men. Additionally, the issues around decision making with regards to land use and the sale of the project outputs when it comes to both men and women should also be included.
- Existing cropping patterns, yields and trends

- Existing allocation of land within the scheme
- Water allocation and its efficiency to and within the scheme
- Production support services and performance
- Farm income and off-farm employment data
- Cost recovery and O&M records