MILLENNIUM CHALLENGE GEORGIA FUND / MCG
REDUCING POVERTY THROUGH GROWTH

Millennium Challenge Georgia Fund

RID Impact Evaluation Project

Deliverable E

Impact Evaluation Design And Data Collection

September 21, 2009

TBILISI BUSINESS SERVICE CENTER

ACT Marketing Research & Consulting

EXECUTIVE SUMMARY

This Report is the Impact Evaluation Design for the Regional Infrastructure Development program of Millennium Challenge Georgia. The overall objective of the Design is to estimate the impact of the RID projects with suitable counterfactuals and to provide additional insight in areas where a counterfactual might not be feasible.

The Introduction (later in this Report) describes the Report in some detail. In this Executive Summary we wish to make several points to set the stage as people review the Design.

This Report Focuses On The Analytical Methods To Be Used In The Design; Survey Details Will Be Included In The Next Report To Be Prepared

There are more than 20 deliverables within the RID IEP. In this scheme, the Impact Evaluation Design (this Report) is separate from the Detailed Survey Design (technical features of the surveys, described in the next few reports). From a Design-creation perspective this is a very good division of work.

The sequence of Impact Evaluation Design first, survey details second caused us to focus on the Key Research Questions and the best analytical methods to use to answer those questions. We have been able to do this without becoming bogged down in survey details. We have noticed that many of the experts we deal with are naturally drawn to the technical details of the surveys to the exclusion of some larger-picture issues, such as selecting the best combination of analytical methods.

The practical effect of this division of work is that this Report is 80 percent about the analytical methods to be used to answer the Key Research Questions and 20 percent about the surveys to be undertaken. Analytical methods include:

- Baseline and ex-post survey analysis
- Treatment and control analysis
- Micro-model analysis
- Social Accounting Matrix (SAM) and Computable General Equilibrium (CGE) analysis
- Micro-simulation analysis
- Case study analysis.

The Design Is Very Broad And Deep; Consequently, Impact Will Be Measured In Many Areas

The Key Research Questions are very expansive. The Impact Evaluation Design is equally broad. Impact measurement falls into six Impact Groups:

- Direct impact on individual households: monetary costs of water and sewer services, willingness to switch to the new water systems, coping time, water consumption, water-borne disease, perceptions of safety and physical properties of water, access to public sanitation information, individual sanitation practices, time and inconvenience of less than 24/7 water and gender issues

- Direct impact on individual firms: monetary costs of water and sewer services, willingness to switch to the new water systems, water consumption and the new water systems as enablers of growing existing companies or creating new companies

- Direct impact on water utilities: supply and demand of water and sewer services, water quality, cost structure, financial viability and efficiency

- Direct impact on Governmental institutions: the public health system and large Governmental users of water (*i.e.*, prison, military bases)

- Direct, indirect and induced impact on the overall economy: output (GDP, productivity), prices (real prices and inflation), poverty (employment, wages, household expenditures), inequality (household expenditures, gender issues, wealth) and national accounts (current account, capital account, public finance)

- Complementary impact between the RID projects and other MCG initiatives.

Impact will be rigorously measured in some of these areas and less rigorously in others. Many impact measurements will be very helpful when MCG and others need to make practical decisions in the future (*e.g.*, tariff rates).

The Design Strikes A Balance Between Analytical Rigor In Proving Impact And Creating Results That Can Be Used Practically

Best practice in impact evaluation requires complete analytical rigor in regard to design and counterfactuals. A usual result of this emphasis is a relatively short list of measurements that are actually reported on. However, the conclusions about impact reflected in those measures are very well defended statistically.

The Design includes a good number of hypothesized impacts that will be confirmed or refuted rigorously. These are noted a Primary Metrics; they will be fully listed in the next Report since they are closely related to sample size issues.

At the same time, there are practical uses for other less rigorous results that could come from the RID IEP Design. This information may not meet the analytically rigorous standards (*e.g.*, there may not be proper counterfactuals) but the information provided will nevertheless the extremely helpful when practical decisions have to be made.

For example, proving (with suitable counterfactuals) that spending on coping drops by 25 percent because of the new water system is important to evaluate the overall impact of the new water system. However, that conclusion does not help to answer the real practical question of the level at which the tariff should be set.

A pleasant side-effect of creating a rigorous impact evaluation Design is that the Design can, at the same time, produce many practical results.

The Design Has Gone Through A Rigorous Review Process To Ensure That It Is Properly Structured

Over the past two months early versions of this Report were circulated among a great number of experts, including MCG and MCC staff, water experts from RTI International, CGE experts on the RID IEP team and others who willingly gave their time to improve the Design.

Each person was asked to comment on opportunities for improvement. The comments of the experts have been fully incorporated into this final version of this Report.

To the end the comments made mostly had a sense of clarification of one point or another. In a few cases we changed our approach somewhat to better achieve RID IEP objectives. The remaining comments focused more on the technical aspects of the surveys (*e.g.*, the sampling methodology) than on the Design of the impact evaluation.

The one comment received from several sources that is not yet fully resolved. Experts told us that the Design is very ambitions. The Design has broad reach and the analysis that will be possible at the end is very deep. Comments in this area were 1) can the proposed surveys be done with reliable results and 2) can the proposed analysis be done.

Our work with ACT suggests that the surveys are possible, although difficult. To the end we may need to reduce the number of surveys somewhat to fit within the agreed upon survey budget. This issue will be finalized in the next report (Deliverable F). Sufficient resources for analysis does remain problematic. We will perform those analyses specified in the contract. However, there will be a broad range of analyses that could be done that may remain unexploited at the end of the RID IEP. For example, the RID IEP is not a tariff study. Nevertheless, there will be voluminous data and information that would shed light on the advantages and disadvantages of different water tariff schemes.

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LIST OF ABBREVIATIONS

ACT	ACT Research
ADA	Agriculture Development Activity
CGE	Computable General Equilibrium (analysis and models)
CRRC	Caucasus Research Resource Center
CV	Compensating Variation
DS	Department of Statistics of Georgia
ERR	Economic Rate of Return
EUR	Euro
EV	Equivalent Variation
FDI	Foreign Direct Investment
FIZ	Free Industrial Zone (in Poti, and perhaps in Kutaisi)
GoG	Government of Georgia
GRDF	Georgia Regional Development Fund
IDP	Internally Displaced Person
IEC	Information, Education and Communication campaign
ISET	International School of Economics at Tbilisi State University
MCC	Millennium Challenge Corporation
MCG	Millennium Challenge Georgia
NRW	Non-Revenue Water
PE	Partial Equilibrium (analysis)
RID Project	The entire Regional Infrastructure Rehabilitation Project
RID Projects	The individual city projects within the RID Project
RID IEP	RID Impact Evaluation Project
ROW	Rest of the World
SACE	Statistical Classification of Economic Activities in the European Community
SAM	Social Accounting Matrix

SPSS	Statistical Package for Social Sciences.
S-J	Samtskhe-Javakheti Road Rehabilitation
TBSC	Tbilisi Business Service Center
USD	United States Dollar

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(for information only)

1 INTRODUCTION

The 5-year, 395,3 million MCG Compact seeks to reduce poverty and stimulate economic growth through rehabilitation of regional infrastructure and developing enterprises in the regions of Georgia. The objective of the Regional Infrastructure Development (RID) Project, one of Millennium Challenge Georgia's (MCG's) five projects, is to improve municipal service delivery.[1] The grant amount will be primarily used for the rehabilitation of water supply and sewage systems in several towns of Georgia.

The objective of the RID Impact Evaluation Project (RID IEP) is to assess the impact of five water projects (three which also include sewer systems). The five individual RID projects are expected to improve the operation of important population centers, reduce business transaction costs, contribute to economic growth and poverty reduction and improve the quality of life for more than a quarter million Georgians, particularly benefiting the poor.

This Report describes the Impact Evaluation Design (Design) that best suits the needs of the RID IEP. The Design is based on our understanding of the RID projects, conditions in the RID cities, timelines for the RID projects, overall schedule for the RID IEP and industry-standard impact evaluation methods. The emphasis in the Design (this Report) is on the analytical methods that will be used to accomplish RID IEP objectives. Subsequent reports (such as Deliverable F) will contain detailed descriptions of the technical aspects of the different surveys to be undertaken.

Briefly put, the RID IEP Impact Evaluation Design is a combination of survey-based and economic modeling methods. These two complementary methods combine to meet the unique needs and constraints of the RID projects and the RID IEP. A unique feature of this particular evaluation is that during the allotted time for the study, including Phase III that is to be ex-post work, many of the infrastructure projects will not be completed. The Design was crafted to succeed under this constraint.

Survey methods will serve several purposes. They will provide baseline data, as most beneficiaries of the RID projects have yet to receive the planned benefits; that is, most of the RID projects have not yet been fully implemented. This will allow MCG to conduct ex-post impact evaluations should MCG choose to do so.

Survey methods also will permit estimation of current water and sewer costs for individual households and firms as they cope with poor quality water and irregular water service. These direct (and in the future avoided) costs will permit the RID IEP to estimate economic rates of return for the individual RID projects and for the RID Project overall. Making these estimates will be possible just after data is collected without the need to wait a long time to collect full ex-post data.

Finally, the survey data will be used as inputs to economic models (specifically Computable General Equilibrium (CGE) models and micro-simulation models). Several anticipated indirect and induced impacts, not captured by usual survey methods will be estimated through the economic models.

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[1] The entire Regional Infrastructure Rehabilitation Project is termed "the RID Project". The five individual projects are termed "the RID projects".

The requirements for the Design and the contents of this Report are noted in the Terms of Reference for the RID IEP as:

> "Final detailed evaluation design and data collection report, including key research questions, evaluation methodology and design, descriptions of surveys, key indicators, target areas, target groups (treatment and control), beneficiaries and implementation and data collection Plan."

1.1 REPORT ORGANIZATION

This Report is divided into 12 Chapters. There is a separate document containing 13Appendixes. The material in the Report generally falls into three areas: 1) background material with a general description of the analytical methods used as an integrated whole, 2) detailed design of the used analytical methods and 3) treatment and control and surveys.

Chapters 2 through 4 contain background material. They describe the RID IEP and the overall Design that will be used. Readers already familiar with the RID IEP can probably skip these Chapters. Related information on the Key Research Questions, the RID cities and background information on CGE models is shown in Appendixes A to D.

Chapters 5 to 10 discuss the analytical methods, Metrics and Data Elements in each of the six Impact Areas (i.e., individual households, individual firms, water utilities, Governmental institutions, overall economy and complementary activities). These Chapters are at a medium-level of detail. Much more detailed information on individual households, individual firms and water utilities is contained in Appendixes E to J. More detail on the CGE models and micro-simulation analysis to be done are shown in Appendix K. Appendixes L and M show the full list of Metrics and Data Elements.

Chapters 11 and 12 describe treatment and control issues and the suite of surveys that will be undertaken to provide the data needed for the impact evaluation. The description of the surveys is at a high level as their detailed design is the next step in the RID IEP; they are not within the scope of this particular Report.

The following Section describes the content of each Chapter and the related Appendixes in a bit more detail.

1.2 BACKGROUND CHAPTERS

Chapter 1 – Introduction (this Chapter) describes the context for the RID IEP and the organization of this Report.

Chapter 2 – Impact Areas And Analytical Methods discusses how the various pieces of the Design fit together as an integrated whole. It describes how the RID IEP focuses on RID project impacts rather than outputs or outcomes. It describes the Impact Hierarchy, into which all impact areas fit, and then discusses the six analytical methods that together comprise the Impact Evaluation Design. It concludes with a description of how the Design moves from Impact Sub-Categories to measurement Metrics to Data Elements.[2] Later Chapters describe

[2] These specialized terms are defined in the Chapter.

the actual Design in full detail. Appendix A discusses the Key Research Questions in some detail. Appendix B describes the RID cities in the context of impact evaluation.

Chapter 3 – Micro-Models To Measure Impact describes how the Impact Evaluation Design uses a suite of micro-models to estimate current water and sewer costs and coping times for a variety of economic players (*e.g.*, individual households, individual firms). As an example, the Chapter discusses the conceptual application of the micro-models to individual households, then to households as a group and finally as inputs to the economic models described in Chapters 4 and 9. Detailed descriptions of the use of the micro-models to particular economic players are contained in Chapters 5 to 7.

Chapter 4 – CGE Models To Measure Impact describes the class of economic models that are part of the Impact Evaluation Design. In this Chapter the models are introduced; detailed descriptions of the unique features of the models for the RID IEP are handled in Chapter 9.

The Chapter starts with a short discussion of the economic methods that were considered before settling on Computable General Equilibrium (CGE) analysis. The Chapter then describes CGE analysis and models in a non-technical way. The Chapter ends with discussions of how CGE analysis has been applied to a wide range of economic issues, including water and small economies. Appendix C contains a more technical discussion of the history and theoretical underpinnings of CGE analysis while Appendix D shows a simplified CGE model that was used during the development of the Design.

1.3 ANALYTICAL METHOD CHAPTERS

The following six Chapters discuss impact measurement in the six Impact Groups, one by one.

Chapter 5 – Individual Households Impact Group discusses how the impact of the RID Projects on individual households – at the micro-level – will be measured and reported.[3] There are two Impact Categories: total water and sewer cost and quality of life. A water audit to measure actual water consumption is also described. Measurement of impact in each area is described in moderate detail. Additional details are shown in Appendixes E, F and G.

Chapter 6 – Individual Firms Impact Group describes impacts on individual firms at the micro-level.[3] Two Impact Categories are discussed: total water and sewer cost and business enablers. Measurement of impact in each area is discussed in moderate detail. Additional details are shown in Appendix H.

Chapter 7 – Water Utilities Impact Group discusses the effects the RID projects will have on water utilities in each of the RID cities in operational and financial areas. Measurement of impact is described in moderate detail. Additional details are shown in Appendix I.

Chapter 8 – Governmental Institutions Impact Group discusses how the impact of the RID projects on Governmental institutions will be assessed. These institutions include the public health system and prisons and military bases.

[3] Macro-level impacts (indirect and induced) are considered as part of the overall economy Impact Group in Chapter 9.

Chapter 9 – Overall Economy Impact Group describes the use of Computable General Equilibrium (CGE) models to assess macro-economic effects of the RID projects at the individual RID city level. Chapter 4 described CGE models in general. This Chapter 9 describes the CGE models that will be used for the RID IEP and the decisions that were made in creating the Design. The Chapter also describes how micro-simulation will be used to understand RID project impact on poverty and inequality. The Chapter ends with ways the CGE models can be used for other infrastructure projects in Georgia (*e.g.*, water projects other than the RID projects). Additional details are shown in Appendixes J and K.

Chapter 10 – Complementary Activities describes how the RID IEP will use primarily case studies to determine the interaction between the RID projects and other MCG projects including the Samtskhe-Javakheti (S-J) Road Rehabilitation, the Agriculture Development Activity (ADA) and the Georgia Regional Development Fund (GRDF). The impact of the RID projects on the Poti Free Industrial Zone (FIZ) is also described in this Chapter.

1.4 TREATMENT AND CONTROL AND SURVEY CHAPTERS

Chapter 11 – Treatment And Control describes how the RID IEP addresses the important issues of treatment and control. It discusses how we will create a pool of individual households and firms as a control group. There will not be an attempt to create controls at the city level. Rather a stratified design will be used with matching at the individual household and firm level. Difference-of-differences will be used in most impact areas outside of general economy effects. Much more detail on treatment and control issues will be contained in subsequent reports, including the next Deliverable F.

Chapter 12 – Planned Surveys discusses the surveys and case studies that will be undertaken by the RID IEP. Each survey and case study is described in some detail with particular attention paid to key indicators, target areas, target groups (treatment and control) and beneficiaries. Much more detail on the planned surveys will be contained in subsequent reports, including the next Deliverable F.

IMPACT EVALUATION DESIGN - GENERAL

2 IMPACT AREAS AND ANALYTICAL METHODS

Undertaking impact evaluation requires considering the studied-project's objectives, identifying both likely positive and negative outcomes, specifying measurements and needed data for different types of possible outcomes, examining the extent to which outcomes can be attributed to the studied project and finally determining the cause and effect relationships that govern those outcomes.

This Chapter describes the process the RID IEP used to develop the Impact Evaluation Design. This is how we approached and solved the Design problem. Later Chapters describe the actual Design in full detail.

The Chapter is divided into eight Sections. The first Section stresses that the RID IEP focuses on measuring the impacts of the RID projects. The Section draws a sharp line between monitoring and evaluation on the one hand and impact assessment on the second. This is to clarify the difference between outputs (generally a monitoring and progress evaluation matter) and impacts. The RID IEP focuses on impacts.

The second Section discusses how the RID developed the final list of needed Data Elements, a key output of the Impact Evaluation Design.[4] This Section stresses how we moved from the Key Research Questions to general to specific impact areas and then to specific measures (Metrics) to use in each impact area and then to the individual Data Elements needed to calculate or report the Metrics. This train of thought (Key Research Questions to needed Data Element) will be reversed once data is collected to perform the data processing that will produce the final report (Data Element to quantitative conclusions in the final report).

Section three describes the impact areas that will be measured by the RID IEP. This includes a list of six Impact Groups (*e.g.*, individual households, overall economy), leading to an Impact Hierarchy that includes Impact Groups, Categories and Sub-Categories (all impact areas). The Impact Hierarchy shows the way the rest of the Impact Evaluation Design is organized (*e.g.*, each of the Impact Groups has its own Chapter in this Report). As an aside, the impact areas refer to impacts that ***might accrue*** to the RID projects. Whether these benefits are ***actually received*** is the subject of the RID IEP generally.

The fourth Section defines and describes each of the Impact Groups in a bit more detail.

Section five describes the six analytical methods that are used in the Design. Each impact area is addressed by one or more of the analytical methods. The Section also discusses how each analytical method will be used to estimate RID Project impact at this moment and *c.* 2011 and *c.* 2015. Chapters 5 to 10 describe the use of the analytical methods for particular Impact Groups with additional details in Appendixes E to K.

The sixth Section shows how the RID IEP moved from the Impact Sub-Categories to individual Metrics and to Data Elements. Chapters 5 to 10 discuss the Metrics and related Data Elements with additional detail in Appendixes E to K. Appendixes L and M show the full list of Metrics and Data Elements.

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[4] A Data Element is a bit of data needed to calculate or report a measurement in a particular impact area. Data Elements come from new RID IEP surveys and from existing data sources.

Section seven briefly describes how survey results will be aggregated to produce overall results. Given that sampling will be done properly, the aggregation is essentially a simple summing. More details on aggregation will be contained in subsequent reports.

Finally, Section eight discusses the proof of concept for the Design. Elements of the Design have all been used before, but never in the combination envisioned for the Design. This Section discusses the risks and mitigations for this situation.

2.1 FOCUS ON IMPACT

The objectives of the RID IEP are clearly in the field of impact measurement (outcomes). However, the current stage of the RID projects (*i.e.*, before construction has finished and even before it has begun in several cases), usually would be in the field of monitoring and progress evaluation (generally outputs). This Section briefly compares and contrasts monitoring and progress evaluation (outputs) and impact measurement (outcomes) in the context of the RID IEP. The Section concludes with a discussion of the implications of these distinctions for the RID IEP.

2.1.1 Monitoring And Progress Evaluation

Monitoring and progress evaluations are tools used to inform management and key stakeholders how well an *ongoing* policy, program or intervention appears to be meeting stated goals. A key emphasis in monitoring and progress evaluation is to measure outputs, assess progress and then make changes as needed to the *ongoing* process or project. All the RID projects are *ongoing* at the present moment with planned completion dates from late 2009 to 2011.

Through systematic data collection and analysis, project outputs during implementation are assessed as the indicators of *ongoing* goal-attainment. For example, kilometers of new pipes and number of firms serviced by the new water system might be project outputs. By evaluating progress relative to immediate outputs (*e.g.*, km of pipe, number of firms), the monitoring and progress evaluation framework assumes that higher-level goals (*e.g.*, outcomes and impacts such as economic growth) are likely to be met if the immediate outputs occur. That is, that economic growth will occur as firms are serviced by the new water system. Significantly, monitoring and progress evaluation does not investigate whether these firms have actually increased economic activity as a result of the new water system; it is simply assumed to be so during program or project implementation.

2.1.2 Impact Measurement

If monitoring and progress evaluation focus on the outputs of *ongoing* processes or projects, then impact measurement focuses on the outcomes of *completed* processes or projects. Outcomes can be measured after the changes have had time to create an impact. Impact measurement includes tools to:

- Identify and measure changes in outcomes (*e.g.*, income, consumption, health, GDP)
- Analyze direct and indirect causal relationships between the intervention and observed changes in outcomes
- Attribute changes in outcomes (in whole or part) to the intervention.

In contrast with monitoring and progress evaluation, impact measurement focuses on higher-level objectives such as quantifying whether the RID projects positively affect poverty levels in the RID cities.

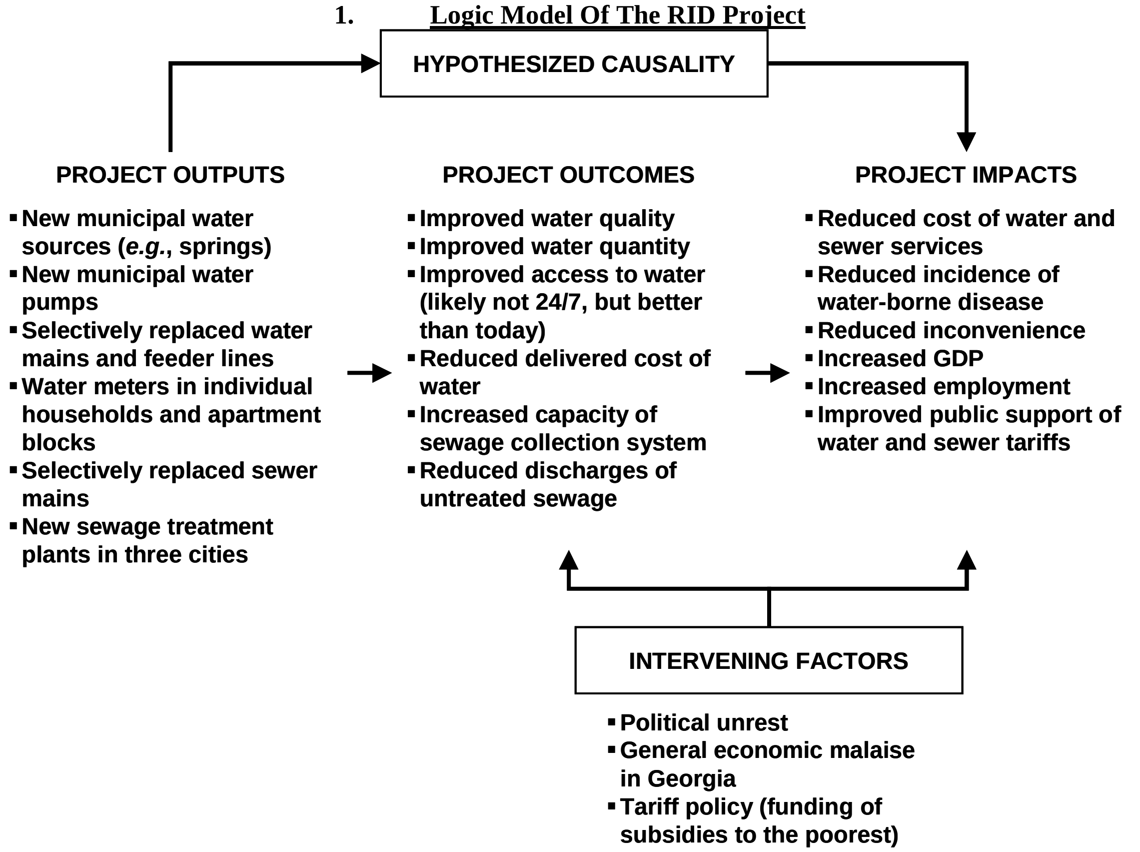
2.1.3 Implications For RID IEP

The RID IEP is clearly impact (outcome) focused. Consequently, there are only a few things in the Impact Evaluation Design that have a sense of outputs in a monitoring and progress evaluation sense.[5] Rather, the Design focuses on measuring the outcomes of the new water systems in the context of economic growth and quality of life for citizens.

Focusing nearly exclusively on outcomes greatly complicates the task. Usually there are multiple inputs that affect the outcome area. For example, an increase in tourism in Kobuleti (an outcome) could be due to the new water system or to the general improvement in the Georgian economy. The Design is crafted so as to be able assign causality to observed outcomes, up to a certain point.

The following chart shows the overall logic model for the RID Project.

1. Logic Model Of The RID Project



2.2 FROM KEY RESEARCH QUESTIONS TO DATA ELEMENTS (VARIABLES)

This Section briefly describes how the RID IEP moved from the Key Research Questions to Data Elements and how we will reverse the path to move from Data Elements to the final report. The Key Research Questions are listed and discussed in Appendix A.

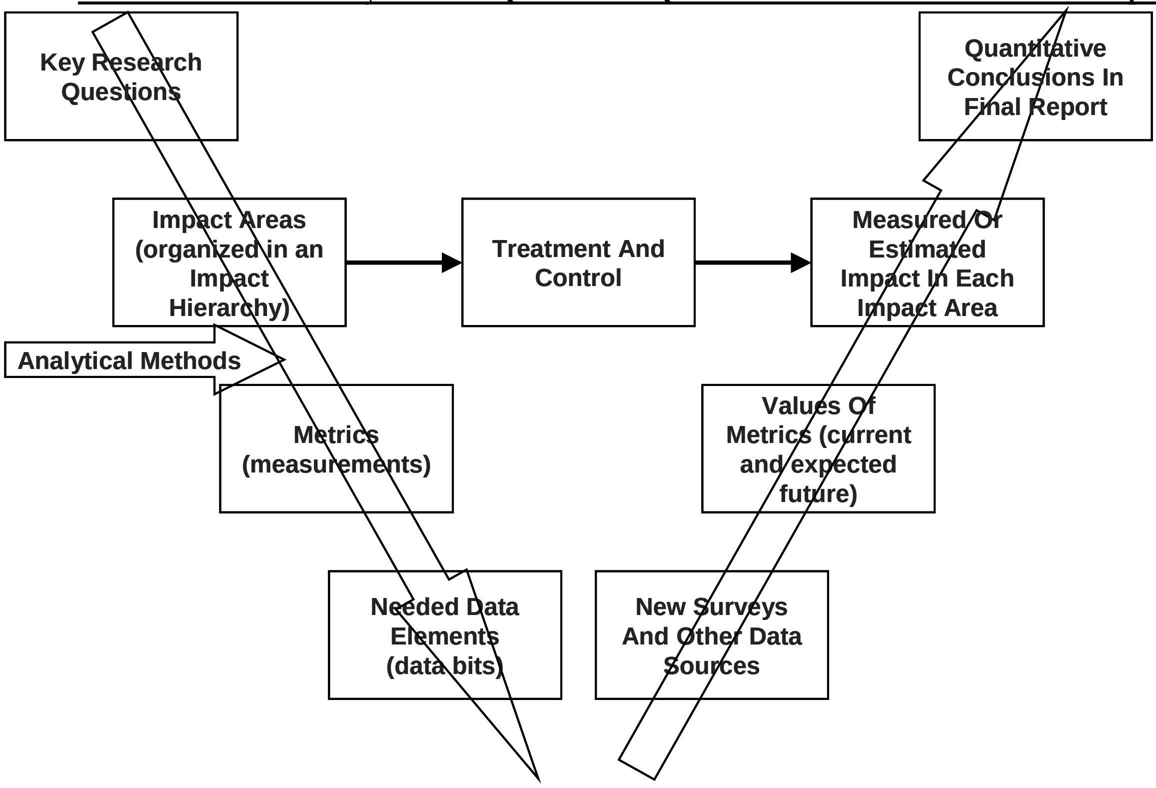
[5] One such matter is the number of people receiving water from the new water systems.

A common way of proceeding in an impact evaluation is to imagine all the data that might be needed, collect all the data (that might be needed), decide what data to use (*i.e.*, what data to analyze) and leave the remaining orphaned data (not needed for the analysis) unused.

The approach the RID IEP has taken is different. With the Key Research Question as a base, we identified impact areas and then organized them into an Impact Hierarchy. Treatment and control issues were considered while organizing impact areas into the Impact Hierarchy. We selected a range of analytical methods suitable for analyzing the situation in the impact areas as a whole. Within each impact area we then developed a range of specific Metrics (measurements) that would illuminate the particular impact area. Finally we specified the precise Data Elements that are needed to calculate or report each Metric. This approach is shown in the following chart.

This train of thought (Key Research Questions to needed Data Element) will be reversed once data is collected to produce the final report (Data Element to quantitative conclusions in the final report).

2. <u>Schematic Path From Key Research Questions To Quantitative Conclusions In The Final Report</u>



Source: RID IEP Analysis.

Conceptually, at the end of the RID IEP there should be no collected data that has not been used in some fashion. The only possible exception might be some demographic data that, to the end, proved not worthy of being reported upon.

Several features of Data Elements are worthy of mention. To the end, approximately 3 000 Data Elements will be used for various purposes; two-thirds will be inputs to the Social Accounting Matrix (SAM) used in the Social Accounting Matrixes (SAMs) And Computable General Equilibrium (CGE) Analysis (described later).

Each Data Element has several features in common:

- Each Data Element is an exact number (*i.e.*, “about 3” cannot be used but “3” can be used; keeping in mind that we never claim that “3” is the right number)

- Each Data Element has a name and a description (understandable more or less to the non-technical person; some may be very technical in nature, but even those technical definitions are commonly understood by experts)

- Each Data Element number comes from some place; that is it has a source that can be very precisely defined (in a meta-data sense for instance).

As part of the Impact Evaluation Design, the Data Elements can be simply listed in a long table with four columns: name, description, general type of source (*i.e.*, RID IEP surveys, existing primary data, existing secondary data and estimated data) and specific source. The specific source must always be findable by a person who has the list of Data Elements (and who chooses to track down the source).

Finally, while not a property of the individual Data Element, the Data Elements can be organized in a hierarchy to aid understanding. Obviously a list of 3 000 Data Elements with no organization would be very unwieldy or even impossible to understand. There is not an objectively perfect organization (that is, one that comes from the data itself) but for certain there is one hierarchy that can be used to understand the overall structure.

The Impact Evaluation Design includes a table of Data Elements. Many are shown in the text of this Report. The full list is shown in Appendix M.

2.3 IMPACT HIERARCHY

Not surprisingly, there is a long list of impacts that might accrue to water and sewer systems. Some impacts are easy to understand while others are subtle. Some impacts are easy to quantify while others are very hard or even impossible to quantify.

This Section discusses the range of impacts that accrue to water systems and organizes them into an Impact Hierarchy containing many impact areas. The detailed Impact Evaluation Design, discussed in later Chapters, covers how to measure impact (with Metrics) in each impact area.

The Section starts with a discussion of a comprehensive list of impacts identified by the RID IEP; this is generally a brainstormed list.[6] The list of impacts is then grouped and prioritized into six Impact Groups.

The second Sub-Section then sub-divides each Impact Group into two further levels (Impact Categories and Impact Sub-Categories). This overall structure of impacts (Impact Groups, Categories and Sub-Categories) is the Impact Hierarchy. The Hierarchy is logical and relatively easy to understand. However, it must be admitted that it is not the only possible organizational scheme for impacts. However, for the purposes of the RID IEP it has guided the detailed design work.

[6] Note these are possible benefits. The objective of the RID IEP is to determine if these benefits are actually achieved by the RID projects.

The next Section defines and describes each of the Impact Categories and Sub-Categories in greater detail.

2.3.1 <u>Impact Groups</u>

Early in the design process the RID IEP did an in-depth review of water and sewer system impact areas and then brainstormed about the impacts the RID projects might have. The following chart shows the list of impact areas. We believe that this list is comprehensive and all likely impact areas are covered by either the specified point or in a detail under one of the points.

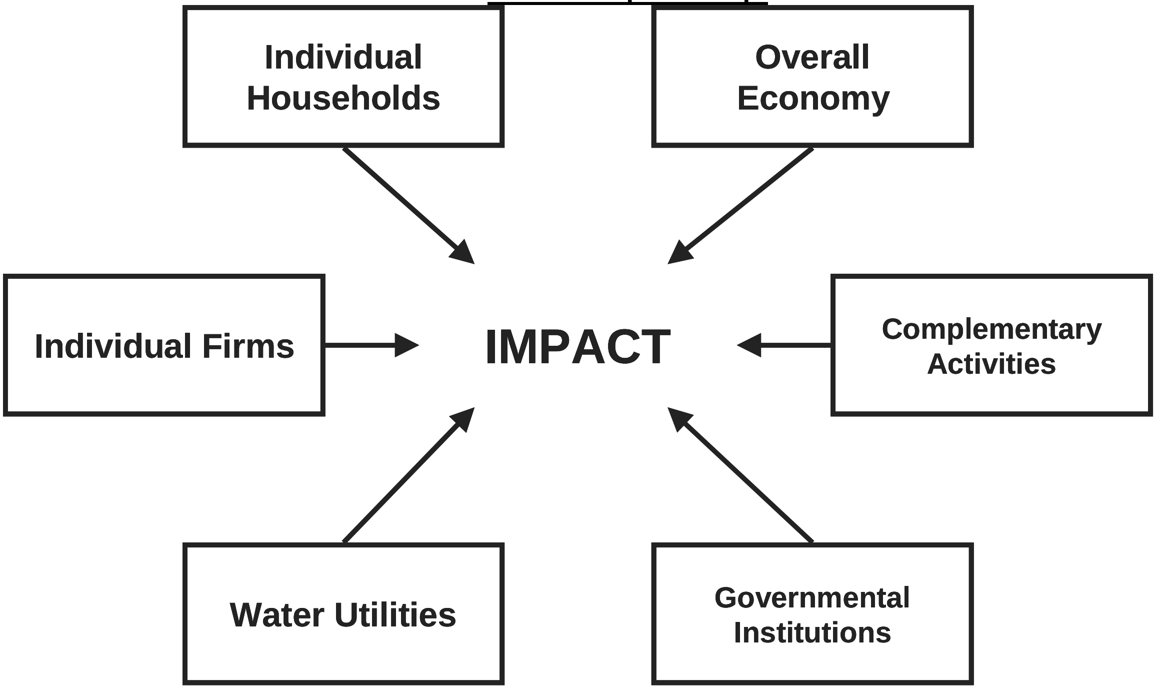
3. General Areas Of Impact From RID Projects

■ Stimulate local economy through infrastructure development works ■ Reduce system maintenance costs ■ Reduce municipal subsidies to water company ■ Reduce first-time business opening costs by eliminating need for coping infrastructure ■ Reduce first-time home owner costs by eliminating need for coping infrastructure ■ Eliminate daily coping costs for businesses (i.e., collect, pump, store, treat and/or purchase) ■ Eliminate daily coping costs for households (i.e., collect, pump, store, treat and/or purchase) ■ Effects of consumption tariffs for businesses ■ Effects of consumption tariffs for domestic consumers ■ Remove water delivery pressure constraint for developers and businesses (i.e., can build higher)	■ Reduce employees that are neede by businesses for alternative water system maintenance ■ Impact small businesses, such as car washes, which rely on unmetered water ■ Impact household subsistence agriculture if potable water is used for backyard gardens; adjacent plots ■ Impact on demand for bottled water by tourists, hotels and restaurants ■ Increase business investment (particularly tourism) signaling through reliability and stability of the system ■ Improve potable water quality ■ Improve riverine water quality (two locales) ■ Reduce pollutant emissions from elimination of pumping ■ Save energy from reduction/elimination of pumping ■ Improve cleanliness and attractiveness of cities

Source: RID IEP Analysis.

We then developed a range of sub-benefit areas and candidate measurements; the objective here was to develop a better understanding of the range of likely impacts rather than making any decisions on particular measurement methods. Potential impacts were then aggregated into the six RID IEP Impact Groups shown in the following chart; all impacts reported by RID IEP fall into one of these six Impact Groups. The meanings of the individual Impact Groups are described further later in this Chapter.

4. RID IEP Impact Groups



Source: RID IEP Analysis.

2.3.2 Impact Hierarchy

The RID IEP further divided the Impact Groups into Impact Categories and Sub-Categories. Each Impact Category and Sub-Category is described in the following Section. Note that every impact to be examined by the RID IEP falls within one of the Impact Sub-Categories (and hence into one of the Impact Categories and into one of the Impact Groups). This provides a true hierarchy of impact for the RID IEP.

The following chart shows the RID IEP Impact Hierarchy. A representative Metric is shown for each Impact Sub-Category for explanatory purposes. The representative Metric is included only to better explain the meaning of the Impact Sub-Category; it is not the most important Metric in the Sub-Category.

Later Chapters describe the suite of Metrics in each Sub-Category in complete detail. For example, in the first line of the chart the representative Metric for:

- Impact Group: Individual Households
- Impact Category: Total Water And Sewer Cost
- Impact Sub-Category: Monetary Costs

is Total Annualized Semi-Variable Cost Of Water And Sewer. In fact, the Design contains many Metrics related to water and sewer costs separately and to fixed, semi-variable and variable costs for each.

There are a number of Primary Metrics (not the representative Metrics shown in the chart) that drive the sample sizes for the individual surveys. The Primary Metrics are defined in Chapter 11 as part of treatment and control.

5. RID IEP Impact Hierarchy

IMPACT GROUP	IMPACT CATEGORY	IMPACT SUB-CATEGORY	REPRESENTATIVE METRIC FOR IMPACT SUB-CATEGORY ("Change in …")
Individual Households	Total Water And Sewer Cost	Monetary Costs	Total Annualized Semi-Variable Cost Of Water And Sewer
		Willingness To Switch	Likelihood To Switch For Water And Sewer Combined (larger is more likely to switch)
		Coping Time	Annual Time Spent On Managing Private Water System
		Water Consumption	Annual Water Consumption By Shower And Bathtub For Bathing
	Quality Of Life	Health Incidents	Number Of Incidents Of Gastrointestinal Disease In Household In Last Month
		Perceptions Of Safety	How Are The Sources Of Water That Is Used For Potable Uses Treated Before Consumption
		Perceptions Of Organoleptic Properties	Perception Of Taste Of Alternative Sources Of Water (excluding bottled water)
		Public Sanitation Information	Frequency Household Receives Information On Testing Of Water Quality (specific test results)
		Individual Sanitation Practices	Number Of Individuals Who Wash Hands With Soap And Water Before Nearly Every Meal
		Time And Inconvenience Of Not 24/7 Water	Most Likely Use Of Newly-Free Time If Water Was Available 24/7
		Self-Reported Water Consumption	Portion Of Water That Is Used For Domestic Purposes
		Gender Issues	Total Number Of Hours Spent Working In The Home By Women
Individual Firms	Total Water And Sewer Costs	Monetary Costs	Total Annualized Semi-Variable And Annual Variable Cost Of Water And Sewer
		Willingness To Switch	Ratio Of Current To Future Water And Sewer Costs
		Water Consumption	Water Quantity Content Per Unit Produced
	Business Enablers	Expand Existing Business	Opportunity Cost Of Coping
		Enter New Business	Ratio Of Current And Future Fixed Costs Of Entering A New Business
Water Utilities	Operations	Supply	Average Duration (hr/day) And Frequency Of Water Provision (days/wk) In Last Month
		Demand	Water Delivered To Customers
		Water Quality	Water Test Failure Ratio
	Finance	Cost Structure	Electricity Cost As Percentage Of Total Water-Related Costs
		Financial Viability	Collection Rate From Households
		Efficiency	Employees Per 1 000 Customers
Governmental Institutions	Public Health System	Institutional Arrangements	Allocation Of Staff Among Health Hazards (e.g., water vs. infant mortality)
		Water Borne Disease Incidence	Number Of Disease Outbreaks Caused By Municipal Water
	Other Budgetary Institutions	Prisons	Money spent on electricity to run well pumps
		Military Bases	Money spent on transporting water by tanker truck
Overall Economy	Output	GDP	National GDP And GDP In Each RID City
		Productivity Of Labor	GDP Per Capita
		Productivity Of Capital	GDP Per Investment Level
	Prices	Real prices	Real Price In Each Sector
		Inflation	Consumer Price Index (CPI)
	Poverty	Employment Level	Size Of Labor Force
		Wages	Real Wages
		Expenditures	Total Consumption
	Inequality	Household Expenditures	Distribution Of Household Expenditures (Gini index)
		Gender	Relative Sizes Of Male And Female Labor Force
		Wealth	Distribution Of Wealth (Gini index)
	National Accounts	Current Account	Net Exports
		Capital Account	Net Foreign Direct Investment
		Public Finance	Water Utility Subsidy
Complementary Activities	S-J Road Project	Tourism	Case Study Results (*e.g.*, number of tourists from Armenia in Borjomi and Kobuleti)
	ADA	Agricultural Output	Case Study Results (*e.g.*, increased output due to better water supply)
	GRDF	Economic Activity At Micro (company) Level	Case Study Results (*e.g.*, reduced production costs due to better water supply)
	Free Industrial Zone (FIZ)	General Economic Activity In The FIZ	Case Study Results (e.g., water as an enabler of investment)
		General Economic Activity In Poti	Case Study Results (*e.g.*, indirect and induced effects from investments at the FIZ)

Source: RID IEP Analysis.

2.4 DESCRIPTIONS OF IMPACT GROUPS WITHIN THE IMPACT HIERARCHY

The previous Section introduced the form of how the RID IEP classifies the impacts from the RID projects: the Impact Hierarchy. This Section describes each of the six Impact Groups, Impact Categories and Impact Sub-Categories in somewhat greater detail. The next six Chapters deal in detail with the Impact Groups down to the Data Element level.

2.4.1 Individual Households

Impact on individual households includes all direct impacts on households as single units (*e.g.*, spending on water and sewer services), on individual members of households (*e.g.*, health effects), on groups of similar households and on all households generally. Direct impacts are where it is generally easy to draw a direct connection between a particular RID project output (*e.g.*, connection to the new water system) and an outcome (*e.g.*, less money spent using a private water well).

There are two Impact Categories. Total Water And Sewer Costs includes all money and time costs incurred by individual households related to water and sewer services such as fees to the water company, electricity spent to pump water from an alternative water source and time spent managing water services. An engineering approach is used to calculate these costs and times. This is augmented by a willingness to switch (to the new water and sewer systems) analysis. Quality Of Life includes non-economic effects of the RID projects such as health and water quality. The Design does not monetize time spent by households on coping with less than 24/7 water, although this is of course possible if needed later.

2.4.2 Individual Firms

Impact on individual firms includes all direct impacts on firms as single units, on groups of similar firms and on all firms generally. Direct impacts are where it is generally easy to draw a direct connection between a particular RID project output (*e.g.*, connection to the new water system) and an outcome (*e.g.*, less money spent using spring water transported by tank truck).

There are two Impact Categories. Total Water And Sewer Costs includes all money and time costs incurred by firms related to water and sewer services. This includes fees to the water utility, money and time spent on alternative water sources and measures of whether firms will be motivated to switch from alternative water sources to the new water system. Business Enablers considers how the new water systems will stimulate investment in current or new businesses. The Design does monetize time spent by firms on coping with less than 24/7 water since the firms pay wages to employees for this time.

2.4.3 Water Utilities

There are five separate water utilities in the five RID cities, plus additional water utilities in the control cities. The RID projects will have unique impacts on each utility when compared to other types of businesses. Consequently, water utilities are included as a separate Impact Group.

There are two Impact Categories. Operations include impacts related to supply and demand for water and water quality. Finance includes impacts on the financial standing of the utilities.

2.4.4 Governmental Institutions

The Governmental institutions Impact Group includes the public health system (as affected by water issues) and governmental institutions as large users of water (primarily for domestic water purposes in prisons and military bases). In the context of the RID IEP, the public health system deals with preventative aspects of health and with population-level rather than individual-level health issues.

2.4.5 Overall Economy

Impact on the overall economy includes direct, indirect and induced effects. The first of these three impacts (direct) is included within individual households and firms and governmental institutions as noted before. As individual households and firms adjust to their connection to the new water systems the direct impacts on those households and firms begin to ripple through the economy in indirect ways. For example, reduced spending on water coping costs causes households to change their consumption patterns (*i.e.*, they buy things other than electricity for water pumping) and these changes cause growth in the sectors that they (newly) buy from. These are indirect impacts. As those indirect benefit recipients, in turn, spend their increased income there are further chain-reaction or multiplier effects. These are induced effects. The Overall Economy Impact Group measures these direct, indirect and induced (multiplier) impacts. By subtraction (of direct impact from the individual household and individual firm groups) it will be possible to isolate the indirect and induced impacts.

There are five Impact Categories. Output measures changes in GDP and productivity at the RID-city level. Prices concerns changes in real prices in the RID cities; for example, an increase in activity in the tourism sector could raise prices for land. Poverty concerns ***overall levels*** of employment, wages and household expenditures. Inequality, on the other hand, measures changes in the ***distribution*** of household expenditures, gender effects and wealth. Finally, National Accounts concerns impacts on the standard national accounts.

2.4.6 Complementary Activities

There are three other MCG-related projects that may influence RID impact, and vice versa: the S-J Road Project, the Agriculture Development Activity (ADA) and the Georgian Regional Development Fund (GRDF). The Complementary Impact Group includes those impacts where the result of both the RID projects and the other project involving a particular beneficiary might multiply the overall impact. In other words, the whole impact is greater than the sum of the individual impacts. These effects will be captured by the RID IEP through case studies.

This Impact Group also includes the Poti Free Industrial Zone.

2.5 ANALYTICAL METHODS USED IN THE IMPACT EVALUTION DESIGN

The RID IEP will use a variety of analytical methods to measure impact. The different methods were selected by the RID IEP and integrated into a single Design because of the breadth of impact areas on the one hand and the timing situation of the RID IEP and the RID projects.[7] Both of these considerations required the use of multiple analytic methods.

The specific analytical methods are discussed in this Section at a general level. First the methods themselves are described. Then the application of the methods to the impact areas is discussed; each impact area is addressed by one or more of the analytical methods. Finally, the application of each analytical method for estimating RID project impact *at this moment* and *c.* 2011 and *c.* 2015 is described.

2.5.1 Baseline And Ex-Post Survey Analysis

Some types of impact can be measured only by taking two snapshots separated by time and comparing the results, with suitable controls. This is because even given perfect information about the baseline situation it is very difficult to properly hypothesize likely impact without a follow-up survey. For example, people's opinion about the taste of municipal water will be collected and results reported on a five-point index. We might be able to hypothesize that the taste evaluation will improve as the new water systems come online. But the RID IEP will not be able to prognosticate the amount of the improvement. This must wait for the ex-post study to be completed.

By definition, impacts measured by this analytical method will use data only from the RID IEP surveys.

Approximately 25 percent of all Metrics are based on this analytical method. The greatest use of this analytical method is in the individual household Quality Of Life Impact Category.

Baseline and ex-post surveys are discussed in more detail in Chapters 5 and 6 as they apply to individual households and individual firms. Chapter 12 summarizes the surveys that are included in the RID IEP.

2.5.2 Treatment And Control Analysis

Treatment and control methods will be used to help document the counterfactuals. This design and analytic method will be used with the baseline and ex-post survey analysis just described and the micro-model analysis described next.

The main purpose of treatment and control is to demonstrate causality for key elements of measurement. The key elements which can show causality are:

- Concomitant variation (correlation)
- Appropriate time order of occurrence
- Elimination of other possible causal factors.

The basic Impact Evaluation Design (one-group pretest-posttest design, without treatment and control) addresses the first two elements. The third element, eliminating other possible factors, requires a treatment and control method.

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[7] Specifically, the RID IEP will be complete before many impacts have had sufficient time to develop in the RID cities.

The RID IEP considered creating controls for each RID city. To the end this was not possible because of the unique features of each of the RID cities. Rather, the RID IEP has created two strata: industrial cities (Poti and Kutaisi) and resort cities (Kobuleti, Borjomi and Bakuriani). The RID IEP has also selected nine other cities in Georgia that also fit into these same two strata (four as industrial cities and five as resort cities). The RID IEP will sample within each strata to permit reaching final conclusions on impact using a differences of differences method at the individual household and individual firm level.

Treatment and control issues are discussed more thoroughly in Chapter 11.

2.5.3 Micro-Model Analysis

RID IEP prepared a number of Excel-based micro-models that reflect the behavior and costs of water and sewer services for particular economic players. Comparison of behavior and costs without and with a new water and sewer systems measures impact. For example, for individual households there is a model that uses engineering-oriented inputs such as the number of well pumps, hours of operation and efficiency to estimate the money spent by the household on coping with irregular water supply. The money spent on coping will largely be avoided once new water systems begin operation.

The two parts of the "micro-model" term are significant. The models are *micro*-focused, at the level of the individual household or firm. During analysis results for the individual household or firm will be aggregated for reporting purposes. Finally, they are *models* that simplify (complex) coping methods and costs. It is one thing to ask an individual household "how much do you spend to cope with irregular water supply" (likely with significant errors) and quite another to ask detailed questions on the things that create the coping cost in the first place such as the number of well pumps and their hours of operation (likely with many fewer errors).

Most of the data for the micro-model analysis will come from the RID IEP surveys.

The micro-model analysis is described in greater detail in Chapter 3 generally and in Chapters 5 to 8 as applied to individual households, individual firms, water utilities and Governmental institutions respectively.

2.5.4 Social Accounting Matrixes (SAMs) And Computable General Equilibrium (CGE) Analysis

The micro-model analysis method relies on engineering-oriented inputs at the level of the individual household or firm to determine direct impact. SAMs and CGE analysis, on the other hand, takes individual household and firm data, aggregates it to the macro-level and then directly produces macro-economic results (*e.g.,* change in GDP attributable to the RID projects). The macro-impact includes direct impact (as from the micro-model analysis) plus indirect and induced impacts. The SAMs and CGE analysis method is more fully described in Chapters 4 and 9 and Appendixes C, D and J.

At the national level, data for the SAMs and CGE analysis will come from existing DS sources. At the RID city level, data will come from the RID IEP surveys.

2.5.5 Micro-Simulation Analysis

Micro-simulation analysis takes macro-level results (*e.g.*, change in average individual household income level) and disaggregates it to an estimated distribution of household income (*i.e.*, percent of households at each income level).

Data for the RID IEP micro-simulation analysis will come from the (macro-level) CGE results noted above and household data from the RID IEP surveys. Micro-simulations are discussed in Chapter 9 and Appendix K.

2.5.6 Case Study Analysis

In some cases the broad application of the five analytical methods described above is not suitable. This typically occurs when there are only a few affected firms (*e.g.*, the fish company in Poti that has received funding from GRDF) or the impact of the new water and sewer systems is somewhat tenuous (e.g., the combined effect on tourism from Armenia of the new water system in Borjomi and the renovated S-J road). The RID IEP will use case study analysis in these situations.

Data for the case studies will be in-depth interviews during RID IEP with affected firms and institutions. Case study analysis is described in Chapter 8 for the Public Health System and Chapter 10 for the Complementary Activities Impact Group.

2.5.7 Application Of Analytical Methods To Impact Areas

Each impact area will be analyzed using one or more of the analytical methods as shown in the following chart.

6. Analytical Methods Used For Each Impact Sub-Category

IMPACT GROUP	IMPACT CATEGORY	IMPACT SUB-CATEGORY	ANALYTICAL METHOD USED					
			BASLINE AND EX-POST SURVEY	TREATMENT AND CONTROL	MICRO-MODELS	SAMs AND CGE	MICRO-SIMU-LATION	CASE STUDIES
Individual Households	Total Water And Sewer Cost	Monetary Costs		√	√			
		Willingness To Switch	√	√	√			
		Coping Time		√	√			
		Water Consumption	√ (water audit)	√				
	Quality Of Life	Health Incidents	√	√				
		Perceptions Of Safety	√	√				
		Perceptions Of Organoleptic Properties	√	√				
		Public Sanitation Information	√	√				
		Individual Sanitation Practices	√	√				
		Time And Inconvenience Of Not 24/7 Water	√	√				
		Self-Reported Water Consumption	√	√	√			
		Gender Issues	√	√				
Individual Firms	Total Water And Sewer Costs	Monetary Costs		√	√			
		Willingness To Switch		√	√			
		Water Consumption		√	√			
	Business Enablers	Expand Existing Business			√			√
		Enter New Business			√			√
Water Utilities	Operations	Supply		√	√			
		Demand		√	√			
		Water Quality		√	√			
	Finance	Cost Structure		√	√			
		Financial Viability		√	√			
		Efficiency		√	√			
Governmental Institutions	Public Health System	Institutional Arrangements						√
		Water Borne Disease Incidence						√
	Other Budgetary Institutions	Prisons			√			
		Military Bases			√	√		
Overall Economy	Output	GDP				√		
		Productivity Of Labor				√		
		Productivity Of Capital				√		
	Prices	Real prices				√		
		Inflation				√		
	Poverty	Employment Level				√		
		Wages				√		
		Expenditures				√		
	Inequality	Household Expenditures				√	√	
		Gender				√	√	
		Wealth				√	√	
	National Accounts	Current Account				√		
		Capital Account				√		
		Public Finance			√	√		
Complementary Activities	S-J Road Project	Tourism						√
	ADA	Agricultural Output						√
	GRDF	Economic Activity At Micro (company) Level						√
	Free Industrial Zone (FIZ)	General Economic Activity In The FIZ						√
		General Economic Activity In Poti						√

Source: RID IEP Analysis.

2.5.8 Application Of Analytical Methods To Estimating Impact At This Moment

As noted at the beginning of this Section, the RID IEP will be complete before many of the impacts of the RID projects have had time to fully develop. With this in mind, the RID IEP selected methods that would give estimates of impact at this moment and also in an ex-post study in late 2010 or early 2011. The following chart shows how each analytical method will, or will not, produce estimates of impact at this moment, *c.* 2011 and *c.* 2015.

7. Degree To Which Each Analytical Method Will Estimate Or Measure Impact At Different Times

ANALYTICAL METHOD	DOCUMENT BASELINE SITUATION	ESTIMATE LONG-TERM IMPACT AT THIS MOMENT	DOCUMENT EX-POST SITUATION AND ESTIMATE IMPACT *c*. 2011	DOCUMENT EX-POST SITUATION AND ESTIMATE IMPACT *c*. 2015
Baseline And Ex-Post Survey Analysis	Yes	No	Limited; Short Time For Impact To Develop	Yes
Treatment And Control	Yes	No	Limited; Short Time For Impact To Develop	Yes
Coping-Micro-Model Analysis	Yes	Yes At The Micro-Level	Yes, Refine Earlier Estimate At The Micro-Level	Yes, Refine Earlier Estimate At The Micro-Level
SAMs And CGE Analysis	Yes	Yes At The Macro-Level	Yes, Refine Earlier Estimate At The Macro-Level	Yes, Refine Earlier Estimate At The Macro-Level
Micro-Simulation Analysis	Not Applicable	Yes For Distribution Effects	Yes, Refine Earlier Estimate Of Distribution Effects	Yes, Refine Earlier Estimate Of Distribution Effects
Case Study Analysis	Yes	General Impact Only	Preliminarily Confirm Earlier Conclusions About General Impact	Confirm Earlier Conclusions About General Impact

Source: RID IEP Analysis.

The RID IEP will be able to examine the ex-post situation in late 2010 or early 2011, before the Millennium Challenge Georgia Compact ends. Consequently, the RID IEP will be able to apply the analytical methods to estimate and measure impact as shown in the second to the last column in the chart.

2.6 FROM IMPACT SUB-CATEGORIES TO METRICS TO DATA ELEMENTS

The previous Sections described how the Design moves from the Key Research Questions to the Impact Hierarchy and then addresses the impact areas with a range of analytical methods. This Section briefly describes how the Design moves from the impact areas to Metrics (measurements) to needed Data Elements (data).

2.6.1 From Impact Sub-Categories To Metrics

The Impact Sub-Categories were examined one by one and the best way to create the range of related Metrics was chosen. The specifics of each impact area are discussed in subsequent Chapters. In this Section we merely describe the links between Impact Sub-Category to Metrics to Data Elements.

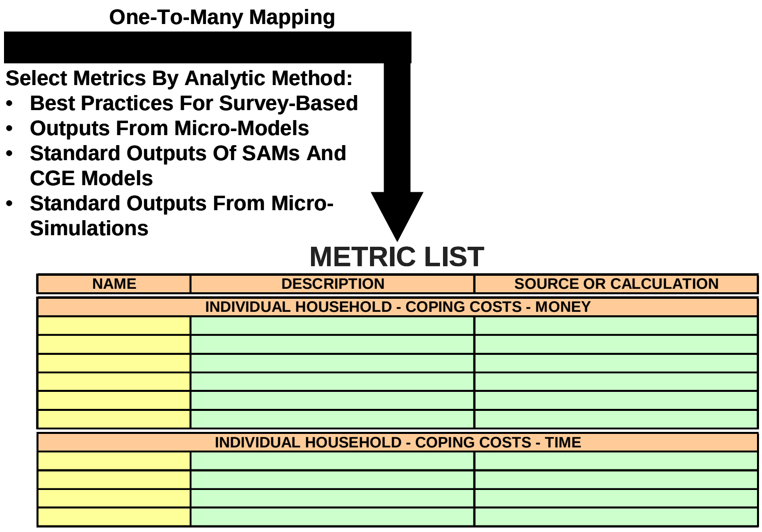
As shown schematically in the following chart, we examined each impact area and chose suitable Metrics along with their calculation method. For impact areas based primarily on baseline and ex-post survey analysis we reviewed work by others in these areas (best practices) to select suitable Metrics and their calculation method. For impact areas that rely primarily on micro-models we relied on the structure of the model itself (*i.e.*, what are the calculated values in the model and are they Metrics?).[8] For SAMs and CGE analysis we used standard outputs of such models (*e.g.*, GDP). For micro-simulation analysis we also relied on usual outputs of such models (*e.g.*, Gini Index). For case study analysis we do not specify any particular Metric as the analysis method primarily results in a description of the situation rather than explicit Metrics.

For each Metric there is a source or calculation that produces the Metric value.

To the end, there is usually a one-to-many mapping between Impact Sub-Category (one) and Metrics (many).

8. <u>Schematic Of How Impact Area And Analytic Method Influenced Selection Of Metrics</u>

IMPACT GROUP	IMPACT CATEGORY	IMPACT SUB-CATEGORY	REPRESENTATIVE METRIC FOR IMPACT SUB-CATEGORY ("Change in ...")
Individual Households	Total Sewer And Water Costs	Monetary Costs	Money spent on electricity to run well pumps Quantity of water consumed
		Time Costs	Hours per week securing water supply
	Quality Of Life	Health	Number Of Incidents Of Gastrointestinal Disease In Household In Last Month
		Perceptions Of Safety	How Are The Sources Of Water That Is Used For Potable Uses Treated Before Consumption
		Perceptions Of Organoleptic Properties	Perception Of Taste Of Alternative Sources Of Water (excluding bottled water)
		Public Information	Frequency Household Receives Information On Testing Of Water Quality (specific test results)
		Water Consumption	Portion Of Water That Is Used For Domestic Purposes
		Sanitation	Number Of Individuals Who Wash Hands With Soap And Water Before Nearly Every Meal
		Time And Inconvenience	Amount Of Time Spent Gathering Water From Distant Locations (e.g., community tap, spring, bottled water)
Individual Firms	Total Water And Sewer Costs	Monetary Cost	Expenditure On Water And Sewer Services
		Time And Productivity	Employee Time Spent On Securing Water
	Business Enablers	Willingness To Switch	Ratio Of Current To Future Water And Sewer Costs
		Expand Existing Business	Switching Cost From Alternative To Municipal Water And Sewer
		Enter New Business	Share Of Alternative Water Consumption In Total Consumption
Water Utilities	Operations	Supply	Non-Revenue Water
		Demand	Water Supplied To Customers
		Water Quality	Number Of Laboratory Tests Failed
	Finance	Cost Structure	Money Spent On Electricity To Run Well And Distribution Pumps
		Financial Viability	Collection Rate
		Efficiency	Employees Per 1 000 Customers
Governmental Institutions	Public Health System	Size Of PHS	Case Study Results (*e.g.* , number of staff dedicated to water issues)
		Effectiveness Of PHS	Case Study Results (*e.g.* , effect on ability to identify and take action on outbreaks of water-borne disease)
	Other Budgetary Institutions	Prisons	Money spent on electricity to run well pumps
		Military Bases	Money spent on transporting water by tanker truck
Overall Economy	Output	GDP	National GDP And GDP In Each RID City
		Productivity Of Labor	GDP Per Capita
		Productivity Of Capital	GDP Per Investment Level
	Prices	Real price	Real Price In Each Sector
		Inflation	Consumer Price Index (CPI)
	Poverty	Employment Level	Size Of Labor Force
		Wages	Real Wages
		Expenditures	Total Consumption
	Inequality	Household Expenditures	Distribution Of Household Expenditures (Gini index)
		Gender	Relative Sizes Of Male And Female Labor Force
		Wealth	Distribution Of Wealth (Gini index)
	National Accounts	Current Account	Net Exports
		Capital Account	Net Foreign Direct Investment
		Public Finance	Water Utility Subsidy
Complementary Activities	S-J Road Project	Tourism	Case Study Results (*e.g.* , number of tourists from Armenia in Borjomi and Kobuleti)
	ADA	Agricultural Output	Case Study Results (*e.g.* , increased output due to better water supply)
	GRDC	Economic Activity	Case Study Results (*e.g.* , reduced production costs due to better water supply)
	Free Industrial Zone	Economic Activity	Case Study Results (*e.g.* , water as enabler of investment)



Source: RID IEP Analysis.

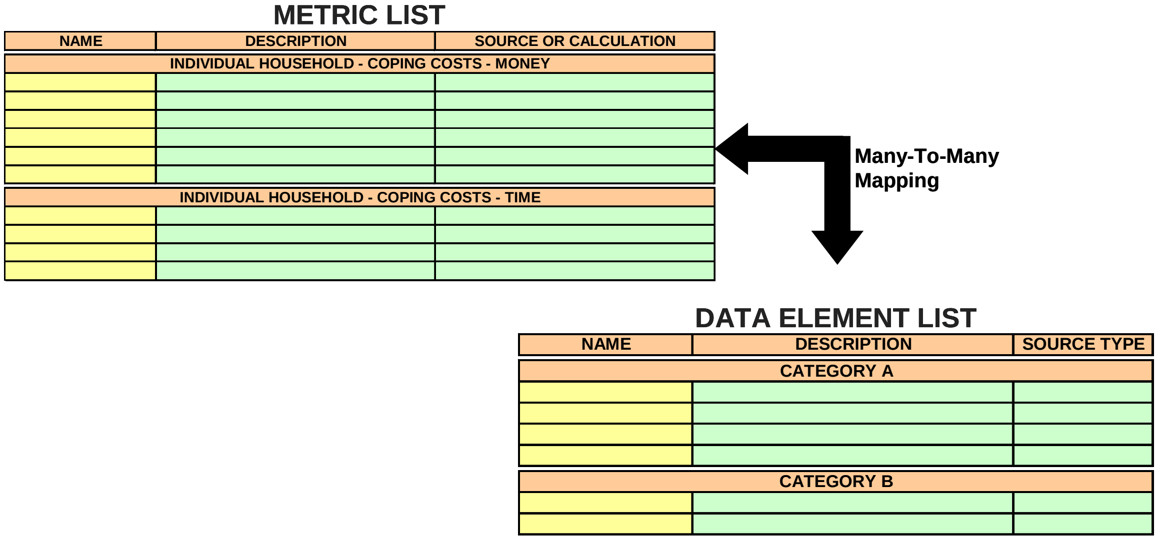
2.6.2 <u>From Metrics To Data Elements</u>

Each Metric is calculated from one or more Data Element (*i.e.*, a bit of data). Each Metric has a known formula for converting the Data Element(s) into the Metric value. A particular Data Element may be related to one or several Metrics; that is, there is a many-to-many mapping between Metrics and Data Elements This is shown schematically in the following chart.

In certain cases a Metric is also a Data Element and vice-versa. For example, hours spent by a firm each week operating an alternative water source (*e.g.*, private well). This value is simultaneously a Metric (for individual firms – costs – time and productivity) and a Data Element (for this same Metric and others where a money value is assigned to the time). In such cases the item is included in both the Metric List and the Data Element List.

[8] The design of the micro-models themselves came from exploratory interviews we did with individual households, individual firms and water utilities.

9. Schematic Of How Metrics Determined The Selection Of Data Elements



Source: RID IEP Analysis.

2.7 AGGREGATION

Surveys for obtaining data elements for each of micro-models are conducted at the individual household or firm level. After data collection the aggregation process will be followed to generalize results for each RID IEP city and for all RID IEP cities together.

One of the main determinants of valid generalization of sample data for a population is a proper sampling methodology and data-weighting procedures. Sampling methodology also defines the tools of aggregation. The tool used by RID IEP is quiet straightforward and it sums up sampling data proportionally to the population.

In order to aggregate results the data will be weighted. In case of households, each household will be given a weight that is opposite to the likelihood of falling into the sample. In particular, the weight $W_i = N_i/n_i$ will be given to each interviewed household in i-type of towns, where N_i is a number of households in the town and n_i is the number of households sampled in the town. Almost the same procedure will be applied to aggregate firm level results. Each enterprise will be given the size which is opposite to the likelihood of falling into the sampling, particularly, the weight $W_i = N_{ij}/n_{ij}$ will be given to each enterprise of j-type of stratum in the i-type of town, where N_{ij} is the number of enterprises in the stratum and n_i is the number of enterprises sampled in this stratum.

For example, assume that proper representative sample was constructed and inquired for the population of one of RID IEP city. That is, it is feasible to generalize the results obtained for the sample for entire population. The sample consists of groups of respondents who share common characteristics, while others do not. For example in the individual household micro-mode, only a portion of the population has coping cost for constructing private water wells. If the population of the city includes 100 households with private wells and sample selects only 20 percent of this group, then results of coping cost for this group will be aggregated for the entire city by multiplying the sample data by five.

Aggregation of data for all RID IEP cities will involve simple weighting and summation of aggregated data for five cities. Future reports, particularly Deliverable F, will describe aggregation methods more thoroughly in the context of the particular sampling methodology being used.

2.8 PROOF OF CONCEPT

The Impact Evaluation Design is novel. Elements have been used in Georgia and other countries but never in the combination used by the RID IEP. Pre-post surveys are well established but they alone cannot answer all the Key Research Questions. Almost none of the economic methods have been used in Georgia before. Not surprisingly, the novelty of the approach does entail some risks.

The RID IEP has closely evaluated the risks of its novel approach. Engineering approaches to estimating coping costs has been done before in a wide variety of settings. In fact, the micro-models used in the Design are substantially simpler than models TBSC has used in the past in Georgia. However, the scale of data collection (*i.e.*, the number of households and businesses to which the micro-models will apply) is greater than has been done before.

A good feature of CGE analysis is that it scales well. These methods have been used for the entire world economy down to country, city and even individual firm levels. This means that applying the CGE analysis to individual RID cities is entirely reasonable. DS has provided data for a SAM before, and will do so again for the SAM and CGE analysis at the national level. Micro-simulations are also well understood and they too scale well.

Both CGE and micro-simulation analysis are well established in the economist's toolkit. While they are not quite off the shelf methods, they are, nevertheless, readily applicable by journeymen economists. Having said that, there still is a certain amount of art to their application and the RID IEP will need the proper artist during use.

Consequently, the RID IEP believes that the core methods are reasonable for use for the Impact Evaluation Design. To confirm this the RID IEP prepared a number of greatly simplified models that took data from micro-models, applied it to a simplified SAM and CGE model and then disaggregated the results through a micro-simulation. The results of these tests are shown in Sub-Section 4.2.4 and Sub-Section 9.3. All the various pieces worked well together and the RID IEP sees no reason why it will not scale well to the RID city level.

While developing the Impact Evaluation Design the RID IEP reviewed hundreds of pages of papers and reviews on impact evaluation methods for water systems and other types of infrastructure projects. On the basis of that review the RID IEP selected and creatively applied the mix of methods that best meets all the requirements of the Key Research Questions. The RID IEP is believes that the Impact Evaluation Design is the best way to accomplish overall RID IEP objectives.

During Design reviews a comment was made that the Design may be too ambitious in two areas: 1) it will require too much data collection and 2) resources to analyze the resulting data will be limited. The first concern is that we may be trading quantity of data for quality of data. That is, by collecting data on so many different Metrics we may fail to collect quality data on any of them. This is a genuine risk that we have considered carefully. In fact, the amount of data to be collected is not as large as it might seem. For example, most of the elements of the household micro-model will not apply to most households because they do not use a broad range of coping strategies. As a result, a properly structured questionnaire with good skips will immediately significantly shorten the interviews. Combined with a good incentive program, we believe that we will achieve our objectives. To the end we will test the length and quality of the surveys when we do pilot testing.

The second concern about the amount of analysis enabled by the RID IEP is very real. We will analyze the resulting data to the maximum extent possible within the analysis budget. We will meet all the requirements of the Contract. At this moment it seems likely that there will be substantial additional analysis that could be done, but that will not be done as it is outside our scope of work. For example, there will be a lot of information on willingness to pay and the current and future costs that could be used to understand alternative tariff policies. The RID IEP is not a tariff study so much of this analytical opportunity will not be exploited as part of the RID IEP. Rather, we will focus our analytic efforts on those matters within the scope of the Contract.

3 MICRO-MODELS TO MEASURE IMPACT

As noted in the previous Chapter, the Impact Evaluation Design uses six analytical methods in six Impact Groups. The details of the analytic methods are discussed in the following Chapters on each of the Impact Groups.

However, micro-models are used in four of the six Impact Groups (*i.e.*, individual households, individual firms, water utilities, plus parts of governmental institutions). Consequently, this Chapter discusses the (same) way micro-models are used to measure and estimate impact in all these Impact Groups. That is, the use of micro-models in practice is discussed in this Chapter. The specific details within each micro-model are in the respective Impact Group Chapters.

This Chapter has four Sections. First we discuss how a micro-model is used to estimate normal (non-coping) costs and coping costs for a single economic player. The second Section describes how the micro-model is used to estimate the impact of the new water and sewer system on the same single economic player. The third Section describes how the results for the single economic player are generalized to an entire Impact Group. The final Section shows how the results of the micro-model are also used in the SAM and CGE analysis that is used to estimate overall economy impacts.

This Chapter uses the micro-model for individual households as an example. Exactly the same method applies to individual firms, water utilities and some parts of Governmental institutions.

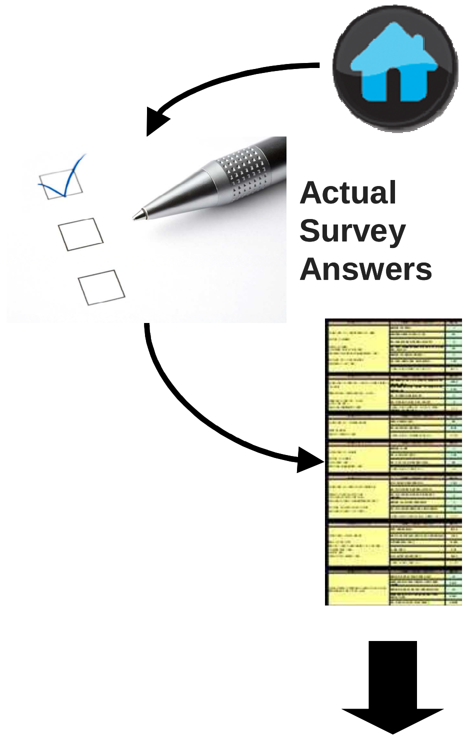
3.1 CURRENT WATER AND SEWER SERVICE COSTS FOR ONE INDIVIDUAL HOUSEHOLD

The micro-model for individual households was developed by meeting with a wide range of households to understand their water and sewer service strategies and costs. An engineering orientation was taken, with particular attention paid to identifying those inputs that determine costs. For example, if the household has a private well then costs are driven by, among other things, the number of well pumps, their power ratings, their load factor, their operating hours and the price of electricity. Details of how this general micro-model approach is applied to individual households, individual firms, water utilities and certain governmental institutions are given in later Chapters.

The following chart shows how the individual household micro-model will be used to estimate and measure water and sewer service costs for a single household. During RID IEP survey work, data will be collected on each of the cost drivers specified in the micro-model (*e.g.*, coping strategy used, number and power ratings of pumps). This data is input into the micro-model and a number of Metric values are output. The chart shows Total Water Cost as one Metric; this comprises 25 of coping costs (pumps, maintenance) plus 5 for actual purchases of municipal water now. In fact, there are many Metrics that are output by the micro-model.

10. Schematic Of How The Micro-Model Estimates Current Water And Sewer Service Costs For A Single Household

Current Situation
Poor Water Supply



Actual
Coping Cost: 25
Municipal Water Cost: 5
Total Water Cost: 30

Source: RID IEP Analysis.

The micro-model is comprehensive so the output will be a good estimate of actual coping costs.[9] The micro-model outputs a broad range of Metrics related to water and sewer service costs in terms of money and time.

3.2 WATER AND SEWER SERVICE COSTS FOR ONE INDIVIDUAL HOUSEHOLD WITH NEW WATER AND SEWER SYSTEMS

The situation with a good water supply is then hypothesized as shown on the following chart. If the household switches to the municipal water supply exclusively, then many of the cost drivers clearly drop to zero (*e.g.*, the time well pumps run) and most coping costs fall to zero.[10] At the same time costs for municipal water rise since more water is coming from that

[9] We will also ask individual households how much they believe they spend on coping. The RID IEP believes that the engineering approach reflected in the micro-models will provide a far superior estimate of actual coping costs.

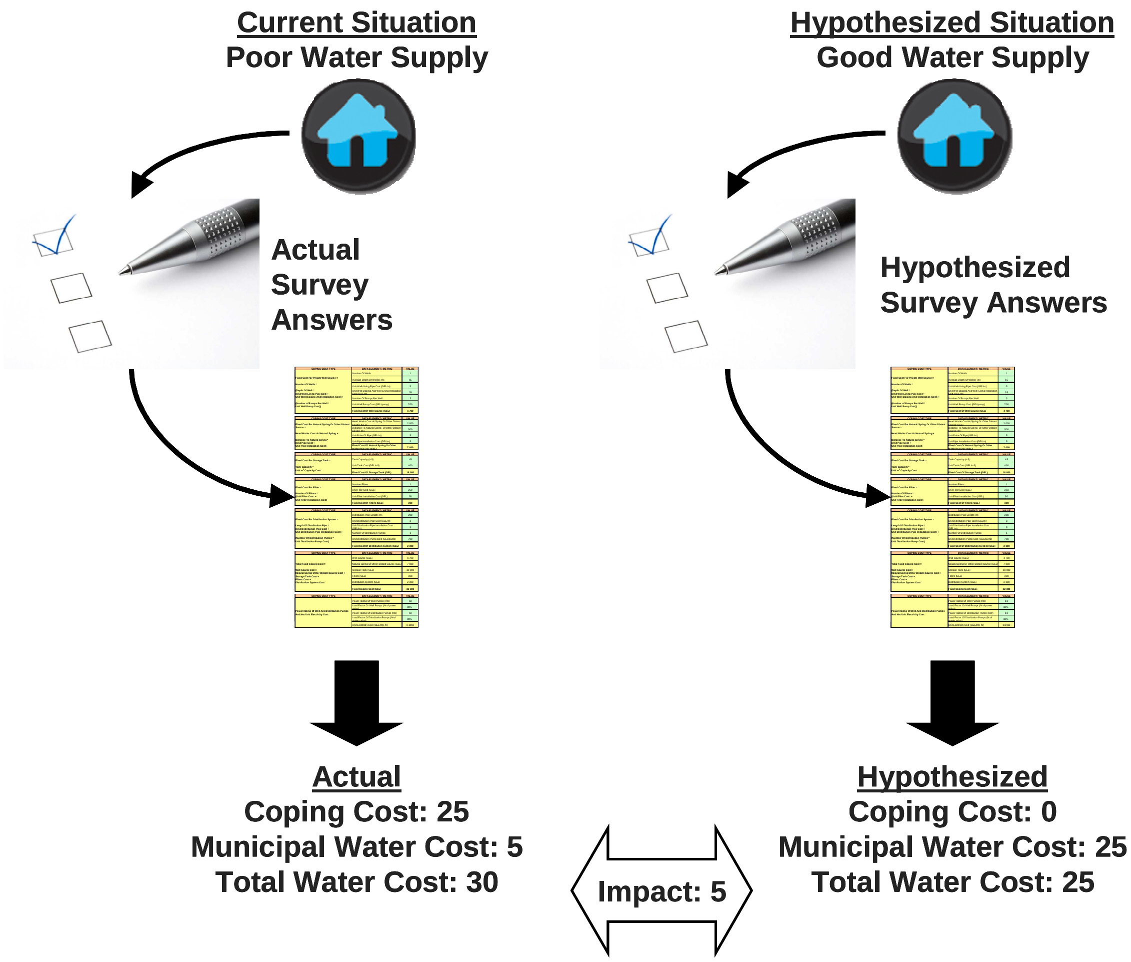
[10] The micro-model assesses the economic benefit of the household switching to the municipal water system exclusively. Switching behavior is driven by the ratio of current water cost (including coping costs) and future (municipal) water costs.

source than in the past. We will ask households about how much water they believe they consume; except for Poti, no meters are installed in households in the RID cities. These estimates are likely to be unreliable so there will be a separate water audit done to better estimate actual water consumption.

This (hypothesized) good water situation is reflected in hypothesized survey answers that are input into the micro-model to create new Metric values.

By comparing the outputs from the micro-model for the current situation (with a poor water supply) and the hypothesized situation (with a good water supply) the RID IEP will be able to estimate the impact of the RID project on each individual household at this time. These estimates will be validated if follow-up surveys are done *c.* 2011 and *c.* 2015.

11. Schematic Of How The Micro-Model Estimates Impact For A Single Household

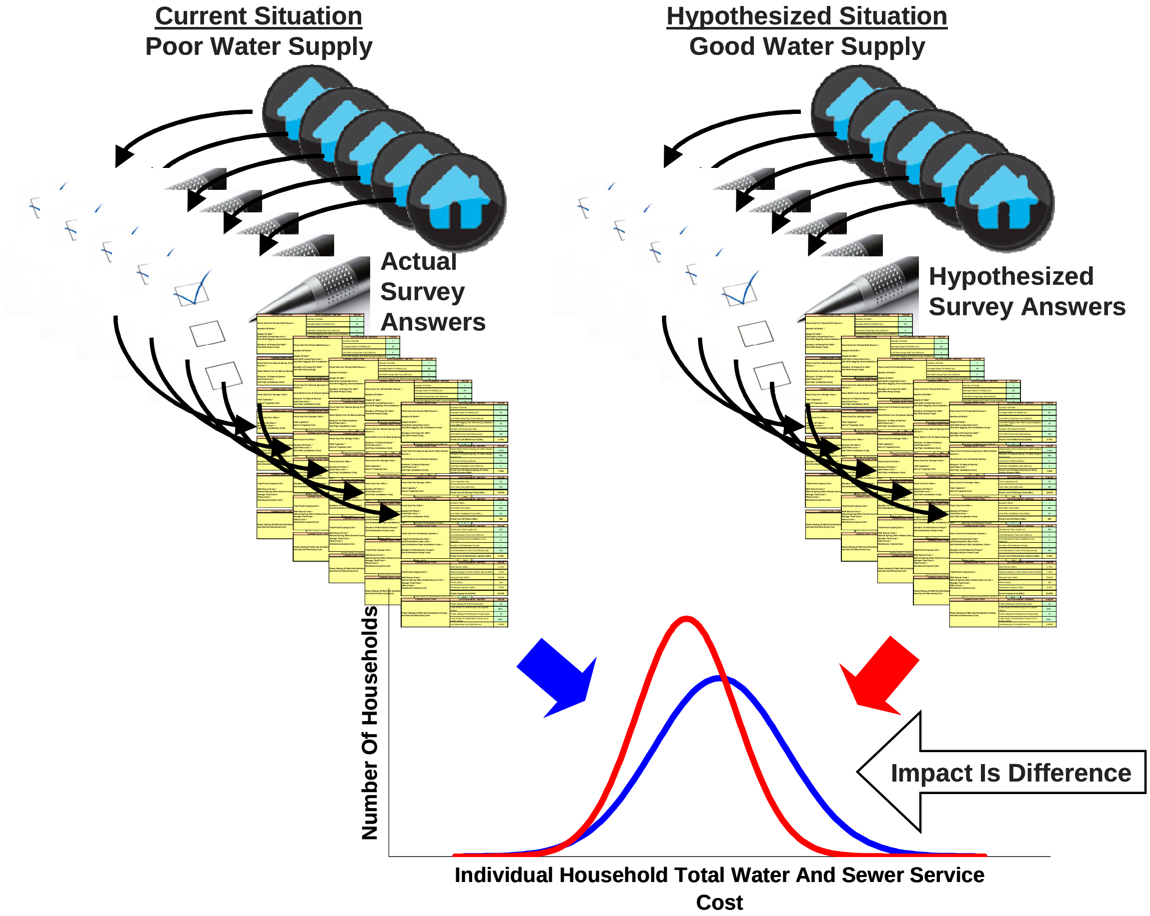


Note: Includes only variable coping costs. Hypothesized answers are straightforward to imagine: hours the distributional pump runs each day falls to zero when there is a good water supply.
Source: RID IEP Analysis.

3.3 WATER AND SEWER SERVICE COSTS FOR INDIVIDUAL HOUSEHOLDS AS A GROUP WITHOUT AND WITH A NEW WATER AND SEWER SYSTEMS

Applying the micro-model to all individual households creates a distribution of water and sewer service costs for individual households as a group as shown in the following chart. Hypothesizing the situation with a good water supply creates a second distribution of water and sewer service costs for the same group. Comparing those two distributions shows the impact of the RID project on individual households as a group.

12. Schematic Of How To Estimate Impact For Individual Households As A Group



Note: Includes only variable coping costs. Hypothesized answers are straightforward to imagine: hours the distributional pump runs each day falls to zero when there is a good water supply.
Source: RID IEP Analysis.

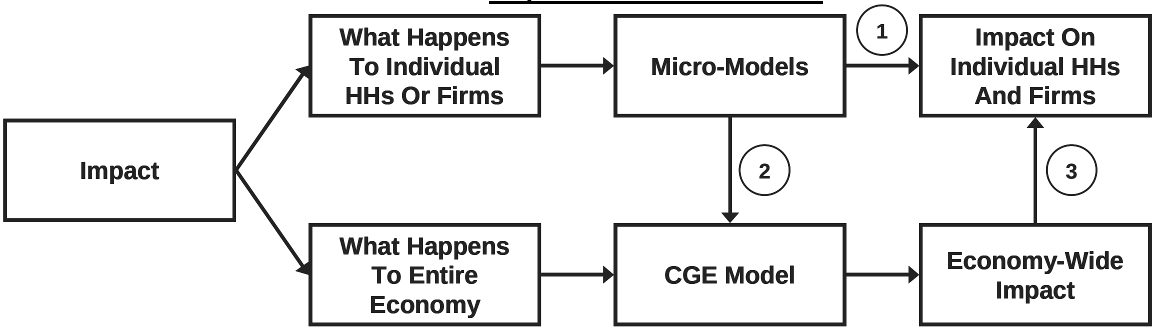
In the example here, the new water system reduces the average cost of water for individual households as a group as well as narrowing the dispersion of costs about the mean.

3.4 MICRO-MODELS AS INPUT TO ECONOMIC MODELING

The micro-models are important for estimating water and sewer service costs for individual households.[11] The models are used for two other purposes as well. As shown in the following chart, (1) the models form the basis for assessing impact on individual households. They also (2) help in the SAM and CGE analysis to understand changes that the new water and sewer systems might require in the production and consumption functions of the CGE models. This will help the CGE models determine economy-wide impacts. Finally, they (3) indirectly form the basis for micro-simulations that will be done using economy-wide results to assess distributional issues related to direct, indirect and induced impacts on households (*e.g.*, differential effects of the RID on poor households).

[11] As well as individual firms, water utilities and some parts of Governmental institutions.

13. Triple Role Of Micro-Models



Source: RID IEP Analysis.

To be clear, the micro-models are data collection and simulation models. They structure the data to be collected to understand costs faced by individual households and firms. They show the economic features that are considered when making decisions about switching to the new water system. They are not regression models in the usual sense.

Taken together, the micro-models form an integrated part of the Impact Evaluation Design.

4 CGE MODELS TO MEASURE IMPACT

Early on it became clear that survey-based methods alone would not be sufficient to determine the impact of the RID projects. There were several considerations:

- Evaluation of impact with only survey-based methods requires both ex-ante and ex-post data
- Impact takes a rather significant amount of time to develop after new water systems begin operation (*e.g.*, time to switch to the new water system, time for new businesses to open)
- For the RID IEP there probably is not the luxury of doing an ex-post survey significantly after the new water systems begin operation[12]
- Regardless of timing issues, survey-based methods alone cannot determine indirect and induced impacts (*e.g.*, cascaded spending, overall GDP growth).

With this in mind, the RID IEP chose to use both survey-based and economic methods to estimate impact. The two approaches are complementary because the economic methods can estimate impact in areas where survey-based methods fall short (*e.g.*, total GDP growth) and survey-based methods can estimate impact where economic methods fall short (*e.g.*, health effects).

This Chapter describes the economic methods chosen by the RID IEP (*i.e.*, SAM and CGE analysis) in both applied and theoretical contexts.[13] The first Section briefly discusses the range of economic methods that were considered and explains the reason why CGE analysis, in particular, was selected. The second Section describes and illustrates CGE analysis in a manner suitable for non-economists. Appendix C describes the theoretical underpinnings of CGE analysis and the range of areas in which CGE analysis is applied. Appendix D shows the results of a simplified CGE model tested by the RID IEP. Appendix J has a full discussion of the key design issues faced by the RID IEP as it created the Impact Evaluation Design.

4.1 ECONOMIC METHODS CONSIDERED

Two economic methods were considered by the RID IEP to assess overall economy impacts: Partial Equilibrium analysis and Computable General Equilibrium (CGE) analysis. Each method is briefly reviewed in the following Sub-Sections.

4.1.1 Partial Equilibrium Analysis

Partial Equilibrium analysis looks at the effects of one change (*e.g.*, a policy, a project, new consumer preferences) on one or two sectors in the economy. It does not have breadth in investigating impacts on a wide array of sectors (*i.e.* prices in other sectors are given). If an

[12] Any ex-post study done as part of the RID IEP would, necessarily, be done very soon after several of the RID projects are complete. However, the Impact Evaluation Design can be applied in several years to obtain a good ex-post data set.

[13] This Chapter focuses on CGE models generally. A later Chapter discusses the specifics of the CGE models being used by the RID IEP.

impact is hypothesized to be primarily confined to one or two sectors, then Partial equilibrium analysis is well poised to investigate those effects.[14]

After visits in the RID cities it became apparent to the RID IEP that impacts from the RID projects are not restricted to only one or two sectors. Rather, the effects are very broad and vary greatly from city to city. Consequently, we chose not to use PE analysis for the RID IEP

4.1.2 Social Accounting Matrix (SAM) And Computable General Equilibrium (CGE) Analysis

SAM And CGE analysis (or simply CGE analysis) focuses on equilibrium in an entire economy (*i.e.*, among many sectors rather than just between one or two sectors). It is founded on three assumptions about behavior and markets:

- Consumers act to maximize their utility (their overall level of well-being); they are price-takers
- Firms act to minimize their costs for any given level of production
- Markets for goods and productive factors must clear (*i.e.*, output levels adjust so that demand equals supply for all factors).

Within CGE analysis, these assumptions can be adjusted as needed to better reflect economic reality.

CGE analysis is suitable when a change will have direct, indirect and induced impacts in many sectors.[15] Water and sewer systems have very large ripple effects in many sectors (no pun intended). These ripples are complex chains of private and local government responses to the new water and sewer systems.

CGE analysis lets one identify both positive and negative effects of such changes. It lets one examine the extent to which observed outcomes can be attributed to a particular project. CGE analysis determines the cause and effect relationships that govern these outcomes. The specific connection between cause and effect sometimes can be a bit of a black box so it is important to properly interpret CGE analysis results.

CGE analysis is wide angle, data intensive and complex in execution; it requires advanced skills and an economists' dedication to explaining effects. Nevertheless, it is relatively easy to understand in concept, as described in the next Section (Basics Of CGE Analysis).

The RID IEP will use CGE analysis to assess the overall economy impact of the RID projects and will answer many of the high-level key research questions (*e.g.*, impact of the RID projects on GDP). This will be possible even though the RID projects will not be finished before the end of the MCG Compact; CGE analysis is a modeling solution to RID project completion timing problems.

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[14] Partial Equilibrium analysis is based on *ceteris paribus* (all else being equal).

[15] A direct effect is when an individual household no longer must spend money on a private water supply. An indirect effect is when that household buys more of a non-water product in the market. That indirect effect ripples through the entire supply chain to create induced effects.

To the end, we selected CGE analysis for RID IEP because it will allow us to understand direct, indirect and induced impacts; attribute impact to RID projects (or otherwise); determine how impact and attribution vary by different time horizons and answer the Key Research Questions more simply, particularly who receives benefits and when.

4.2 BASICS OF CGE ANALYSIS

This Section describes CGE analysis in a greatly simplified form. The theoretical underpinning of CGE analysis is discussed in Appendix C.

This Section has four Sub-Sections. First, the premises behind CGE analysis are reviewed. Then, the general structure and elements of a CGE model are shown with a number of charts. The use of CGE analysis to estimate the direct, indirect and induced impacts of a shock is then described. The Section ends with a discussion of a simplified CGE model of a new water system and the results of that analysis.

4.2.1 Premises Behind CGE Analysis

In any general-equilibrium model there are three elements that need to fit together simultaneously: consumers, firms and market clearing.

Consumers need to maximize utility, both within the period and between periods (if the CGE model is dynamic). Consumers usually behave as price-takers.

Firms need to minimize costs for any given level of production. Under free entry, the final output level is determined by means of a zero-profit condition, which establishes the equilibrium number of firms in the market (at every studied location). In competitive CGE models, firms also take prices as given, though under imperfect competition prices can be manipulated. Generally, the free-entry assumption is characteristic of the long run in static models, whereas in the short run the number of operating firms is given.

Both markets for goods and markets for productive factors need to clear (*i.e.*, output levels adjust so that supply equals demand). The demand for factors needs to be equal to their endowments. These factor endowments (of labor and capital) are usually exogenous, though in dynamic models it is possible to incorporate population growth and capital accumulation.

Therefore, in a simple model with two goods and two factors of production, there will be six basic equations:

- Two describing the product-market equilibrium
- Two describing the factor-market equilibrium
- Two describing the zero-profit conditions.

In CGE analysis the six equations are used to solve for the same number of endogenous variables:

- Output levels (for both goods)
- Factor prices

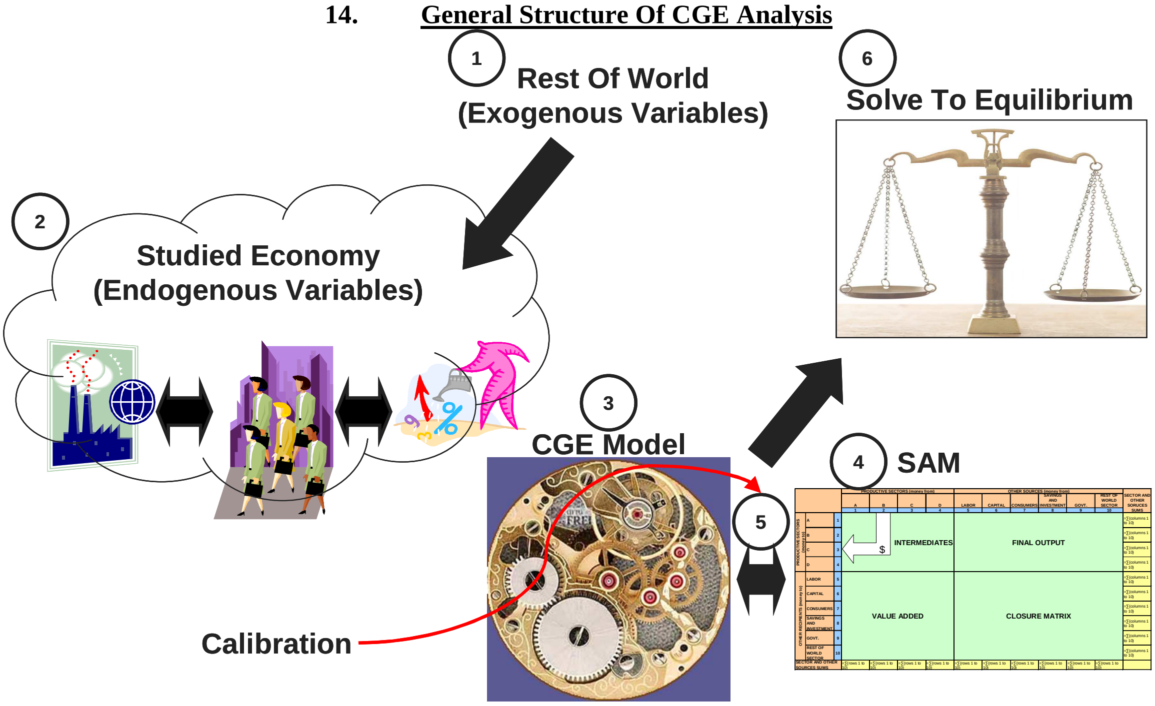
- Good prices.

By using Walras' law, it is always possible to drop one of the equations, since we are only interested in relative prices for the final goods (*i.e.*, one of the goods can be taken as the numeraire).

4.2.2 <u>General Structure Of A CGE Model</u>

During CGE analysis a model of a Studied Economy is created, calibrated and an equilibrium point is determined as shown schematically in the following chart. The six elements of the CGE analysis are described in the following paragraphs.

14. <u>General Structure Of CGE Analysis</u>



Source: RID IEP Analysis.

<u>Rest Of The World (1).</u> In CGE analysis, the world economy is divided between the Rest of the World (ROW) and the Studied Economy (2). The ROW includes economic variables that are outside the control of the Studied Economy (*i.e.*, economic variables that are exogenous such as worldwide interest rates or the price of petroleum).

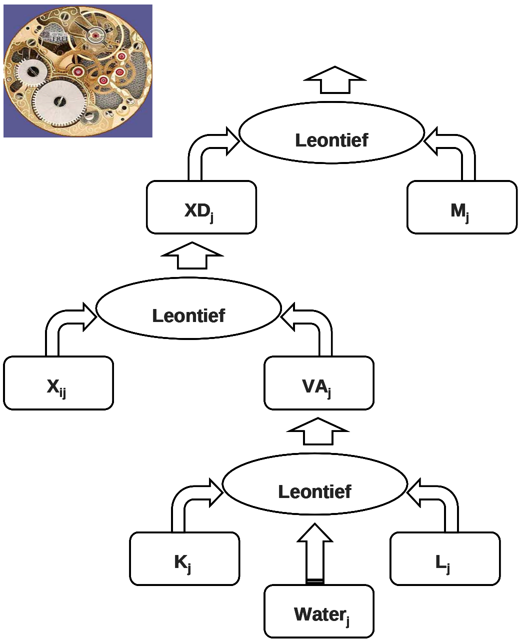
Exogenous variables from the ROW for Georgia (for the RID IEP) include things such as: the geo-political situation vis-à-vis the Silk Road, international demand for tourism services, forecasts of international GDP and CPI changes. Possible exogenous variables for individual RID cities (where the rest of Georgia is the ROW) include: national infrastructure-investment levels, public deficit, external deficit of the Georgian economy and political instability.

<u>Studied Economy (2).</u> The Studied Economy can be a country, a region, an individual city or an individual company. For the RID IEP the Studied Economies are the five RID cities plus the national Georgian economy to a small extent.

<u>CGE Model (3).</u> The CGE model contains relationships (equations) among economic variables (*e.g.*, producers, consumers, factors of production). These production and consumption functions have a great number of parameters that determine the relationships among the economic variables.

The following chart shows some of these relationships schematically. Although the equations look complicated, they are in fact quite straightforward and very well understood and analyzed by economists.

15. **Schematic Of Internal Relationships Among Economic Variables In A CGE model**



Consumers: Cobb-Douglas

$$\max \quad U(C_j, DAHO) = (\prod_{j=1}^{10} C_j^{\alpha_j}) DAHO^{\beta} \qquad \forall j = 1...10$$

$$\text{s.t.} \quad YDISP = (1 - ID)(wL + rK + ipcTSP + TRM)$$

Exogenous Investment And Endogenous Saving

$$\sum_{j=1}^{10} DI_j pinv = DAHOpinv + DP + DPRM$$

Public Sector: Exogenous Public Deficit

$$RIP_j = IP_j \sum_{i=1}^{10} a_{i,j} p_i XD_j + (wl_j + rk_j) VA_j \qquad \forall j = 1...10$$

$$RD = ID(wL + rK + ipcTSP + TRM)$$

$$DP = RD + \sum_{j=1}^{10} RIP_j - TSPipc - \sum_{j=1}^{10} DG_j p_j \qquad \forall j = 1...10$$

Foreign Sector: Exogenous Commercial Deficit

$$DPRM = prm \sum_{j=1}^{10} IMPO_j - TRM - prm \sum_{j=1}^{10} E_j \qquad \forall j = 1...10$$

Source: RID IEP Analysis.

<u>Social Accounting Matrix (SAM) (4).</u> The values of the many parameters in the CGE model are estimated using known data about the Studied Economy. This known data is shown in a Social Accounting Matrix (SAM). SAMs are in common use in the world to evaluate impact of policy changes. Although there is at least one SAM for Georgia, it is dated so a new one will be created for the RID IEP.

The following chart shows the form of a SAM. Essentially, the SAM shows the flow of money in the Studied Economy.[16] The column headers are all the sources of money in the Studied Economy. The row headers have the same names as the column headers. The row headers are all the uses of money in the Studied Economy. Each cell reflects the amount of money flowing *<u>from</u>* the sector in the column header *<u>to</u>* the sector in the row header. The white arrow in the chart shows one such flow, *<u>from</u>* sector B *<u>to</u>* sector C.

The total money flowing *<u>from</u>* a sector (the sum of a column) must equal the total money flowing *<u>to</u>* the sector (the sum of the row with the same name). For example, the sum of column 7 must equal the sum of row 7 (both Consumers). Since SAMs nearly always use data from a variety of sources, the CGE modeler must use a number of analytical methods to ensure that the sum of a column equals the sum of the related row. This process is called balancing the SAM.

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[16] Social Accounting Matrices And Extended Input-Output Tables, by Carsten Stahmer, 2002, describes the linkages between SAMs and Input-Output Tables in the European System of National Accounts. In particular, SAMs add value added and ultimate use features to Input-Output tables.

16. General Form Of A Social Accounting Matrix (SAM)

			PRODUCTIVE SECTORS (money from)				OTHER SOURCES (money from)						SECTOR AND OTHER SOURCES SUMS
			A	B	C	D	LABOR	CAPITAL	CONSUMERS	SAVINGS AND INVESTMENT	GOVT.	REST OF WORLD SECTOR	
			1	2	3	4	5	6	7	8	9	10	
PRODUCTIVE SECTORS (money to)	A	1											=∑(columns 1 to 10)
	B	2											=∑(columns 1 to 10)
	C	3		$	INTERMEDIATES				FINAL OUTPUT				=∑(columns 1 to 10)
	D	4											=∑(columns 1 to 10)
OTHER RECIPIENTS (money to)	LABOR	5											=∑(columns 1 to 10)
	CAPITAL	6											=∑(columns 1 to 10)
	CONSUMERS	7			VALUE ADDED				CLOSURE MATRIX				=∑(columns 1 to 10)
	SAVINGS AND INVESTMENT	8											=∑(columns 1 to 10)
	GOVT.	9											=∑(columns 1 to 10)
	REST OF WORLD SECTOR	10											=∑(columns 1 to 10)
SECTOR AND OTHER SOURCES SUMS			=∑(rows 1 to 10)	=∑(rows 1 to 10)	=∑(rows 1 to 10)	=∑(rows 1 to 10)	=∑(rows 1 to 10)	=∑(rows 1 to 10)	=∑(rows 1 to 10)	=∑(rows 1 to 10)	=∑(rows 1 to 10)	=∑(rows 1 to 10)	

Source: RID IEP Analysis.

The relationship between Labor and Consumers deserves special mention. Money flows *from* productive sectors *to* labor (e.g., *from* column 3 *to* row 5). The same money then flows *from* labor *to* consumers (*i.e.*, *from* column 5 *to* row 7) and then *from* consumers *to* productive sectors and other items shown in the lower left corner of the SAM (*i.e.*, *from* column 7 *to* rows 1 to 10).

The SAM has four quadrants. The upper left quadrant contains all intermediate production in the Studied Economy. This shows the flow of money between various productive sectors (*e.g.*, *from* sector C *to* sector D).

The upper right quadrant is purchase (and use) of final output from the productive sectors, for example, the intersection of column 7 and row 3 shows the purchase of the output of sector C by consumers (consumers pay money to sector C and receive goods or services in return). This quadrant is final demand including consumption, investment, savings and investment and net exports (*i.e.*, the ROW sector).

The lower left quadrant shows the value added by the productive sectors; this is money spent by the productive sectors on things other than intermediate inputs. This includes wages (money spent on and value added by labor), returns on investment (money spent on and value added by capital), taxes (money sent to the Government) and imports (money sent to the ROW to buy imports).

The lower right quadrant is called the Closure Matrix because it incorporates some data that is absent in the rest of the SAM. These new data reflect the destination of labor and capital income (*e.g.*, how that income is spent on consumption, investment and taxes for the Government). It also shows how the Government transfers resources to consumers via transfers. To the end, the Closure Matrix connects sources of income (productive factors) with sources of demand. It allows obtaining induced effects, whereas the rest of the SAM only yields direct and indirect effects.

One of the assumptions of CGE analysis is that economy is in balance (*i.e.*, it is at equilibrium), which means that the supply of each good and service, labor and capital is equal to the demand. The Closure Matrix contains the data that balances the whole economy.

For the RID IEP, several different SAMs will be used. A national SAM (in two forms) will be created using data from DS. Five city-level SAMS (also in two forms) will be created using new primary data from the RID IEP surveys.

Calibration (5). During calibration the known values in the SAM are used to estimate the parameters in the equations that are in the CGE model. Often there is sufficient data in the SAM to fully estimate all the parameters. In other cases some external data is needed to fully estimate the parameters. The micro-models described in earlier Chapters will be used as needed for this purpose for the RID IEP.

Equilibrium (6). After calibration, the CGE model is a model of the Studied Economy at equilibrium. In the case of the RID IEP, the Studied Economy (be it the national economy or the individual RID city economies) will be at equilibrium *without the new water and sewer systems*.

A Second View Of The Social Accounting Matrix (SAM). The SAM can also be visualized as a generalized macroeconomic model of the structure of the economy as shown in the following chart.

17. Social Accounting Matrix (SAM) As A Generalized Macroeconomic Model Of The Economy

Money From → $A = C + I + G + X$

Money To

	Productive Sectors	Labor	Capital	Consumers	Savings And Investment	Govt.	ROW Sector
Productive Sectors	A	0	0	C	I	G	X
Labor	W	0	0	0	0	0	0
Capital	∏	0	0	0	0	0	0
Consumers	0	W	∏	0	0	0	0
Savings And Investment	0	0	0	0	0	PD	(ROWD)
Govt.	T1	0	0	T2	0	0	0
ROW Sector	M	0	0	0	0	0	0

Final Output

Final Output

Value Added

Intermediates
Actually Many Columns And Rows
(many sectors)

$$A = W + \prod + T1 + M$$

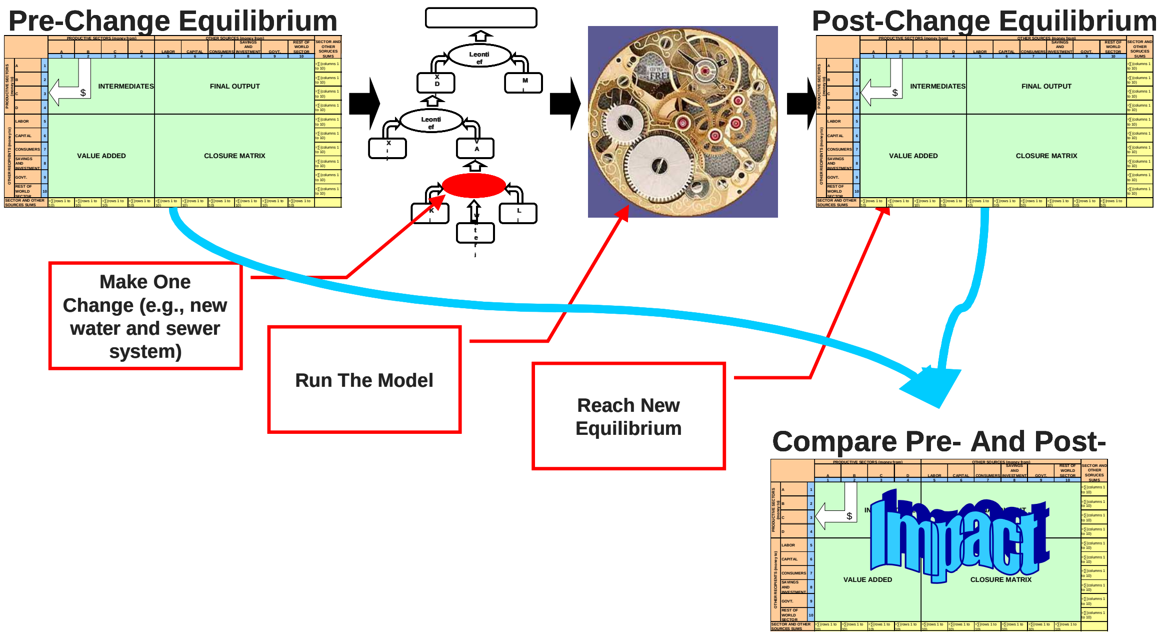
Source: RID IEP Analysis.

4.2.3 Applying A Shock To A CGE Model To Determine Its Effect

The next step in CGE analysis is to apply a shock to the CGE model and trace its effect on the entire economy. For the RID IEP the "shock" is the operation of the new water systems. The new water system is a form of new technology. For business, new technology will cause production functions to change (*e.g.*, the fixed cost of water may decrease, the variable cost of water may increase). For households, new technology will change their consumption patterns (*e.g.*, money previously spent on water coping costs will be spent in other areas).

These effects, due to the new technology, are reflected in adjusted parameters and, sometimes, form of the production and consumption functions. When the CGE model is again allowed to reach equilibrium (with the new parameters and functional forms) the state of the economy after the new technology is shown in a new SAM. This is shown schematically in the following chart.

18. <u>Determining Impact Of A Shock (*e.g.*, a new water and sewer system)</u>



Source: RID IEP Analysis.

Comparing the equilibrium state of the Studied Economy before and after the application of the change (the new water and sewer system) will let the RID IEP understand the direct, indirect and induced impacts of the change. Since the SAM is a representation of the Studied Economy, all the individual cells in the SAM can be compared pre- and post-change to understand the impact of the change on each individual element. For example:

- The sum of the changes in the cells in the upper left quadrant (the productive sectors) shows total change in GDP
- The change in the sum of the consumption column shows total change in consumption by households
- The change in the sum of the Government row shows total change in taxes.

There are, of course, many other impacts (changes) that can be read directly from the comparison of the pre- and post-change SAMs.

4.2.4 <u>Simplified Example Of CGE Analysis</u>

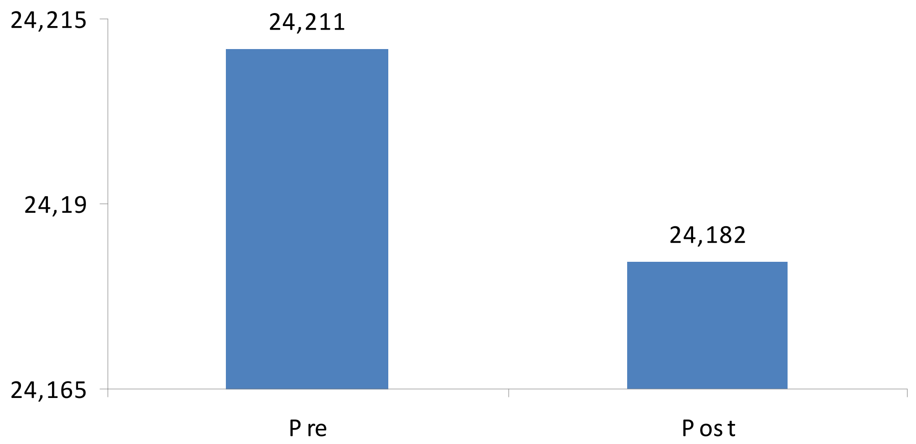
The RID IEP created a model of a simple economy including three productive sectors (*i.e.*, large hotels, small guesthouses and the rest of the economy).[17] Details of the model are shown in Appendix D.

We created a typical SAM and estimated the model parameters. The model was calibrated to an equilibrium state without a new water system using data from a small survey among hotels in several locations.[18]

A single shock of a new water system was applied to this greatly simplified model. The production functions were changed to reflect the new technology and the CGE model was re-calibrated, giving a new SAM.

Comparing the pre- and post-change SAMS estimated the sum of direct, indirect and induced changes in the economy (*i.e.*, estimate of overall impact). For example, as shown in the following two charts nominal wages fell but overall worker welfare increased because prices fell by more than the decrease in nominal wages.

19. Effect Of New Water System On Nominal Wages In Simplified CGE Model



Source: RID IEP Analysis.

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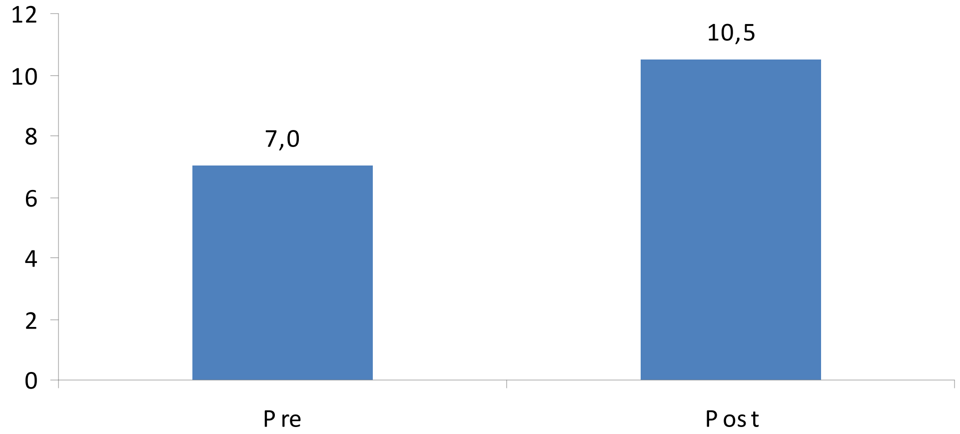
[17] This simplified CGE model is described in a discussion document (*CGE For Poets – With GAMS Software*, May 18, 2009).
[18] This survey was done to better understand the ways hotels cope with water problems. These results were primarily used to create the micro- models discussed in other Chapters.

20. <u>Effect Of New Water System On Worker Welfare In Simplified CGE Model</u>



Source: RID IEP Analysis.

Note that these results are for a very simplified economy and the results from the full CGE models used for the RID IEP will be very different. Nevertheless, the results from this simplified model suggest the type of results that can be expected from the full RID IEP CGE analysis. Details about the simplified model are shown in Appendix D.

DETAILED DESIGN IN EACH IMPACT GROUP

5 INDIVIDUAL HOUSEHOLDS IMPACT GROUP

This Chapter describes the portions of the Impact Evaluation Design related to individual households at the micro-level.[19] As described in Chapter 2, impacts on individual households are divided into two Impact Categories (*i.e.,* Total Water And Sewer Costs, Quality Of Life) and then further divided into several Impact Sub-Categories as shown in the following chart.[20] The final column in the chart shows one representative Metric for each Impact Sub-Category.

There are a number of Primary Metrics (not the representative Metrics shown in the chart) that drive the sample sizes for the individual surveys. The Primary Metrics are defined in Chapter 11 as part of treatment and control.

21. Impact Hierarchy For Individual Households Impact Group

IMPACT GROUP	IMPACT CATEGORY	IMPACT SUB-CATEGORY	REPRESENTATIVE METRIC FOR IMPACT SUB-CATEGORY ("Change in …")
Individual Households	Total Water And Sewer Cost	Monetary Costs	Total Annualized Semi-Variable Cost Of Water And Sewer
		Willingness To Switch	Likelihood To Switch For Water And Sewer Combined (larger is more likely to switch)
		Coping Time	Annual Time Spent On Managing Private Water System
		Water Consumption	Annual Water Consumption By Shower And Bathtub For Bathing
	Quality Of Life	Health Incidents	Number Of Incidents Of Gastrointestinal Disease In Household In Last Month
		Perceptions Of Safety	How Are The Sources Of Water That Is Used For Potable Uses Treated Before Consumption
		Perceptions Of Organoleptic Properties	Perception Of Taste Of Alternative Sources Of Water (excluding bottled water)
		Public Sanitation Information	Frequency Household Receives Information On Testing Of Water Quality (specific test results)
		Individual Sanitation Practices	Number Of Individuals Who Wash Hands With Soap And Water Before Nearly Every Meal
		Time And Inconvenience Of Not 24/7 Water	Most Likely Use Of Newly-Free Time If Water Was Available 24/7
		Self-Reported Water Consumption	Portion Of Water That Is Used For Domestic Purposes
		Gender Issues	Total Number Of Hours Spent Working In The Home By Women

Source: RID IEP Analysis.

Also as noted in Chapter 2, three of the six analytical methods are used to evaluate impact on individual households as shown in the following chart. All impact areas for individual households will be subject to treatment and control methods.

[19] Overall economy impacts measured by the CGE analysis are discussed in Chapter 9.

[20] Throughout this Report the term "impact area" refers to one cell in this table at the Impact Group, Category or Sub-Category levels. Consequently, Individual Households, Total Water And Sewer Costs and Health are each impact areas, although at different levels in the Impact Hierarchy.

22. Analytical Methods Used For Individual Households Impact Group

IMPACT GROUP	IMPACT CATEGORY	IMPACT SUB-CATEGORY	REPRESENTATIVE METRIC FOR IMPACT SUB-CATEGORY ("Change in ...")	ANALYTICAL METHOD USED: BASLINE AND EX-POST SURVEY	TREATMENT AND CONTROL	MICRO-MODELS	SAMs AND CGE	MICRO-SIMU-LATION	CASE STUDIES
Individual Households	Total Water And Sewer Cost	Monetary Costs	Total Annualized Semi-Variable Cost Of Water And Sewer		√	√			
		Willingness To Switch	Demand Curve For Municipal Water	√	√	√			
		Time Costs	Annual Time Spent On Managing Private Water System		√	√			
		Water Consumption	Annual Water Consumption By Shower And Bathtub For Bathing	√ (water audit)	√				
	Quality Of Life	Health Incidents	Number Of Incidents Of Gastrointestinal Disease In Household In Last Month	√	√				
		Perceptions Of Safety	How Are The Sources Of Water That Is Used For Potable Uses Treated Before Consumption	√	√				
		Perceptions Of Organoleptic Properties	Perception Of Taste Of Alternative Sources Of Water (excluding bottled water)	√	√				
		Public Sanitation Information	Frequency Household Receives Information On Testing Of Water Quality (specific test results)	√	√				
		Individual Sanitation Practices	Number Of Individuals Who Wash Hands With Soap And Water Before Nearly Every Meal	√	√				
		Time And Inconvenience Of Not 24/7 Water	Most Likely Use Of Newly-Free Time If Water Was Available 24/7	√	√				
		Self-Reported Water Consumption	Portion Of Water That Is Used For Domestic Purposes	√	√	√			
		Gender Issues	Total Number Of Hours Spent Working In The Home By Women	√	√				

Source: RID IEP Analysis.

At a summary level, the first Section of this Chapter describes three overall Metrics for the individual households Impact Group. There are many Metrics related to impact on individual households. However, the three Metrics discussed in the first Section are representative of what will be in the executive summary of the final report of the RID IEP.

The second Section of this Chapter concerns the money and time spent by households for water and sewer services, willingness of households to switch to the new water and sewer systems and the amount of water households consume. This includes payments to the water utility as well as coping costs related to private wells and other alternative sources of water and sewer services.

The individual household micro-model is used to estimate both the monetary and time Impact Sub-Categories (and related Metrics) of the RID projects. The micro-model also specifies the precise Data Elements needed to calculate the Metrics for the monetary and time Impact Sub-Categories.

The third Section turns to the quality of life Impact Category including health incidents; perceptions of safety of water and sewer systems; perceptions on taste, smell, cleanliness and color of water; public sanitation information; individual sanitation practices; time and inconvenience of less than 24/7 water; self-reported water consumption and gender issues. The Section specifies the Metrics for these Impact Sub-Categories and the Data Elements needed to report the Metrics for quality of life for individual households.

5.1 OVERALL IMPACT FOR INDIVIDUAL HOUSEHOLDS GROUP

Individual households are one of six Impact Groups in which overall impact from the RID projects will be reported. Considering the Key Research Questions and what the RID IEP knows about the impact of water and sewer systems on individual households, the RID IEP will report the summary Metrics (impacts) for the individual household Impact Group that are shown in the following chart. Additional Metrics will be reported in the Executive Summary of the final RID IEP report as needed. Note that many more Metrics related to the individual households Impact Group are discussed in the remainder of this Chapter.

23. Summary Metrics For The Individual Households Impact Group

SUMMARY METRIC (Change In ...)	MEAN FOR REPORTING GROUP			
	OVERALL	CITY X	HOUSEHOLD TYPE Y	OTHERS AS DESIRED
Total Annualized Semi-Variable And Annual Variable Cost Of Water And Sewer				
Self-Reported Incidence Of Water-Borne Disease Among Young Children In Last Two Weeks				
Total Annual Water Consumption				

Source: RID IEP Analysis.

A variety of reporting groups will be used (*e.g.*, overall, by individual city, by household type) for the three summary Metrics. We will also report confidence intervals for the mean of each reporting group as well as other measures of distribution of values among individual households in the reporting group.

After ex-post surveys, the values reported will be based on the Treatment and Control aspects of the Design (*i.e.*, difference of differences) discussed in Chapter 11.

Each of the summary Metrics is described further in the following paragraphs.

Total Annualized Semi-Variable And Variable Cost Of Water And Sewer. The first Metric equals the total spending by households on water and sewers services including municipal water (at tariff rates) and variable coping costs (*e.g.*, electricity to run a private well pump). Values come from the detailed micro-model of water and sewer costs for individual households discussed in the next Section of this Chapter.

The pre-post change in this summary Metric represents the direct monetary impact on households of the RID projects. If the Total Expenditure falls once households have access to the new water and sewer systems then one can expect households to voluntarily switch from alternative sources of water and sewer service to municipal water and sewer services.

Self-Reported Incidence Of Water-Borne Disease Among Young Children In Last Two Weeks. The second Metric measures the self-reported incidence rate of water-borne disease. Self-reporting is used because there are not reliable public records of incidents and most households self-medicate in any case.

The pre-post change in this summary Metric represents the direct health impact on households of the RID projects.

Total Annual Water Consumption. The third summary Metric shows the result of a detailed water audit among a sub-set of households. It is difficult to forecast whether water consumption will rise or fall once the new water and sewer systems begin operations. If households switch to municipal water (with meters) then they will have an incentive to use less water. On the other hand, the presence of water 24/7 will make it easier for households to increase water consumption, regardless of the cost.

The pre-post change in this summary Metric represents the impact on water consumption of the RID projects.

5.2 TOTAL WATER AND SEWER COST IMPACT CATEGORY

Individual households have responded to unreliable water in a variety of ways. All of these ways of coping with unreliable water create costs for households compared to a situation where there is potable municipal water 24/7. This Section describes these individual household coping strategies and related costs in terms of both money and time. This Section also considers municipal water and sewer costs since the (potential) reduction in total water and sewer costs (however supplied) is what will provide the economic motivation for individual households to switch to the new water and sewer systems.

Overall water consumption by individual households (based on a water audit) is also included in this Section.

The individual household micro-model gathers together all the various factors that affect water and sewer costs for individual households. Depending on the coping strategy used by a particular household, some elements of the micro-model will not apply; these sections of the micro-model would report zero cost in this case. The micro-model discussed here is a generalization of ten individual models that were prepared by the RID IEP for different RID cities and different living arrangements. The generalization step complicated the resulting model but did not remove any detail of the city-specific or living-arrangement-specific models.

Given a particular coping strategy, it is more or less straightforward to estimate total water and sewer costs for an individual household. Costs are largely determined by the coping strategy chosen by the household (*e.g.*, whether to install a private water well or not), operating costs (*e.g.*, electricity costs) and the municipal water and sewer tariffs. The coping strategy is determined by several factors: average length of water supply (per day, per week), technical possibility of digging a well and so forth.

The micro-model considers all the possible coping strategies used by individual households and categorizes costs into fixed, semi-variable and variable. Time used to provide reliable water is also included in the micro-model.

The micro-model was designed on the basis of exploratory interviews with a broad range of households.

This Section has nine Sub-Sections. The first describes the range of coping strategies used by individual households. These are defined in some depth to ensure a common understanding of their meanings.

The next three Sub-Sections discuss fixed, semi-variable and variable costs for individual households at a summary level. The detailed calculations, Metrics and Data Elements in the micro-model are shown in Appendixes E, L and M. The following Sub-Section combines the costs into annual water and sewer costs.

The next Sub-Section describes the economic willingness of individual households to switch to the new water and sewer systems. It calculates a ratio between current and future total water and sewer costs. The larger the ratio the more households will save by switching and the higher the likelihood that they will actually switch.

The following Sub-Section also looks at willingness to switch, but now based on perceptions of value rather than economic factors alone. This is not based on the micro-model but rather on a series of questions concerning affordability that will be asked in the households.

The next Sub-Section discusses the coping time households expend because municipal water is less than 24/7. Nearly every coping strategy entails the household spending time on water and sewer issues, time that could be spent on other endeavors if municipal water was available 24/7.

The final Sub-Section concerns a water audit that will be done to determine actual water consumption among individual households.

5.2.1 Coping Strategies

Preparatory interviews and focus groups with households identified a broad range of coping strategies used by households because they do not have municipal water 24/7. Nearly every household has a coping strategy of one type or another. In many cases households use more than one coping strategy at the same time. To the end, coping strategies are related to improving the municipal water supply (*e.g.*, storing municipal water for later use) or creating an alternative source of water (*e.g.*, a private well), improving sewage arrangements or all three. Coping strategies are also sometimes used for problems in the municipal sewer systems.

There are five broad Coping Need Areas with several Coping Methods within each as shown in the following chart. Textual comments about the features of each Coping Need Area and Coping Method are also specified in the chart.

Coping strategies are merely the combination of several basic Coping Methods as shown in the chart. This permits the cost of a coping strategy, and overall water and sewer costs, to be calculated by simply adding up the estimated household spending on each applicable Coping Method.

24. Coping Methods Used By Individual Households

COPING NEED AREA	COPING METHOD	FEATURES
Water Supply	Municipal Water Connection	Municipal water connected to local water storage, directly to household or both
	Neighbor's Municipal Water Connection	Agreement with neighbor to use his or her municipal water connection; connected to local water storage, directly to household or both
	Shared Municipal Water From A Public Tap (often in the building's courtyard)	Water from public tap typically transported to household by bucket or plastic tank; water may be placed (poured) into local water storage upon return home
	Private Water Well	Private well constructed by household; primarily at private houses; may have an electric pump manual pump or a windlass with bucket; may be connected to local water storage, directly to household or both; may require carrying water to houshold
	Neighbor's Private Water Well	Agreement with neighbor to use his or her private well; may be connected to local water storage, directly to household or both; may require carrying water to houshold
	Shared Private Water Well	Well that is bult and managed by a group of households; connection to shared or private local storage, directly to household or both; may require carrying water to household
	Spring Or Other Distant Source	A natural spring some distance from household; transportation (vehicle or walking) needed to transport water to household; if possible, spring is connected to local storage by supply pipe with headworks of some type at spring
	Bottled Water	Mainly used for drinking and cooking purposes
	Tanker Truck Water	Water brought to household in large increments; always placed in some type of local water storage
Water Storage	None	Reliable municipal water makes local water storage unnecessary
	Outside Water Storage Tank	Typically at private houses; can be at ground level (with a water distribution pump at the outlet) or elevated (with a filling pump at the inlet)
	Neighbor's Outside Water Storage Tank	As with Outside Water Storage Tank, except shared with a neighbor
	Private Roof Tank At Apartment Block	For a single household in an apartment block; often requires a pump to fill the tank
	Shared Roof Tank At Apartment Block	For many or all households in an apartment block; often requires a pump to fill the tank
	Shared Ground-Level Or Underground Tank At Apartment Block	For many or all households in an apartment block; requires some type of pressurizing pump (shared or individual)
	Inside Water Storage Tank	Tank for single household, typically in bathroom; filled from a variety of water sources
	Buckets And Other Water Containers	Hand-carried storage; filled with spring or municipal water
Water Filters	Water-Treatment	Filter shared by several or many households
	Point-Of-Use	Filter on individual water tap in household
Water Distribution System	Gravity-Fed System	Needs elevated water storage tank; often there is a tank filling pump at the inlet
	Pump-Pressurized System	Needed with groundlevel or underground water storage tanks; distribution pump to pressurize water as it exits from storage tank
	Distribution Piping	Pipes leading from water storage tank to a connection with house
Sewer System	Municipal Sewer System Connection	Connection to municipal sewer system
	Sewer Outfall System	Long pipe to river or sea; may require pump adjacent to household or at outfall end works
	Sewage Storage Tank	Steel or metal tank; distribution pumps and pipes; typically emptied by sewage tanker truck
	Sewer Tank Truck	Connection for sewer truck to sewage storage tank

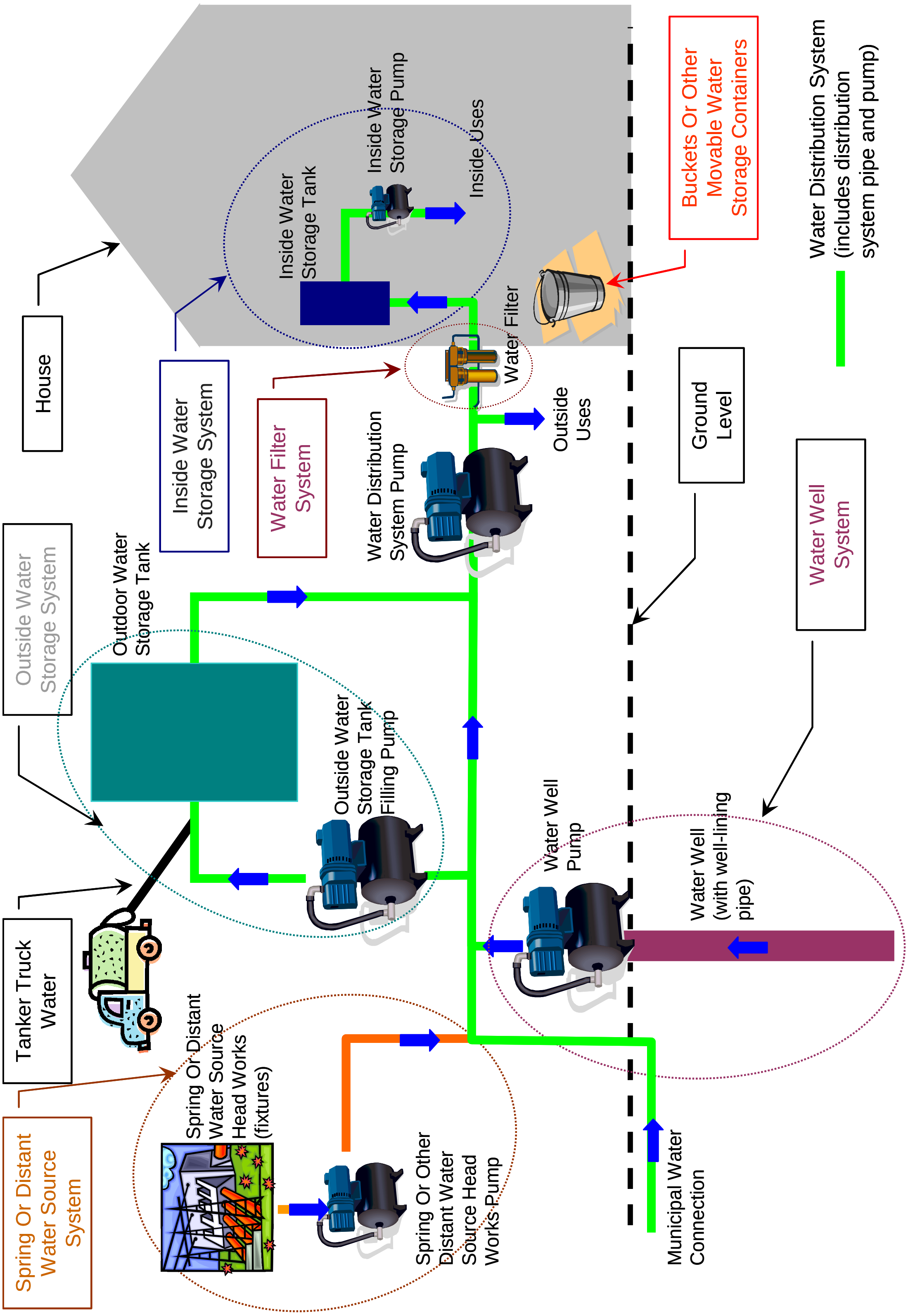
Source: RID IEP Analysis.

The different elements of water systems are shown in the following chart and described in the following. The terms used in the chart are used throughout the individual household (and other) micro-models.

Water Supply. There are several water sources including private or shared municipal water connections, private or shared water wells, spring water, bottled water and tanker truck water. Municipal water is mainly available with a schedule while provision from other sources (alternative sources), such as a water well, has no temporal pattern. Technical means used to obtain alternative source water include manual or mechanic well pumps, head works and piping.

Water supply has a sense of obtaining a fixed volume of water each day without considering the temporal pattern of usage. Supply could be 24/7 or one hour every two days. In both cases the source and quantity of water supplied is what is important. The means of ensuring access to water 24/7 is discussed next in the context of water storage.

25. <u>Schematic Of Household Water Systems</u>



Water Storage. Water storage is used by households to ensure access to water 24/7. Technical means include shared or private storage tanks (*e.g.*, *e*levated, on the roof, in-bathroom, ground-level, underground, steel or concrete), pumps used for filling storage tanks and piping that connects the tank to water sources.

Water Filter. Filters are sometimes used to purify water. Filters are either for general water treatment (for all water used in one or more households) or point-of-use (a filter on a single tap in the home).

Water Distribution System. The water distribution systems comprise three elements. If there is an elevated water storage tank then the system is typically just piping to bring the water down to ground level under gravity-fed pressure. If the storage tank is not elevated (or not elevated enough) then there is a pressurizing water distribution pump. Finally there is a variety of distribution piping to delivery pressurized water (either gravity fed or from a pressurizing pump) to the household.

In apartment blocks, the riser pipe from the basement to the individual household plus the pressurizing pump for the riser are part of the local distribution system for the household. If water is stored in a tank on the roof of the apartment block, then the pipe from the roof water storage tank to the household is part of the local distribution system.

Sewer. Households may have connections to the municipal sewer system, a private sewage storage tank or a private outflow pipe ending in a river or the sea. If the household does not have a connection to the municipal sewage system then sewage tanker trucks are used to periodically empty the sewage storage tank.

5.2.2 Water And Sewer Fixed Cost

Fixed costs are costs incurred for building initial water and sewer infrastructure. Fixed costs are incurred only once and then they are sunk costs. Examples of these types of costs are fees to connect to the municipal water system, water well construction costs and pump and tank purchase costs.

The following chart shows the fixed water and sewer costs that individual households may incur. Not all individual households incur all or even any of these costs.[21] Generally, any fixed costs other than connection to the municipal water and sewer systems would be considered to be coping costs – costs incurred by the household because there is not reliable water 24/7.

The following charts are relatively small and perhaps difficult to read. Larger versions are shown in Appendix F.

[21] In the micro-model the representative household incurs all types of costs, giving unrealistically high total water and sewer costs. This is not typical; most household will face costs much less than those shown in these fragments of the micro-model.

26. Individual Household Water And Sewer Fixed Cost

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE მნიშვნელობა
Total HH Non-Coping-Related Fixed Cost For Water And Sewer = Fixed HH Cost Of Municipal Water Connection + Fixed HH Cost Of Municipal Sewer Connection **Total HH Coping-Related Fixed Cost For Water = (Fixed HH Cost Of Water Well System + Fixed HH Cost Of Spring Or Distant Water Source System + Fixed HH Cost Of Outside Water Storage Tank System + Fixed HH Cost Of Water Distribution System) * (2 / 2) + (Fixed HH Cost Of Inside Water Storage System + Fixed HH Cost Of Buckets And Other Movable Water Storage Containers + Fixed HH Cost Of Water Filter System)** **Total HH Coping-Related Fixed Cost For Sewer = Fixed HH Cost Of Sewage Storage System + Fixed HH Cost Of Sewage Outfall System** **Total HH Fixed Cost Of Water And Sewer = Total HH Non-Coping-Related Fixed Cost For Water And Sewer + Total HH Coping-Related Fixed Cost For Water + Total HH Coping-Related Fixed Cost For Sewer**	Fixed HH Cost Of Municipal Water Connection	GEL	1 200
	Fixed HH Cost Of Municipal Sewer Connection	GEL	1 400
	Total HH Non-Coping-Related Fixed Cost For Water And Sewer	**GEL**	**2 600**
	Fixed HH Cost Of Water Well System	GEL	5 115
	Fixed HH Cost Of Spring Or Distant Water Source System	GEL	2 354
	Fixed HH Cost Of Outside Water Storage Tank System	GEL	860
	Fixed HH Cost Of Water Distribution System	GEL	2 160
	Fixed HH Cost Of Inside Water Storage System	GEL	125
	Fixed HH Cost Of Buckets And Other Movable Water Storage Containers	GEL	50
	Fixed HH Cost Of Water Filter System	GEL	150
	Total HH Coping-Related Fixed Cost For Water	**GEL**	**10 814**
	Fixed HH Cost Of Sewage Storage System	GEL	2 250
	Fixed HH Cost Of Sewage Outfall System	GEL	1 480
	Total HH Coping-Related Fixed Cost For Sewer	**GEL**	**3 730**
	Total HH Fixed Cost Of Water And Sewer	**GEL**	**17 144**

Source: RID IEP Analysis.

Each of the fixed costs shown in the preceding chart is a Metric that is calculated from a number of Data Elements. The following chart shows an example of such a calculation for a private water well.[22] Often these costs are shared among a number of households. Consequently, the micro-model always has the last two rows shown in the chart related to number of households sharing the cost and the allocated cost to a single household (noted by the "HH" in the name of the Metric).

[22] In charts from micro-models the green cells in the value column are numbers collected from individual households or engineering firms (typically Data Elements to be collected) while yellow cells in the value column are numbers calculated by the micro-model (typically Metrics to be reported and analyzed further).

27. Individual Household Fixed Cost Of Water Well

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE მნიშვნელობა
Fixed Cost Of Water Wells = Number Of Water Wells * (Average Depth Of Water Wells * (Unit Water Well Lining Pipe Cost + Unit Water Well Digging And Well-Lining Installation Cost)) **Fixed Cost Of Water Well Pumps = Number Of Water Well Pumps * Unit Water Well Pump Cost** **Fixed Cost Of Water Well System = Fixed Cost Of Water Wells + Fixed Cost Of Water Well Pumps + Water Well Electrical Control System Cost + Testing Of Water At Startup Cost** **Fixed HH Cost Of Water Well System = Fixed Cost Of Water Well System / Number of HHs Sharing Water Well System Today**	Year Of Constructing Wells		1960
	Number Of Water Wells		1
	Average Depth Of Water Wells	m	65
	Unit Water Well Lining Pipe Cost	GEL/m	5
	Unit Water Well Digging And Well-Lining Installation Cost	GEL/m	35
	Fixed Cost Of Water Wells	**GEL**	**2 600**
	Number Of Water Well Pumps		3
	Unit Water Well Pump Cost	GEL	700
	Fixed Cost Of Water Well Pumps	**GEL**	**2 100**
	Water Well Electrical Control System Cost	GEL	400
	Testing Of Water At Startup Cost	GEL	15
	Fixed Cost Of Water Well System	**GEL**	**5 115**
	Number of HHs Sharing Water Well System Today		1
	Fixed HH Cost Of Water Well System	**GEL**	**5 115**

Source: RID IEP Analysis.

Appendix E shows the detailed calculations of all types of fixed costs for individual households including related Metrics and Data Elements.

5.2.3 Water And Sewer Semi-Variable Cost

These types of costs are typically driven by either time (*e.g.*, well refurbishment) or a large volume of water obtained from a water source (*e.g.*, tank refurbishment). In all cases semi-variable costs are generally known to occur, but they occur infrequently. For example, replacement of pumps belongs to this cost category, because exploitation defines its frequency and they are replaced relatively infrequently.

For reporting purposes, semi-variable costs are annualized (*i.e.*, the semi-variable cost is divided by the expected number of years between incurring the cost).

The following chart shows annualized semi-variable water and sewer costs for an individual household. Not all individual households incur all or even any of these costs. Generally, all the shown semi-variable costs are coping costs – costs incurred by the household because there is not reliable water 24/7.

28. Individual Household Semi-Variable Water And Sewer Cost

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE მნიშვნელობა
Total Annualized HH Semi-Variable Cost Of Water = (Annualized HH Semi-Variable Cost Of Water Well System + ... Spring Or Distant Water Source System + ... Outside Water Storage System + ... Water Distribution System) * (2 / 2) + ...Inside Water Storage System + ...Buckets And Other Moveable Water Storage Containers + ... Water Filter System + ... Water Testing **Total Annualized HH Semi-Variable Cost Of Sewer = Annualized HH Semi-Variable Cost Of Sewage Storage System + Annualized HH Semi-Variable Cost Of Sewage Outfall System** **Total Annualized HH Semi-Variable Cost Of Water And Sewer = Total Annualized HH Semi-Variable Cost Of Water + Total Annualized HH Semi-Variable Cost Of Sewer**	Annualized HH Semi-Variable Cost Of Water Well System	GEL/yr	950
	... Spring Or Distant Water Source System	GEL/yr	158
	... Outside Water Storage System	GEL/yr	765
	... Water Distribution System	GEL/yr	733
	...Inside Water Storage System	GEL/yr	246
	...Buckets And Other Moveable Water Storage Containers	GEL/yr	42
	... Water Filter System	GEL/yr	25
	... Water Testing	GEL/yr	15
	Total Annualized HH Semi-Variable Cost Of Water	**GEL/yr**	**2 934**
	Annualized HH Semi-Variable Cost Of Sewage Storage System	GEL/yr	209
	Annualized HH Semi-Variable Cost Of Sewage Outfall System	GEL/yr	238
	Total Annualized HH Semi-Variable Cost Of Sewer	**GEL/yr**	**446**
	Total Annualized HH Semi-Variable Cost Of Water And Sewer	**GEL/yr**	**3 381**

Source: RID IEP Analysis.

Each of the Metrics shown in the preceding chart is calculated from a number of Data Elements. The following chart shows an example of such a calculation for an outside water storage system.

29. Individual Household Annualized Semi-Variable Cost For Outside Water Storage System

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE მნიშვნელობა
Annualized Semi-Variable Cost Of Outside Water Storage Tanks = (Number Of Outside Water Storage Tanks * Unit Outside Water Storage Tank Replacement Or Refurbishment Cost) / Expected Time Between Outside Water Storage Tank Replacement Or Refurbishment	Expected Time Between Outside Water Storage Tank Replacement Or Refurbishment	yr	20
	Number Of Outside Water Storage Tanks		1
	Unit Outside Water Storage Tank Replacement Or Refurbishment Cost	GEL	5 000
	Annualized Semi-Variable Cost Of Outside Water Storage Tanks	**GEL/yr**	**250**
Annualized Semi-Variable Cost Of Outside Water Storage Tank Filling Pumps = (Number Of Outside Water Storage Tank Filling Pumps * Unit Outside Water Storage Tank Filling Pump Replacement Or Refurbishment Cost) / Expected Time Between Outside Water Storage Tank Filling Pump Replacement Or Refurbishment	Expected Time Between Outside Water Storage Tank Filling Pump Replacement Or Refurbishment	yr	2
	Number Of Outside Water Storage Tank Filling Pumps		2
	Unit Outside Water Storage Tank Filling Pump Replacement Or Refurbishment Cost	GEL	400
	Annualized Semi-Variable Cost Of Outside Water Storage Tank Filling Pumps	**GEL/yr**	**400**
Annualized Semi-Variable Cost Of Outside Water Storage Electrical System Replacement Or Refurbishment = Unit Outside Water Storage Electrical Control System Replacement Or Refurbishment Cost / Expected Time Between Outside Water Storage Electrical System Replacement Or Refurbishment	Expected Time Between Outside Water Storage Electrical System Replacement Or Refurbishment	yr	2
	Unit Outside Water Storage Electrical Control System Replacement Or Refurbishment Cost	GEL	230
	Annualized Semi-Variable Cost Of Outside Water Storage Electrical System Replacement Or Refurbishment	**GEL/yr**	**115**
Annualized Semi-Variable Cost Of Outside Water Storage System = Annualized Semi-Variable Cost Of Outside Water Storage Tanks + Annualized Semi-Variable Cost Of Outside Water Storage Tank Filling Pumps + Annualized Semi-Variable Cost Of Outside Water Storage Electrical Sy	**Annualized Semi-Variable Cost Of Outside Water Storage System**	**GEL/yr**	**765**
	Number Of HHs Sharing Outside Water Storage System Today		1
Annualized HH Semi-Variable Cost Of Outside Water Stora	**Annualized HH Semi-Variable Cost Of Outside Water Storage System**	**GEL/yr**	**765**

Source: RID IEP Analysis.

Appendix E shows the detailed calculations of all types of semi-variable costs for individual households including related Metrics and Data Elements.

5.2.4 Water And Sewer Variable Cost

Variable costs are costs incurred on a regular basis and depend on the volume of water obtained or amount of sewage produced. A typical variable cost is electricity to run a pump. Variable costs include both coping-related costs (*e.g.*, running a private water well pump) and non-coping-related costs (*e.g.*, municipal water bill).

Seasonality. Volumes and variable cost vary greatly by time of year. Consequently, variable costs are separately calculated for the high, shoulder and low seasons and summed to an annual figure.

During the Design review a concern was raised about seasonality. These concerns apply to variable costs as well as all other Metrics where there is a seasonal effect (a great percentage of Metrics).

Seasonality is an important issue for all RID target cities and it can not be ignored. It is true that surveys will be conducted during low seaside tourism and skiing season, but we were advised that it would be impractical to conduct surveys during high seasons because respondents are simply too busy. In general, seasonality creates difficulties regardless of when one does the survey work (*i.e.*, the high season at the seaside is the low season in the mountains and vice-versa).

Consequently, the survey questionnaires will include questions on all seasons. For example, we will ask about the amount of water consumption during high, shoulder and low season periods, as well as about quality and supply of water across different seasons. Our questionnaires and the information collected by us will ensure that we get as clear picture as possible of what is going on in target cities during the whole year period. Aggregation for the entire year as well as by season, if of interest, will be possible.

Costs. The following chart shows variable water and sewer costs for individual households.

30. Individual Household Water And Sewer Variable Cost

			VALUE მნიშვნელობა			
			SEASON სეზონი			ANNUAL TOTAL წლიური ჯამი
CALCULATION	DATA ELEMENT / METRIC	UNIT	HIGH მაღალი	SHOULDER საშუალო	LOW დაბალი	
Total Annual HH Variable Coping Cost Of Water = (Annual HH Variable Cost Of Water Well System + ... Spring Or Distant Water Source System + ... Outside Water Storage System + ... Water Distribution System) * (2 / 2) + (... Inside Water Storage System + ... Tanker Truck Water + ... Coping Related Bottled Water + ... Manually Collected Water From Spring Or Other Water Source) **Total Annual HH Variable Cost Of Water = Total Annual HH Variable Coping Cost Of Water + Municipal Water Bill** **Total Annual HH Variable Coping Cost Of Sewer = Annual HH Variable Cost Of Sewage Storage System + ... Sewer Outfall System + ... Sewage Tanker Truck** **Total Annual HH Variable Cost Of Sewer = Total Annual HH Variable Coping Cost Of Sewer + Municipal Sewage Bill** **Total Annual HH Variable Cost Of Water And Sewer = Total Annual HH Variable Cost Of Water + Total Annual HH Variable Cost Of Sewer**	Length Of Season	wks/yr	4,3	4,3	43,4	n.a.
	Annual HH Variable Cost Of Water Well System	GEL/yr	231	33	133	**398**
	... Spring Or Distant Water Source System	GEL/yr	231	33	133	**398**
	... Outside Water Storage System	GEL/yr	277	231	200	**709**
	... Water Distribution System	GEL/yr	238	159	1 082	**1 478**
	... Inside Water Storage System	GEL/yr	166	139	120	**425**
	... Tanker Truck Water	GEL/yr	86	43	0	**129**
	... Coping Related Bottled Water	GEL/yr	30	11	87	**128**
	... Manually Collected Water From Spring Or Other Water Source	GEL/yr	4	3	1	**8**
	Total Annual HH Variable Coping Cost Of Water	**GEL/yr**	**1 264**	**651**	**1 756**	**3 672**
	Annual HH Variable Cost Of Municipal Water	GEL/yr	61	33	17	**110**
	Total Annual HH Variable Cost Of Water	**GEL/yr**	**1 325**	**684**	**1 773**	**3 782**
	Annual HH Variable Cost Of Sewage Storage System	GEL/yr	64	44	387	**495**
	... Sewer Outfall System	GEL/yr	65	37	290	**392**
	... Sewage Tanker Truck	GEL/yr	200	50	50	**300**
	Total Annual HH Variable Coping Cost Of Sewer	**GEL/yr**	**329**	**131**	**727**	**1 187**
	Annual HH Variable Cost Of Sewage Service	GEL/yr	10	10	100	**120**
	Total Annual HH Variable Cost Of Sewer	**GEL/yr**	**339**	**141**	**827**	**1 307**
	Total Annual HH Variable Cost Of Water And Sewer	**GEL/yr**	**1 664**	**825**	**2 600**	**5 089**

Source: RID IEP Analysis.

Each of the Metrics shown in the preceding chart is calculated from a number of Data Elements. The following chart shows an example of such a calculation for operating a water well system.

31. Individual Household Variable Cost For Operating Water Well Pump

			VALUE მნიშვნელობა			
			SEASON სეზონი			ANNUAL TOTAL წლიური ჯამი
CALCULATION	DATA ELEMENT / METRIC	UNIT	HIGH მაღალი	SHOULDER საშუალო	LOW დაბალი	
Annual Water Well Pump Operating Hours = Length Of Season * Number Of Water Well Pumps Used * Number Of Days In A Week Water Well Pumps Operate * Number Of Hours In A Day Wate Well Pumps Operate **Annual Variable Cost Of Water Well System = Annual Water Well Pump Operating Hours * Effective Power Draw Of Each Water Well Pump * Unit Electricity Cost** **Annual HH Variable Cost Of Water Well System = ((Annual Water Well Pump Operating Hours * Effective Power Draw Of Each Water Well Pump) * Unit Electricity Cost) / Number Of HHs Sharing Water Well System Today**	Length Of Season	wks/yr	4,3	4,3	43,4	**n.a.**
	Number Of Water Well Pumps Used		2	1	1	**n.a.**
	Number Of Days In A Week Water Well Pumps Operate	days/wk	7	5	4	**n.a.**
	Number Of Hours In A Day Wate Well Pumps Operate	hr/day	5	2	1	**n.a.**
	Annual Water Well Pump Operating Hours	**hr/year**	**301**	**43**	**174**	**518**
	Effective Power Draw Of Each Water Well Pump	kW	8	8	8	**n.a.**
	Annual Variable Cost Of Water Well System	**GEL/yr**	**231**	**33**	**133**	**398**
	Number Of HHs Sharing Water Well System Today		1	1	1	**n.a.**
	Annual HH Variable Cost Of Water Well System	**GEL/yr**	**231**	**33**	**133**	**398**

Source: RID IEP Analysis.

Appendix E shows the detailed calculations of all types of variable costs for individual households including related Metrics and Data Elements.

5.2.5 Annual Water And Sewer Cost

Each year individual households face annualized semi-variable and annual variable costs for water and sewer services. The following chart shows Metrics related to these overall costs. These values are the actual amounts spent by individual households on both water and sewer services today. Once the new water and sewer systems begin operation the coping-related costs will likely fall (perhaps to zero) while the municipal water and sewer costs will likely rise due to both quantity and tariff increases.

32. Individual Households Annualized Semi-Variable And Annual Variable Water And Sewer Cost

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE			
			SEASON			ANNUAL
			HIGH	SHOULDER	LOW	TOTAL
Total Annualized HH Semi-Variable And Annual HH Variable Cost Of Water = Annualized HH Semi-Variable Water Coping Cost + HH Variable Water Coping Cost + HH Municipal Water Bill **Total Annualized HH Semi-Variable And Annual HH Variable Cost Of Sewer = Annualized HH Semi-Variable Sewer Coping Cost + HH Variable Sewer Coping Cost + HH Municipal Sewer Bill** **Total Annualized HH Semi-Variable And Annual HH Variable Cost Of Water And Sewer = Total Annualized HH Semi-Variable And Annual HH Variable Cost Of Water + Total Annualized HH Semi-Variable And Annual HH Variable Cost Of Sewer**	Length Of Season	wks/yr	4,3	4,3	43,4	n.a.
	Annualized HH Semi-Variable Water Coping Cost	GEL/yr	243	243	2 449	**2 934**
	HH Variable Water Coping Cost	GEL/yr	1 264	651	1 756	**3 672**
	HH Municipal Water Bill	GEL/yr	61	33	17	**110**
	Total Annualized HH Semi-Variable And Annual HH Variable Cost Of Water	**GEL/yr**	**1 568**	**927**	**4 222**	**6 716**
	Annualized HH Semi-Variable Sewer Coping Cost	GEL/yr	37	37	373	**446**
	HH Variable Sewer Coping Cost	GEL/yr	329	131	727	**1 187**
	HH Municipal Sewer Bill	GEL/yr	3	56	25	**84**
	Total Annualized HH Semi-Variable And Annual HH Variable Cost Of Sewer	**GEL/yr**	**369**	**223**	**1 125**	**1 717**
	Total Annualized HH Semi-Variable And Annual HH Variable Cost Of Water And Sewer	**GEL/yr**	**1 937**	**1 150**	**5 347**	**8 433**

Source: RID IEP Analysis.

Appendix E shows the detailed calculation of the annual water and sewer cost including related Metrics and Data Elements.

5.2.6 Economic Willingness To Switch To New Water And Sewer Systems

Note that if the annual cost shown in the preceding chart falls once the new water and sewer systems begin operation then it can be expected that individual households will switch from their existing water and sewer arrangements to using (only) the municipal systems. The ratio of current cost over expected future cost indicates the level of motivation that individual households will have to switch as shown in the following chart. The larger the ratio (over one) the greater should be the economic motivation of the household to switch to using (only) the municipal systems.

For this example, it appears the household will spend about 97 percent less using the new water and systems compared to existing arrangements. This is a deceptively large decrease because the representative household shown in the micro-model uses all the (expensive) coping strategies causing their apparent spending to be quite high. In fact, households do not use all the coping strategies and will spend much less than is shown in these examples.

33. Individual Households Economic Willingness To Switch

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE მნიშვნელობა
Future Annual HH Municipal Water Bill = Volume Of Water Used Today * Water Tarrff	Volume Of Water Used Today	**m^3/yr**	65
	Water Tarrff	**GEL/m^3**	1,7000
Future Annual HH Municipal Sewer Bill = Volume Of Water Used Today * Sewer Tariff	Sewer Tariff	**m^3/yr**	2,1000
Future Annual HH Municipal Water And Sewer Bill = Future Annual HH Municipal Sewer Bill + Future Annual HH Municipal Water Bill	**Future Annual HH Municipal Water Bill**	**GEL/yr**	**110**
	Future Annual HH Municipal Sewer Bill	**GEL/yr**	**136**
Current Annualized HH Semi-Variable And Annual HH Variable Cost Of Water And Sewer = Current Annualized HH Semi-Variable And Annual HH Variable Cost Of Water + Current Annualized HH Semi-Variable And Annual HH Variable Cost Of Sewer	**Future Annual HH Municipal Water And Sewer Bill**	**GEL/yr**	**246**
	Current Annualized HH Semi-Variable And Annual HH Variable Cost Of Water	**GEL/yr**	**6 716**
	Current Annualized HH Semi-Variable And Annual HH Variable Cost Of Sewer	**GEL/yr**	**1 717**
Likelihood To Switch For Water (larger is more likely to switch) = Current Annualized HH Semi-Variable And Annual HH Variable Cost Of Water / Future Annual HH Municipal Water Bill	**Current Annualized HH Semi-Variable And Annual HH Variable Cost Of Water And Sewer**	**GEL/yr**	**8 433**
	Likelihood To Switch For Water (larger is more likely to switch)		**61,06**
Likelihood To Switch For Sewer (larger is more likely to switch) = Current Annualized HH Semi-Variable And Annual HH Variable Cost Of Sewer / Future Annual HH	**Likelihood To Switch For Sewer (larger is more likely to switch)**		**12,64**
	Likelihood To Switch For Water And Sewer Combined (larger is more likely to switch)		**34,30**

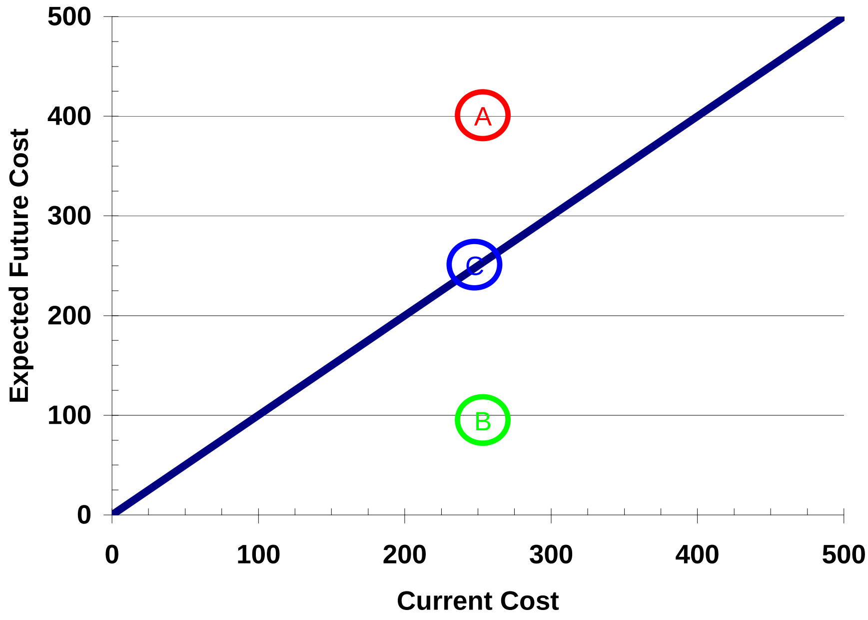
Source: RID IEP Analysis.

Appendix E shows the detailed calculation of the economic willingness to switch including related Metrics and Data Elements.

Note that a large ratio of current to future expected costs does not mean that a particular household will actually switch to the new water and sewer systems; it is merely a measure of the economic motivation to switch. Nevertheless, the further one moves from a ratio of 1,00 the more likely it is for a household to switch or not as shown in the following chart. The diagonal line is where current cost equals expected future cost (a ratio of 1,00). Point A (red) shows where the expected future cost is much greater than current cost. In this case the household will most likely not switch. Point B (green) is the reverse, where expected future cost is much less than current cost. In this case it is very likely the household will switch. At point C (blue) the household is economically indifferent between switching and not-switching.

The economic willingness to switch ratio from the individual household micro-models will give a good sense of the motivations households will have to switch to the new water and sewer system.

34. Schematic Of Economic Willingness To Switch To New Water And Sewer Systems



Source: RID IEP Analysis.

During the Design review a question was raised about whether all decisions whether to switch or not are actually purely economic decisions. We think that assumption on rationality of economic agents is absolutely realistic. We do our models under this assumption. However, there are cases (empirically observed) when people behave irrationally, but this is not a permanent case. Myopic behavior is an example of irrationality. We believe that households have different experiences and different levels of trust towards water utilities and Government policies. Some households will switch because they think that they will be better off, while others will behave differently. Now, which households are rational and which are not? Both of them are rational because they make decisions which they think will maximize their utility. What we mean by subjectivity is different perception, trust and expectations of households about the future will lead different households to different decisions, but all of them will be rational and motivated by economic reasons.

In sum, there are three things to look at: economic motivation, perceptions (or expectations about the future) and micro-model and quality of life issues. Each of these areas are represented with certain Metrics, which when summed give an idea on willingness to switch.

For example, if a household currently spends 10 GEL per month on water and sewer service (including coping costs), then if the expected future bill will be 3 GEL per month then, almost for sure, the household will switch to the new water and sewer system. If the expected future bill will be 20 GEL then almost for sure the household will not switch. However, there is a range of expected future bill (maybe 9 to 11 GEL, or 7 to 13 GEL) where the other factors will become very influential. The Design will provide insight to these tradeoffs.

5.2.7 Perceptional Willingness To Switch And Methods Of Contingent Valuation

Economists favor the individual's valuation of goods to be studied through their behavior on the market. However, the preferences of individuals toward certain products cannot always be observed through purchasing behavior. Purchases of water from the new water systems are of this type. This is due to the share of the population that has never knowingly consumed municipal water and is not aware of the benefits of the "product". On the other hand, the water systems are not yet implemented so the "final product" is not offered yet, which is considered to be 24 hour water supply as opposed to water provision by schedule.

In such circumstances, analysts have concluded that there is no viable alternative to directly asking a sample of people about their valuations. Questionnaires designed to elicit preferences are normally referred as Contingent Valuation (CV) surveys. CV, or sometimes named as hypothetical valuation, is a widely applied cost-benefit analysis which involves directly asking people about their willingness to pay. Due its hypothetical nature, the method is particularly useful for prediction of future impacts.

The method of Contingent Valuation has twofold benefit for the RID IEP. First it allows the simulation of the ex-post situation. Second it gives the information about the perceptional willingness to switch of households. Some households may choose to not switch even though it would be in their best interest economically. Their decision would be based on their perceptions, beliefs and feelings that can only be self-reported.

Two broad alternative ways of asking the valuation question are available:

- Open-ended in which the respondent can name any amount she/he wishes when asked some version of "What are you willing to pay?"

- Dichotomous choice (referendum or yes/no) in which the respondent is asked "Are you willing to pay (at least) X amount of money (per period)?"

The RID IEP will use both methods to evaluate the willingness to switch based on the perceived affordability of water and sewer tariffs. The combination of the two methods will give a better understandability of the willingness to switch.

Open Ended (non-referendum) Choice Method. This method is a non-referendum contingent valuation to determine the optimal and penetration prices of water. As noted previously, this type of method directly asks the respondent to state his/her willingness-to-pay amount for the product.

Below is the particular method belonging to direct CV type, which gives the information about the range of monthly bills for water at which the people are willing to switch. Four questions will be asked of households:

- What would be an Acceptable monthly price for municipal water that you would pay?[23] (*i.e.*, the household would switch)

- What would be an Expensive monthly price for municipal water that you would nevertheless pay? (*i.e.,* the household would still switch)

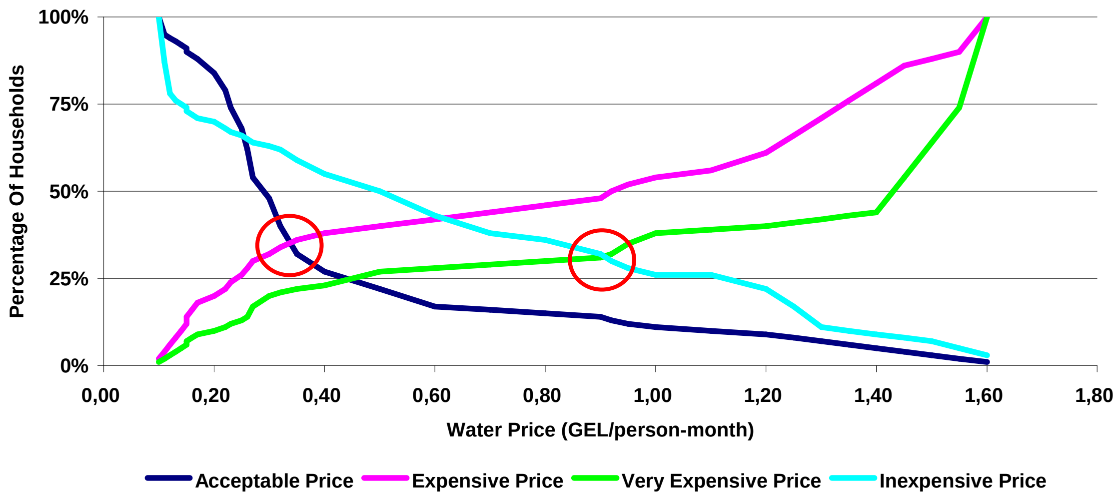
- What would be a Very Expensive monthly price for municipal water that you would not pay? (*i.e.,* the household would not switch)

- What would be an Inexpensive monthly price for municipal water? (*i.e.*, the household would switch).

[23] The question is about the monthly cost of water without regard to the quantity consumed. Individual households would find estimating an Acceptable price for one m^3 of water very difficult.

The data set will have a range of prices with the percentage of households that consider that price Acceptable, Expensive, Very Expensive or Inexpensive. Conclusions about willingness to switch will be reached by 1) comparing the Acceptable and Expensive results and 2) comparing the Inexpensive and Very Expensive results. The method calculates cumulative percentage from the lowest to highest stated for Acceptable and Inexpensive and from highest to lowest price for Expensive and Very Expensive as shown in the following chart.

35. <u>Range Of Prices At Which Households Would Switch To The New Water System</u>



Source: RID IEP Analysis.

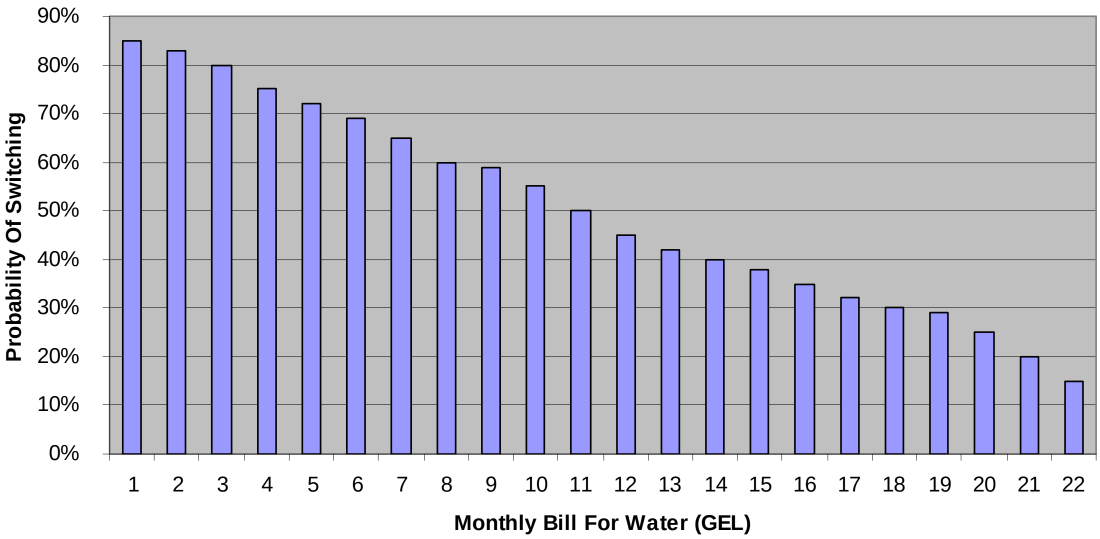
The intersection of the Acceptable and Expensive lines and the intersection of the Inexpensive and Very Expensive lines (both circled) give a range of prices where a suitable percentage of households would consider the price reasonable enough to switch to the municipal water system. For the simulated data in the chart, the range is from 0.38 GEL/person-month to 0.94 GEL/person-month.

The results give plausible information for tariff setting policy analysis, by showing the quick response of the market on lowest and the lightest bounds of tariff levels.

Open ended surveys exhibit substantial drawbacks due to the possibility of untruthfulness of respondent responses. On the other hand the main advantage of this direct method is that respondents propose their own prices which can be more truthful in some cases as opposed to the answers on proposed prices which can bias the perceptions and produce less accurate response.

<u>Dichotomous (referendum) Choice Method.</u> This method is indirect in a sense that it relies on the patterns of responses across a large number of respondents to make references about their preferences on particular price. The name dichotomous or binary is from the fact that respondents will be asked whether they are willing to switch at a particular tariff or not. Following chart shows a set of possible monthly bills for water and the percentage of people responding that they would switch at that tariff.

36. Histogram Of Dichotomous Choice Response For Monthly Water Bill



Source: RID IEP Analysis

For the data of simulated survey, specific bid bills are shown on the horizontal axis ranging from lowest (1 GEL) to the highest price offered (22 GEL) in 1 GEL increments. We can interpret the response frequencies as estimates of probability that the random drawn number of sample of respondents is willing to switch at specific amount of monthly water bill.

The histogram can also be viewed as the rough approximation of a demand curve on municipal water provision. Following the economic analysis, as in the case of standard demand curve, the area under the curve provides the estimate of willingness to pay. The calculation of monthly bill at which individuals are going to switch equals the multiplication of sum of histogram heights by price intervals (1 GEL), which for our simulated data appears to be 11,40 GEL.

A major advantage of binary model is that it meets the condition of inceptive compatibility – the incentive of respondents to give truthful answer rather than strategic. This feature of the model is an important reason for considering the results to be most accurate measurement of a monthly water bill at which the average individual would switch to new system.

<u>Purpose Of Using Two Methods.</u> Application of two methods is used for double checking the responses and also for benefiting from the different information obtained from each. In case of results of second model to fall in the range of monthly bills provided in the direct approach it reveals the plausibility of both surveys.

In addition, the first method gives interesting information for tariff setting purposes that second does not. For example, in case of government applying cross-subsidy policy of subsidizing the poor by charging high rates on the high income group, the direct approach provides of the maximum price that can be charged to the wealthy for funding the subsidy.

But, compared to indirect method, the same approach has less reliable responses and it gives only the range for willingness to switch amount rather than accurate estimate of the most reasonable price.

5.2.8 Coping Time

Nearly all coping methods require that households spend time operating and maintaining their water and sewer systems. This time is typically spent by the individual household for private houses. The RID IEP imputes no value to this time; rather we just report the quantity of time.

Households in apartment blocks typically hire (as a group) an individual to maintain the water and sewer system. These out-of-pocket costs are included as variable costs for households in apartment blocks and are not considered to be coping times.

The following chart shows the time spent by individual households coping with less-than-24/7 water supply. For this imaginary household a total of eight days and two hours are spent on coping-related activities each year (194 hours or a bit more than two eight-hour days per month).

37. Individual Household Time Spent Managing Water And Sewer

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE (DD HH:MM) SEASON HIGH	SHOULDER	LOW	ANNUAL TOTAL
Time Managing Water Supply And Sewer Service = Time Managing Local Water Systems + Time Managing Local Sewer Systems + Time Managing Bottled Water + Time Managing Spring Water	Length Of Season	wks	4,3	4,3	43,4	**52,0**
	Time Managing Local Water Systems	hr/wk hr/yr	4:00	2:00	1:00	**02 21:12**
	Time Managing Local Sewer Systems	hr/wk hr/yr	1:48	1:24	1:09	**02 15:58**
	Time Managing Bottled Water	hr/wk hr/yr	0:28	0:20	0:20	**00 17:54**
	Time Managing Spring Water	hr/wk hr/yr	2:00	1:20	0:40	**01 19:16**
	Total Annual Time Spent Managing Water And Sewer	**hr/wk hr/yr**	**8:16**	**5:04**	**3:09**	**08 02:20**

Source: RID IEP Analysis.

We will not assign a value to the time that individual households spend managing water and sewer systems. However, we will ask respondents what they would do with their newly freed time and, if they indicate a desire to work, what the wage would be for that work. This will increase the overall benefit of the RID projects.

Appendix E shows the detailed calculation of coping times including related Metrics and Data Elements.

5.2.9 Water Consumption

As part of the Quality Of Life Impact Category households will be asked about their estimated usage of water for different purposes. This will be supplemented by a formal water audit among a limited number of households as discussed in this Sub-Section. The full water audit model is shown in Appendix F.

Background. Surveying water consumption is twofold important. First of all, the amount of water consumed is a component of total water and sewer cost. The hypothesis is that the new water system might decrease water consumption as reportedly households store more water than they need and then dump the unused water when municipal water is turned on each day. Water 24/7 will enable households to consume as only as much water as they need. The second importance of water consumption is household behavior. Water 24/7 might improve certain activities that involve water usage that affect the quality of life of households. For example, bathing more and cleaning the house more frequently.

The method that we will use for assessing the amount of water consumption is similar to a procedure called a “Water Audit”. The procedure identifies all water sources in a house and offers engineering tools for handling calculation of water consumed from each of them. (*e.g.*, method for measuring water consumed by flowing gravity flush toilet with tank or how to calculate flow rate of different types of faucets).

The engineering methods of the water audit will be described during detailed survey design. In this Sub-Section there are represented key data elements that will be used for calculation of total water consumption, which is the main Metric of our interest.

Household Size Effects. During the Design review a question was raised about adjusting for household size while examining water consumption. There is a certain scale effect in water consumption for households. This is also important across households living in private houses and apartment blocks. All the issues related to water consumption will be determined by the water audit and the expression of these results is an issue which can be determined after data is collected. Equivalized measures may well be used, but at this moment we do not know what should be the coefficient used for water consumption. The water audit will provide this information.

We also reviewed literature on this topic; however we could not find a coefficient that should be used for water consumption. One option that we found was to rely on expert judgment, but as you can imagine there can be some undesired deviations. We still think that water audit and household surveys will give us sufficient empirical information to derive this coefficient.

Types Of Water Consumption. The micro-model calculates water consumption from all water sources by grouping them into six main groups as follows:

- Water consumption for toilet usage
- Water consumption from in-house faucets
- Water consumption for outdoor faucets
- Water consumption from showerheads
- Water consumption from domestic appliances
- Water consumption from alternative water sources.

Last group refers calculation of water consumption from alternative sources, which is not considered in the methods of the water audit. The purpose of measuring it is to observe how municipal water will substitute the water consumption from alternative sources after the new water systems begin operation as compared to the baseline situation.

Water Consumption For Toilet Usage. The following chart shows how volumes will be calculated for toilets. Households might have two types of flush toilets: in-house or so-called Turkish toilet at the outdoor. Both appliances have tanks and gravity flushes. Types of toilets without flushes are flowed with stored water manually. Water consumption for these types of toilets and all other manual flows of toilets are considered in calculation of stored water both from municipal and alternative sources.

Data Elements for water consumption calculation of flush toilets include number of flushes per day and amount of water consumed per flush.

38. Water Consumption For Toilets

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE TOILET #1
Annual Water Consumption By Toilets = Length Of Season * 7 * Flushes Each Day For Any Purposes * Per Flush Water Consumption	Length Of Season	weeks	52
	Flushes Each Day For Any Purposes	#/day	2
	Per Flush Water Consumption	m^3	0,0100
	Annual Water Consumption By Toilets	**m^3/yr**	**7,28**

Source: RID IEP Analysis

Water Consumption For Indoor Faucets. Consumption of water from all kind of faucets can be measured by multiplying their flow rates and times of operation. The time of operation of a faucet depends on the household activities involving water consumption. Two types of indoor faucets in bathrooms and in the kitchen are very often used for the same purposes. Calculation table below lists all possible reasons of using kitchen and toilet faucets and corresponding times of operation of faucets for each activity (*e.g.*, hand washing, cooking, drinking, cleaning, storing water due to insufficient provision)

39. Water Consumption For Indoor Faucets

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE KITCHEN FAUCET #1
Time Faucet Is On For All Purposes = Time Faucet Is On For Cooking Purposes + Time Faucet Is On For Potable Water Purposes + Time Faucet Is On For Hand Washing + Time Faucet Is On For Watering In-House Plants + Time Faucet Is On For Teeth Brushing + Time Faucet Is On For Washing Dishes + Time Faucet Is On For In-House Wet-Cleaning Procedures + Time Faucet Is On For Outdoor Wet-Clean Procedures + Time Faucet Is On For Laundry + Time Faucet Is On For Treating Domestic Animals + Time Faucet Is On For Storing Water + Time Faucet Is On For Other Purposes Annual Water Consumption By Indoor Faucet = Time Faucet Is On For All Purposes * Flow Rate Of Faucet / 1000	Time Faucet Is On For Cooking Purposes	min/day	30
	Time Faucet Is On For Potable Water Purposes	min/day	10
	Time Faucet Is On For Hand Washing	min/day	10
	Time Faucet Is On For Watering In-House Plants	min/day	10
	Time Faucet Is On For Teeth Brushing	min/day	0
	Time Faucet Is On For Washing Dishes	min/day	10
	Time Faucet Is On For In-House Wet-Cleaning Procedures	min/day	20
	Time Faucet Is On For Outdoor Wet-Clean Procedures	min/day	10
	Time Faucet Is On For Laundry	min/day	0
	Time Faucet Is On For Treating Domestic Animals	min/day	10
	Time Faucet Is On For Storing Water	min/day	50
	Time Faucet Is On For Other Purposes	min/day	10
	Time Faucet Is On For All Purposes	**min/day**	**170**
	Flow Rate Of Faucet	l/min	5,0
	Annual Water Consumption By Indoor Faucets	**m^3/yr**	**0,9**

Source: RID IEP Analysis

Water Consumption For Outdoor Faucets. Outdoor faucet/hoses are grouped in a separate category because it might be used for quite different purposes (*e.g.*, car wash, carpet wash, gardening) and also some of its uses are seasonal (*e.g.*, gardening more frequently in summer and spring and washing car or carpets more in good weather). The following chart shows the calculation for water consumption for outdoor faucets.

40. Water Consumption For Outdoor Faucets

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE FAUCET #1 - SEASON HIGH
Time Outdoor Faucet Is On For Seasonal Activities = ((Time Faucet Is On For Outdoor Gardening + ... For Car Washing Of Own Vehicles + ... For Carpet Washing + ... For Other Non-Economic Purposes + … For Economic Purposes) * 7 * Length Of Season) / 60 **Annual Water Consumption By Outdoor Faucet For Seasonal Activities = Time Outdoor Faucet Is On For Seasonal Activities * 60 * Flow Rate Of Faucet / 1000** **Time Outdoor Faucet Is On For Non-Seasonal Activities = (Time Faucet Is On For Cooking Purposes + ... For Potable Water Purposes + ... For Hand Washing + ... For Watering In-House Plants + ... For Teeth Brushing + ... For Washing Dishes + ... For In-House Wet-Cleaning Procedures + ... For Outdoor Wet-Clean Procedures + ... For Laundry + ... For Treating Domestic Animals + ... For Storing Water + ... For Other Purposes) * 7 * Length Of Season / 60** **Annual Water Consumption By Outdoor Faucet For Non-Seasonal Activities = Time Outdoor Faucet Is On For Non-Seasonal Activities * 60 * Flow Rate Of Faucet / 1000** **Annual Water Consumption By Outdoor Faucet = Annual W**	Length Of Season	wk/yr	4,3
	Time Faucet Is On For Outdoor Gardening	min/day	120
	... For Car Washing	min/day	30
	... For Carpet Washing	min/day	10
	... For Other Non-Economic Purposes	min/day	15
	… For Other Economic Purposes	min/day	180
	Time Outdoor Faucet Is On For Seasonal Activities	**hr/season**	**178**
	Flow Rate Of Faucet	l/min	5,0
	Annual Water Consumption By Outdoor Faucets For Seasonal Activities	**m^3/yr**	**53,4**
	Time Faucet Is On For Cooking Purposes	min/day	10
	... For Potable Water Purposes	min/day	30
	... For Hand Washing	min/day	25
	... For Watering In-House Plants	min/day	20
	... For Teeth Brushing	min/day	10
	... For Washing Dishes	min/day	10
	... For In-House Wet-Cleaning Procedures	min/day	10
	... For Outdoor Wet-Clean Procedures	min/day	10
	... For Laundry	min/day	10
	... For Treating Domestic Animals	min/day	10
	... For Storing Water	min/day	20
	... For Other Purposes	min/day	10,00
	Time Outdoor Faucet Is On For Non-Seasonal Activities	**hr/year**	**88**
	Annual Water Consumption By Outdoor Faucets For Non-Seasonal Activities	**m^3/yr**	**26,3**
	Annual Water Consumption By Outdoor Faucets	**m^3/yr**	**79,77**

Source: RID IEP Analysis

Water Consumption From Bathroom Showerhead. Bathing and showering might also be seasonal. In cold weather, households are reluctant to bathe frequently due to poor heating in houses and to avoid respiratory diseases.

41. Water Consumption For Using Bathroom Showerhead

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE SHOWER / BATHTUB # 1 HIGH
Annual Water Consumption By Shower Head For Showers = Time Showerhead Is On For Taking Shower * 7 * Length Of Season * Flow Rate Of Shower Head / 1000 **Annual Water Consumption By Bathtub Faucet For Baths = Time Bathtub Faucet Is On For Taking Bath * 7 * Length Of Season * Flow Rate Of Bathtub Faucet / 1000** **Annual Water Consumption By Shower And Bathtub For Bathing = Annual Water Consumption By Shower Head For Showers + Annual Water Consumption By Bathtub Faucet For Baths** **Time Bathtub Faucet Is On For Non-Bathing Purposes = (Time Bathtub Faucet Is On For Cooking Purposes + ... For Potable Water Purposes + ... For Hand Washing + ... For Watering In-House Plants + ... For Teeth Brushing + ... For Washing Dishes + ... For In-House Wet-Cleaning Procedures + ... For Outdoor Wet-Clean Procedures + ... For Laundry + ... For Treating Domestic Animals + ... For Storing Water + ... For Other Purposes) * 7 * Length Of Season / 60** **Annual Water Consumption By Bathtub Faucet For Non-Bathing Purposes = Time Bathtub Faucet Is On For Non-Bathing Purposes * 60 * Flow Rate Of Bathtub Faucet / 100** **Annual Water Consumption By Bathtub And Shower Fauce**	Length Of Season	wk/yr	4,3
	Time Showerhead Is On For Taking Shower	min/day	30
	Flow Rate Of Shower Head	l/min	30,0
	Annual Water Consumption By Shower Heads For Showers	**m^3/yr**	**27,1**
	Time Bathtub Faucet Is On For Taking Bath	min/day	15
	Flow Rate Of Bathtub Faucet	l/min	40,0
	Annual Water Consumption By Bathtub Faucets For Baths	**m^3/yr**	**18,1**
	Annual Water Consumption By Shower Heads And Bathtub Faucets For Bathing	**m^3/yr**	**45,2**
	Time Bathtub Faucet Is On For Cooking Purposes	min/day	0
	... For Potable Water Purposes	min/day	10
	... For Hand Washing	min/day	5
	... For Watering In-House Plants	min/day	5
	... For Teeth Brushing	min/day	0
	... For Washing Dishes	min/day	0
	... For In-House Wet-Cleaning Procedures	min/day	5
	... For Outdoor Wet-Clean Procedures	min/day	5
	... For Laundry	min/day	10
	... For Treating Domestic Animals	min/day	3
	... For Storing Water	min/day	0
	... For Other Purposes	min/day	5
	Time Bathtub Faucet Is On For Non-Bathing Purposes	**hr/year**	**24**
	Flow Rate Of Bathtub Faucet	l/min	40,0
	Annual Water Consumption By Bathtub Faucets For Non-Bathing Purposes	**m^3/yr**	**58**
	Annual Water Consumption By Shower Heads And Bathtub Faucets	**m^3/yr**	**102,9**

Source: RID IEP Analysis

Water Consumption For Domestic Appliances. Only washing machines are considered as a domestic appliance involving water exploitation. Other machines, like dishwashers are almost non-existence among target households of survey. The engineering approach will allow assessing amount of water consumption per timing cycle of washing machine operation.

42. Water Consumption For Domestic Appliances

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE SEASON HIGH
Annual Water Consumption For Washing Machine = Number Of Loads In Washing Machine * Length Of Season * Volume Of Water Used By Washing Machine / 1000	Length Of Season	wk/yr	4,3
	Number Of Loads In Washing Machine	#/wk	4
	Volume Of Water Used By Washing Machine	l/load	35,0
	Annual Water Consumption By Washing Machines	**m^3/yr**	**0,60**

Source: RID IEP Analysis

Water Consumption From Alternative Water Sources. Calculation of municipal water consumption is done according to its uses, because it is consumed simultaneously, while water from alternative sources in consumed after storing. Therefore, measurement of alternative water consumption involves data elements such as volume of storage means and frequency of storing as shown in the following chart.

43. Water Consumption From Alternative Water Sources

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE ALTERNATIVE WATER SPRING WATER
Annual Water Consumption From Alternative Water Sources = Number Of Fillings * Volume Of All Moveable Buckets And Containers (in one or more containers) * Length Of Season / 1000	Length Of Season	wk/yr	4,3
	Number Of Fillings	#/wk	3
	Volume Of All Moveable Buckets And Containers (in one or more containers)	l	100
	Annual Water Consumption From Alternative Water Sources	**m^3/yr**	**1,3**
Annual Water Consumption That Is Discarded When New Water Is Added To Storage Containers = Annual Water Consumption From Alternative Water Sources * Portion Of Water That Is Discarded When New Water Is Added	Portion Of Water That Is Discarded When New Water Is Added		50%
	Annual Water Consumption That Is Discarded When New Water Is Added To Buckets And Other Moveable Water Storage Containers	**m^3/yr**	**0,6**

Source: RID IEP Analysis

Household Level Leaks. Part of the total water consumption is the amount of water that is consumed by household unintentionally (*e.g.*, leakages in toilets, drips of faucets). It is very difficult to handle calculation of this type of water consumption. Water audit tools can only detect leakage existence. It involves asking questions like whether the household members hear the noise in toilets or have noticed walls to be wet periodically in the apartment.

Unintentionally consumed water is important because it might distort the measurement of the impact of the new water system. For example, the reason for reduction in water consumption can be due to fixing leaking toilet and not due to the water system change

Despite of all this we do not measure unintentionally consumed water due to following reasons:

- Most of leaking sources are nor relevant in terms of water consumption amount. Large amount of leakages become easily apparent and are fixed in a short time. For example, one leaking pipe can create such damage that most of households would fix it at any cost.

- Leakages that are not fixed are not unintentionally consumed water; not fixing a leaking pipe or toilet is an optimal decision of the household and a fair part of its total water consumption

- Intentionally consumed leakages are small share in total water consumption.

Total Household Water Consumption. Total consumption is the sum of the items listed above.

5.3 QUALITY OF LIFE IMPACT CATEGORY

This Section describes the individual household quality of life Impact Category. Nearly all Metrics in this area are of a pre-post nature; there are few Metrics that will permit the reaching of any conclusions after just the baseline survey.

Metrics describing the impact of the RID projects on the quality of life of individual households fall into eight groups (Impact Sub-Categories):

- Health incidents – Metrics describing water safety, public-health incidents and the frequency of water-borne disease and households' response to them, including treatment costs
- Perceptions of safety of water and water and sewer systems – do households trust municipal and alternative sources of water and water and sewer systems; how reliable is the water delivery schedule
- Perceptions of taste, smell, cleanliness and color of water – independent of perceptions of safety of the water
- Public sanitation information – how the public becomes aware of water and sanitation issues
- Individual sanitation practices – the frequency that individuals take baths, wash clothes and perform other personal sanitation actions that depend on the availability of water and attitudes toward sanitation
- Time and inconvenience – how much time household members must spend dealing with the inconvenience of not having reliable 24/7 water
- Self-reported water consumption – how households use water including any conservation efforts
- Gender issues – amount of time women spend cooking, cleaning and caring for children and the impact of less than 24/7 water on those times.

Each of these Impact Sub-Categories is discussed in the following Sub-Sections.

Note that many of these Impact Sub-Categories were not of particular importance when the RID projects were under consideration. For example, the new water systems were not undertaken to improve individual sanitation practices. However, the new water systems may nevertheless improve individual sanitation practices.

5.3.1 Health Incidents

The RID projects should improve the healthfulness of water; water should be freer of water-borne disease and incidents of water borne disease should be less frequent. This Sub-Section describes how the RID IEP will assess these impacts.

Generally speaking, there are three ways the change in healthfulness of water could be assessed. First would be systematic pre-post quality testing of the water itself. Second would be public health records about the incidence of cases of water-borne disease. Finally, is self-reporting of water-borne illness by households. Each of these is discussed in the following paragraphs.

Water Quality Testing. An excellent way to measure the impact of new water and sewer systems on health would be through a comprehensive water testing program. Such a program would comprise comprehensive testing before the start of the new water system and then continuous testing thereafter.

Unfortunately, this gold standard approach is not possible for the RID IEP; we cannot introduce new water testing protocols to the water utilities. Consequently, the RID IEP will rely on existing and prospective testing by the water utilities.

Water utilities in the RID cities currently test water quality according to a number of protocols. Reportedly some of the testing is reliable and forms a good baseline. However, not all utilities have comprehensive records. In addition, the equipment used by all the water utilities is old and will be replaced as part of the RID projects. Once replaced, water samples that in the past would have been considered healthful might not pass with the new testing equipment, or vice-versa.

Consequently, past and current tests are not totally reliable. Nevertheless, these test results are the best available and the RID IEP will summarize recent historical testing to provide a baseline, although with the caveats noted.

Public-Health Records. A second source of baseline data on the incidence of water-borne disease would be public-health records. Unfortunately, it appears that this is not a suitable data source for the RID IEP. Reportedly, most gastrointestinal diseases are self-medicated and not reported to doctors. Doctors, in turn, do not have a regular practice of reporting these diseases to public health officials. Only in the case of wide-spread outbreaks, thankfully rare, do public health officials even become aware of potential problems.

Consequently, there are no reliable public-health records that could form a baseline for the RID IEP.

Nevertheless, the RID IEP will meet with doctors and public health officials to gain a qualitative understanding of the current public-health situation vis-à-vis water supply; results will be documented in a case study. This will be repeated after the new systems go into operation and changes will be noted.

Self-Reporting Of Health Problems. The RID IEP will rely on self-reporting of health incidents by households to evaluate the impact of the RID projects on health. The following chart shows the Metrics to be used for health incidents in the last two weeks.

44. Metrics Related To Health Incidents In Last Two Weeks

DATA ELEMENT / METRIC	UNIT	VALUE FOR FAMILY CHILDREN UNDER AGE 6 6 წელზე უმცროსი ბავშვები
Number Of Individuals In HH	indiv	
Number Of Incidents Of Diarrhea Disease In HH In ***Last Two Weeks***	incidents	
Number Of Incidents Of Gastrointestinal Disease Other Than Diarrhea In HH In ***Last Two Weeks***	incidents	
Number Of Incidents Of Respiratory Disease In HH In ***Last Two Weeks***	incidents	
Perceived Likelihood These Incidents In ***Last Two Weeks*** Were Caused By Water Borne Disease (vs. food or other reasons)	% incidents	
Number Of Incidents Where Other Family Members Also Became Ill In ***Last Two Weeks***	incidents	
Number Of Incidents Where Neighbors Also Became Ill In ***Last Two Weeks***	incidents	
How Did HH Respond To The Incidents In ***Last Two Weeks*** (e.g., self-medicate, visit doctor)	List	
Among All Incidents Combined, How Many Visits To The Doctor Were Made In ***Last Two Weeks***	dr visits	
Among All Incidents Combined, How Much Did HH Spend On Visits To The Doctor In ***Last Two Weeks***	GEL	
Among All Incidents Combined, How Much Did HH Spend On Drugs In ***Last Two Weeks***	GEL	
Among All Incidents Combined, How Much Did HH Spend On Things Other Than Drugs In ***Last Two Weeks***	GEL	
Among All Incidents Combined, How Many Days Were Lost Due To Being Ill In ***Last Two Weeks*** (includes days lost of work, education, leisure or other other activities)	days	

Source: RID IEP Analysis.

Data on health incidents will be collected by type of household member as shown in the following list:

- Children under age six
- School-aged children
- Healthy adult men
- Healthy adult women
- Elderly and infirm men
- Elderly and infirm women.

Young children are of special interest. On the one hand parents always provide the safest potable water (bottled or boiled water) to them and on the other hand children are more vulnerable to poor quality water.

The household is then asked to assess the likelihood of the sicknesses being due to bad water quality rather than food or other causes. Whether other family members or neighbors also became ill will be asked as well. Reportedly, more gastrointestinal illness is caused by tainted food than by water. These questions will attempt to distinguish between these two causes, primarily by seeing how members of the same household and neighbors do or do not all have the same illness at the same time.

The response by the household to the gastrointestinal disease incident is then evaluated. A list of treatment options are given to respondents to report whether they went to doctor, self-medicated or something else. If the doctor was visited then the number of visits is asked.

Next monetary costs are determined for doctors, drugs and other items. Finally, the number of days of work or school lost to the incidents is asked.

The previous chart showed questions for the last two weeks. The same questions will be asked for incidents over the past year.

5.3.2 Perceptions Of Safety And Adequacy Of Water And Sewer Systems

This Sub-Section discusses perceptions of safety of water and the water and sewer systems. Perceptions are included for both municipal water and water from alternative sources, excluding bottled water (which is assumed to be the standard against which to measure other waters). All perceptions are judgmental by the household.

Water quality varies by season so questions related to perceptions of safety are framed for the high, shoulder and low seasons. The definition of the high season (and the other seasons as well) varies by RID city.

Perceived Safety Of Water. As shown in the following charts, the water sources the household uses for potable purposes is first determined along with treatment, if any, applied before consumption. Quantity of water used for potable purposes each day is determined. This is followed by whether the household does or would drink municipal water today; this is the acid test of perception of water safety. The perception of variability of the safety of municipal water now is then queried. The perception of safety of municipal water five years ago and ten years ago is then asked.

The same Metrics for alternative water sources are also asked.

45. Metrics Related To Sources Of Potable Water

DATA ELEMENT / METRIC	UNIT
Length Of Season (weeks)	wk
Potable Water Source For ***Children Under Age 6***	List
Potable Water Source For ***Children Of School Age***	List
Potable Water Source For ***Healthy Adults***	List
Potable Water Source For ***Elderly And Infirm Adults***	List
Distance From HH To Nearest Potable Water Source	m

Source: RID IEP Analysis.

46. Metrics Related To Perceived Safety Of Municipal Water

DATA ELEMENT / METRIC	UNIT
Length Of Season (weeks)	wk
HH Drinks Municipal Water Straight From The Tap (without treatment)	List
HH Drinks Municipal Water Only After Treatment	List
HH Never Drinks Municipal Water	List
How Municipal Water Used For Potable Purposes Is Treated Before Use	List
Number Of Liters Of Municipal Water Treated For Potable Purposes (liters per person per day)	l
Perception Of Average Safety/Adequacy Within Season Of Municipal Water This Year	Scale
Perception Of Day-To-Day Variability In Safety/Adequacy Within Season Of Municipal Water This Year	Scale
Perception Of Average Safety/Adequacy Within Season Of Municipal Water Five Years Ago	Scale
Perception Of Average Safety/Adequacy Within Season Of Municipal Water Ten Years Ago	Scale

Source: RID IEP Analysis.

Perceived Safety Of Sewer System. The previous chart shows Metrics related to the perceived safety of water systems. There are several safety-related Metrics for the sewer system as shown in the following chart. The frequency of bad smells from the sewer, either in the home or on the street is determined; insufficient water in the sewer system can causes bad smell in the home or on the street. The same questions are asked about the municipal sewer and alternative sewer systems.

47. Metrics Related To Perceived Safety Of Sewer Systems And Satisfaction

DATA ELEMENT / METRIC	UNIT
Length Of Season (weeks)	wk
Distance From HH To Nearest Proper Toilet	m
Perception Of Safety/Adequacy Within Season Of ***Municipal*** Sewer System ***Within Your Household***	Scale
Perception Of Safety/Adequacy Within Season Of ***Municipal*** Sewer System ***Within Your Neighborhood***	Scale
Alternative Sewer System (if any)	List
Perception Of Safety/Adequacy Within Season Of ***Alternative*** Sewer System ***Within Your Household***	Scale
Perception Of Safety/Adequacy Within Season Of ***Alternative*** Sewer System ***Within Your Neighborhood***	Scale
Number Of Days Per Week Within Season When Sewer Smells ***Within Your Household***	days/wk
Number Of Days Per Week Within Season When Sewer Smells ***Within Your Neighborhood***	days/wk
Overall Satisfaction With ***Municipal*** Sewer Services	Scale
Overall Satisfaction With ***Alternative*** Sewer System	Scale
DATA ELEMENT / METRIC	**UNIT**
Time In ***High Season*** With Any Municipal Water (water at even a very low pressure)	hr/day
Time In ***High Season*** With Pressurized Municipal Water (such that a pump is not needed)	hr/day
Time In ***Shoulder Season*** With Any Municipal Water (water at even a very low pressure)	hr/day
Time In ***Shoulder Season*** With Pressurized Municipal Water (such that a pump is not needed)	hr/day
Time In ***Low Season*** With Any Municipal Water (water at even a very low pressure)	hr/day
Time In ***Low Season*** With Pressurized Municipal Water (such that a pump is not needed)	hr/day

Source: RID IEP Analysis.

Water Delivery Schedule. There are few locations in the RID cities with water 24/7. The situation will improve when the new water systems begin operation, but even then it is not expected that water will be available 24/7.[24] The following charts show the Metrics that will characterize the water delivery schedule for individual households. These Metrics will be determined for each day of the week.

48. Metrics Related To Municipal Water Delivery Schedule

DATA ELEMENT / METRIC	UNIT
Time In High Season With Any Municipal Water (water at even a very low pressure)	hr/day
Time In High Season With Pressurized Municipal Water (such that a pump is not needed)	hr/day
Time In Shoulder Season With Any Municipal Water (water at even a very low pressure)	hr/day
Time In Shoulder Season With Pressurized Municipal Water (such that a pump is not needed)	hr/day
Time In Los Season With Any Municipal Water (water at even a very low pressure)	hr/day
Time In Low Season With Pressurized Municipal Water (such that a pump is not needed)	hr/day

Source: RID IEP Analysis.

[24] In the past, poor water delivery schedules were often the result of an unreliable electricity supply. This problem has been largely overcome. Now the limitation on supply schedules is usually water leaks in the distribution pipes; if water is provided 24/7 then the quantity of water lost to leaks will be very large. The RID projects will replace many but not all leaking pipes. Consequently, there will still be a need to provide water for less than 24/7 in order to manage the overall level of water lost to leaks in the distribution system. The overall effect of this will likely be that private wells will go out of service but that water storage tanks, water tank filling pumps and distribution pumps will continue to be used.

49. Metrics Related To Reliability Of Municipal Water Delivery Schedule And Satisfaction

DATA ELEMENT / METRIC	UNIT
Length Of Season (weeks)	wk
Reliability In Season Of Municipal Water Schedule (water at even a very low pressure)	Scale
Reliability In Season Of Pressurized Municipal Water Schedule (such that a pump is not needed)	Scale
Maximum Days In Season HH Can Go Without Any Municipal Water (water at even a very low pressure)	days
Maximum Days In Season HH Can Go Without Pressurized Municipal Water (such that a pump is not needed)	days
Longest Period (number of days) In Season Without Municipal Water Over Past Year	days
Extent To Which Water Storage (coping strategy) Has Eliminated The Inconvenince of Not Having Pressurized Municipal Water 24/7	Scale
Overall Satisfaction With Municipal Water ***Schedule*** (frequency and length of water under pressure)	Scale
Overall Satisfaction With Municipal Water ***Schedule Reliability***	Scale

Source: RID IEP Analysis.

5.3.3 Perceptions Of Organoleptic Properties Of Water

The previous Sub-Section included perceptions of safety of water. This Sub-Section concerns perceptions of taste, smell, cleanliness and color of water, independent of its safety.

Metrics concerning organoleptic properties of both municipal water and water from alternative sources (excluding bottled water) are shown in the following chart.

50. Metrics Related To Perceived Taste, Smell, Cleanliness And Color Of Water

DATA ELEMENT / METRIC	UNIT
Length Of Season (weeks)	wk
Perception Of Taste In Season Of ***Municipal*** Water	Scale
Perception Of Taste In Season Of ***Alternative Source*** Water (excluding bottled water)	Scale
Perception Of Smell In Season Of ***Municipal*** Water	Scale
Perception Of Smell In Season Of ***Alternative Source*** Water (excluding bottled water)	Scale
Perception Of Cleanliness (absence of dirt or floating particles) In Season of ***Municipal*** Water	Scale
Perception Of Cleanliness (absence of dirt or floating particles) In Season Of ***Alternative Source*** Water (excluding bottled water)	Scale
Perception Of Color In Season of ***Municipal*** Water	Scale
Perception of Color In Season Of ***Alternative Source*** Water (excluding bottled water)	Scale
Overall Satisfaction With Physical Features Of ***Municipal Water***	Scale
Overall Satisfaction With Physical Features Of ***Alternative Source*** Water	Scale

Source: RID IEP Analysis.

5.3.4 Public Sanitation Information

There is general acceptance that water management requires that consumers have sufficient information on water- and sanitation-related issues. This information is typically supplied by water utilities or public health departments. The following chart shows Metrics related to communication of this type of information. It is likely that the level of public sanitation information will be low.

51. Metrics Related To Communication Of Sanitation- And Water-Related Information

DATA ELEMENT / METRIC	UNIT
Time Since HH Last Received Information On The Public Health Benefits of Good Water And Sewer Systems	mo
Time Since HH Last Received Information On Proper Water And Sewer Hygiene Practices	mo
Time Since Any One School Age Child Last Received Sanitation Training In School	mo
Extent To Which HH Follows Recommended Hygiene Practices	Scale
Overall Satisfaction with Level Of Knowledge About Proper Water And Sewer Hygiene Practices	Scale
Time Since HH Last Received Information On The Water And Sewer Tariff-Setting Process	mo
Level Of Knowledge About How The Municipal Water Bill Is Calculated	Scale
Level Of Knowledge About How The Municipal Sewer Bill Is Calculated	Scale
Overall Satisfaction With Level Of Knowledge About Water And Sewer Tariffs And Bills	Scale
Time Since HH Last Received General Information On Nature Or Frequency Of Water Testing	mo
Time Since HH Last Received Information On A Specific And Relevant Water Test	mo
Overall Satisfaction With Level Of Knowledge About Water Testing	Scale
Time Since HH Last Received Information On Water Conservation (importance of or methods to do)	mo
Overall Satisfaction With Level Of Knowledge About Water Conservation Methods	Scale

Source: RID IEP Analysis

Individuals are first asked about the frequency of receiving information on the health aspects of water and sewer systems, how to improve healthfulness and education of children on sanitation issues. Then they are asked about their knowledge of the tariff setting process and how their water and sewer bills are calculated. Information on water testing generally or related to specific incidents is then assessed. Finally, information on conservation efforts is questioned.

5.3.5 Individual Sanitation Practices

There are a number of sanitation activities that are related to both water availability and general sanitation practices. The following chart shows Metrics for measuring these individual sanitation activities.

Metrics are determined for individual households by season. Metrics include measures of frequency of showers and baths, hand washing (with and without soap), laundry, changes of clothing, washing of floors, cleaning of bathrooms and kitchens and how long dishes and pots are left unwashed.

52. Metrics Related To Individual Sanitation

DATA ELEMENT / METRIC	UNIT
Length Of Season (weeks)	wk
Number Of Individuals In HH	indivs
Number Of Baths/Showers Taken ***Each Week*** Among All Inhabitants	baths/showers
Number Of Individuals Who ***Do Not*** Wash Hands Before Nearly Every Meal	indivs
Number Of Individuals Who Wash Hands ***With Water Only*** Before Nearly Every Meal	indivs
Number Of Individuals Who Wash Hands ***With Soap And Water*** Before Nearly Every Meal	indivs
Number Of Individuals Who ***Do Not*** Nearly Always Wash Hands After Using Toilet	indivs
Number Of Individuals Who Nearly Always Wash Hands ***With Water Only*** After Using Toilet	indivs
Number Of Individuals Who Nearly Always Wash Hands ***With Soap And Water*** After Using Toilet	indivs
Number Of Loads Of Laundry Done ***Each Week*** Among All Inhabitants	loads/wk
Number Of Changes Of Clothing Worn ***Each Week*** Among All Inhabitants	changes/wk
Number Of Times Floors Are Washed ***Each Week***	#/wk
Number Of Times Bathrooms Are Thoroughly Cleaned ***Each Week***	#/wk
Number Of Times Kitchen Is Thoroughly Cleaned ***Each Week***	#/wk
Number Of Times Water Buckets Or Other Moveable Containers Are Cleaned ***Each Week***	#/wk
Average Time Between Finishing A Meal And Dishes And Pots From Meal Being Washed	min

Source: RID IEP Analysis.

A number of Metrics are asked about sanitation conditions at schools and among children as shown in the following chart. If needed we will follow up with individual schools if this information is not available from parents.

53. Metrics Related To Sanitation Conditions At Schools

DATA ELEMENT / METRIC	UNIT
Names Of School Where Youngest School Age Child Attends	Text
Type Of Toilets For Students In School	List
Separate Toilets For Girls And Boys	List
Availability Of Water In School Toilet	List
Availability Of Soap In School Toilet	List
Sources Of Potable Water At School	List

Source: RID IEP Analysis.

5.3.6 Time And Inconvenience Of Less Than 24/7 Water

Households spend significant time dealing with the inconveniences caused by unreliable water supplies. The following chart shows the Metrics the RID IEP will use to assess these times. The first four Metrics duplicate those considered in the Cost And Time Impact Category discussed earlier in this Chapter. However, as part of Quality Of Life these Metrics will be determined by gender and age of household member.

Data will be collected by gender and age because reportedly there are differences in the amount of time that men and women must spend dealing with the inconveniences. Family member types are young children, school-age children, adult women, adult men, elderly and infirm women and elderly and infirm men.

54. **Metrics Related To Time An Inconvenience Coping With Less Than 24/7 Municipal Water**

DATA ELEMENT / METRIC	UNIT
Time Spent Managing Water Supply System	hr/wk
Time Spent Treating Water Just Before Use	hr/wk
Time Spent Managing Sewage System	hr/wk
Time Spent Gathering Water From Spring Or Distant Source	hr/wk
Time Spent Dealing With Inconveniences Of Less Than 24/7 Municipal Water	hr/wk
Total Time That Would Be Made Available For Other Activities If Municipal Water Was Available 24/7	**hr/wk**
Level Of Non-Time Inconvenience From Having Less Than 24/7 Municipal Water	List
Most Likely Use Of Newly-Available Time If Municipal Water Was Available 24/7	List
Second Most Likely Use Of Newly-Available Time If Municipal Water Was Available 24/7	List

Source: RID IEP Analysis.

Time spent managing local infrastructure is first assessed; this includes private water wells and storage tanks. Time spent treating water (*e.g.*, boiling) is then assessed. Then time spent acquiring water from distant sources (*e.g.*, public tap, spring) is determined. The amount of additional time spent on inconveniences is then assessed. The overall inconvenience for different household members is then determined as well as what each member would do with the newly-freed time when the new water systems begin operation.

5.3.7 Self-Reported Water Consumption And Conservation

The following chart shows Metrics related to water consumption as reported by the household.[25] The distribution of consumption by use is first asked. The method the household uses for water remaining in a water storage tank when new water becomes available is covered next.[26] The frequency of leaks and their costs are then evaluated. Finally, activities undertaken to reduce water consumption (*i.e.*, conservation) are assessed.

[25] A more precise water audit was described in the Total Sewer And Water Costs Impact Category.
[26] Reportedly a great deal of water is drained from the tank, and wasted, before the tank is refilled.

55. **Metrics Related To Self-Reported Water Consumption And Conservation**

DATA ELEMENT / METRIC	UNIT
Portion Of Water That Comes From Municipal Water System	%
Portion Of Water That Comes From Alternative Sources	%
Portion Of Water That Is Used For Domestic Purposes	%
Portion Of Water That Is Used For Garden Purposes	%
Portion Of Water That Is Used For Domestic Pets	%
Portion Of Water That Is Used For Farm Animals	%
Portion Of Water That Is Used For Economic Purposes	%
Portion Of Water That Is Lost To Leaks	%
Portion Of Water That Is Disposed Of When Water Storage Tanks Are Re-Filled	%
Strategy Used For Water In Water Storage Tank When Fresh Water Is Available	List
Frequency Of Leaking Pipes In HH Water System	List
Cost Of Repairs To Leaking Pipes In Last Year	GEL
Frequency Of Leaking Fittings In HH Water System	List
Cost Of Repairs To Leaking Fitting In Last Year	GEL
Water Use Reduction Or Recycling Methods Used At Present	List

Source: RID IEP Analysis.

5.3.8 Gender Issues

Women are typically responsible for significant work within the home, in addition to perhaps working outside the home. The following chart shows the Metrics to be determined on these uses of women's time. The Metrics will be determined for each type of household member (*i.e.*, young children, school-age children, adult women, adult men, elderly and infirm women and elderly and infirm men).

56. Metrics Related To Work Inside And Outside The Home

DATA ELEMENT / METRIC	UNIT	VALUE FOR FAMILY MEMBER მნიშვნელობა ოჯახის	
		HEALTHY ADULT MEN ჯანმრთელი ზრდასრული მამაკაცები	HEALTHY ADULT WOMEN ჯანმრთელი ზრდასრული ქალები
Time Spent On Cooking	hr/wk		
Time Spent On Caring For Children (not play)	hr/wk		
Time Caring For Sick HH Members (sick from water borne disease)	hr/wk		
Time Spent On Cleaning Around HH	hr/wk		
Time Spent On Other Domestic Chores	hr/wk		
Time Spent Working Outside The Home	hr/wk		

Source: RID IEP Analysis.

We will also inquire about perceptions regarding equity vis-à-vis water and sewer systems as shown in the following chart.

57. Perceptions Of Gender Equity Vis-À-Vis Water And Sewer Services

DATA ELEMENT / METRIC	UNIT	AMONG GROUP OF WOMEN		
		HEALTHY YOUNG WOMEN (12-18)	HEALTHY ADULT WOMEN ჯანმრთელი ზრდასრული ქალები	ELDERLY AND INFIRM WOMEN ასაკიანი ქალები
Perception About Equity Of ***Access To Water*** Between Men And Women	Scale			
Perception About Equity Of ***Access To Sanitation*** Between Men And Women	Scale			
Perception About The Level Of Privacy In ***Access To Sanitation***	Scale			
Perception About Equity Of ***Sharing Of Inconvenience*** From Not Having Municipal Water 24/7 Between Men And Women	Scale			

6 INDIVIDUAL FIRMS IMPACT GROUP

This Chapter describes the portions of the Impact Evaluation Design related to individual firms at the micro-level. As described in Chapter 2, impacts on individual firms are divided into two Impact Categories (*i.e.*, Total Water And Sewer Costs, Business Enablers) and then further divided into Impact Sub-categories as shown in the following chart. The final column shows one representative Metric for each Impact Sub-Category.

There are a number of Primary Metrics (not the representative Metrics shown in the chart) that drive the sample sizes for the individual surveys. The Primary Metrics are defined in Chapter 11 as part of treatment and control.

58. Impact Hierarchy For The Individual Firms Impact Group

IMPACT GROUP	IMPACT CATEGORY	IMPACT SUB-CATEGORY	REPRESENTATIVE METRIC FOR IMPACT SUB-CATEGORY ("Change in ...")
Individual Firms	Total Water And Sewer Costs	Monetary Costs	Total Annualized Semi-Variable And Annual Variable Cost Of Water And Sewer
		Willingness To Switch	Ratio Of Current To Future Water And Sewer Costs
		Water Consumption	Water Quantity Content Per Unit Produced
	Business Enablers	Expand Existing Business	Opportunity Cost Of Coping
		Enter New Business	Ratio Of Current And Future Fixed Costs Of Entering A New Business

Source: RID IEP Analysis.

As described in Chapter 5, time that individual households spend coping with less than 24/7 water is reported on but no value is imputed. Consequently, the individual households Impact Group has an Impact Sub-Category called coping time. Individual firms also spend time coping with less than 24/7 water, but in this case the time is spent by paid staff. Consequently, the value of the coping time (the wages paid) are included in monetary costs and there is no separate coping time Impact Sub-Category.

As noted in Chapter 2, three of the five analytical methods are used to evaluate impact on individual firms as shown in the following chart.

59. Analytical Methods Used For The Individual Firms Impact Group

IMPACT GROUP	IMPACT CATEGORY	IMPACT SUB-CATEGORY	ANALYTICAL METHOD USED					
			BASLINE AND EX-POST SURVEY	TREATMENT AND CONTROL	MICRO-MODELS	SAMs AND CGE	MICRO-SIMU-LATION	CASE STUDIES
Individual Firms	Total Water And Sewer Costs	Monetary Costs		√	√			
		Willingness To Switch		√	√			
		Water Consumption		√	√			
	Business Enablers	Expand Existing Business			√			√
		Enter New Business			√			√

Source: RID IEP Analysis.

The first Section of this Chapter describes three overall impact Metrics for the individual firms Impact Group. There are many Metrics related to impact on individual firms. However, the three Metrics discussed in the first Section are representative of what will be in the executive summary of the final report of the RID IEP.

The second Section of this Chapter concerns the total water and sewer costs Impact Category where we discuss the micro-model that applies to individual firms. This model specifies the precise Metrics and Data Elements for individual firms. The third Section turns to the business enablers Impact Category including expand existing businesses and enter new businesses.

6.1 OVERALL IMPACT FOR INDIVIDUAL FIRMS GROUP

Individual firms are one of six Impact Groups in which overall impact from the RID projects will be reported. Considering the Key Research Questions and what the RID IEP knows about the impact of water systems on individual firms, the RID IEP will report the following summary Metrics (impacts) for the individual firms Impact Group. A variety of reporting groups will be used (*e.g.*, overall, by individual city, by firm type). Note that many more Metrics related to the individual firms Impact Group are discussed in the remainder of this Chapter.

60. Summary Metrics For The Individual Firms Group

SUMMARY METRIC (Change In …)	MEAN FOR REPORTING GROUP			
	OVERALL	CITY X	FIRM TYPE Y	OTHERS AS DESIRED
Total Annualized Semi-Variable And Annual Variable Cost Of Water And Sewer				
Water Value Content Of Each Unit Produced				
Implicit Annual Water Consumption From Municipal And Alternative Sources				

Source: RID IEP Analysis.

We will also report confidence intervals for the mean of each reporting group as well as other measures of distribution of values among individual firms in the reporting group. The values reported will be based on the Treatment and Control aspects of the Design (*i.e.*, difference of differences) discussed in Chapter 11.

Each of the summary Metrics is described further in the following paragraphs.

Total Annualized Semi-Variable And Annual Variable Cost Of Water And Sewer. The first Metric equals the total spending by firms on water and sewers services including municipal water (at tariff rates) and variable coping costs (*e.g.*, electricity to run a water well pump). Values come from the detailed micro-model of individual firms discussed in the next Section of this Chapter.

The pre-post change in this summary Metric represents the direct monetary impact on firms of the RID projects. If the Total Expenditure falls once firms have access to the new water and sewer systems then one can expect firms to voluntarily switch from alternative sources of water and sewer service to the (new) municipal water and sewer systems.

Water Value Content Of Each Unit Produced. The current cost of water divided by the number of units produced gives this summary Metric. It reflects the importance of water in the production process. The direction of movement of this Metric after the new water systems are available is not certain. It will depend on changes in tariffs and how firms change their production methods when water prices change. Nevertheless, it is likely that this Metric will fall as municipal water is used and firms are able to use water more efficiently.

The pre-post change in this summary Metric represents the savings (or additional cost) of the new water and sewer systems *after* considering tariff policies.[27]

Implicit Annual Water Consumption From Municipal And Alternative Sources.
Currently firms use water from the municipal system and a number of alternative sources. This Metric combines current municipal water usage with estimates of alternative source usage to give a total consumption level. As with the previous summary Metric, it is not certain which direction this Metric will move once the new water systems begin operation. Consumption may fall because prices (tariffs) rise. Or, consumption may rise since better and more reliable water permits the business to expand. The Metric includes the word "implicit" because it is not possible to measure the amount of alternative water used precisely; we will depend on estimates by firms.

The pre-post change in this Metric represents the change in water consumption due to the new water and sewer systems.

6.2 TOTAL WATER AND SEWER COST IMPACT CATEGORY

Individual firms have responded to unreliable water in a variety of ways. All these methods of coping with unreliable water create costs for firms compared to a situation where there is municipal water 24/7. This Section describes these individual firm coping strategies and related costs. This Section considers both municipal water and sewer costs since the (potential) reduction in total water and sewer costs (however supplied) is what will provide the economic motivation for individual firms to switch to the new water and sewer systems.

The individual firm micro-model gathers together all the various factors that affect total water and sewer costs for individual firms. Depending on the coping strategy used by a particular firm, some elements of the micro-model will not apply; these sections of the model report zero coping costs in this case. The micro-model discussed here is a generalization of nine individual models that were prepared by the RID IEP for different industries in different RID cities. The generalization step complicated the resulting model but did not remove any detail of the industry- and city-specific models.

Given the intensity of water usage and a particular coping strategy, it is more or less straightforward to estimate total water and sewer costs for an individual firm. Coping costs are largely determined by the coping strategy chosen by the firm, which in turn is determined by several factors. Average length of water supply (per day, per week), the technical possibility of digging a well or the proximity of the firm to a natural spring are important factors influencing the coping strategy selection by the firm.

The individual firm micro-model considers all the possible coping strategies used by firms in the RID cities and categorizes coping costs into fixed, semi-variable and variable costs. Variable costs include staff hired to manage the water and sewer systems. The micro-models were designed on the basis of exploratory interviews with a broad range of firms.

[27] It is likely that real costs will fall if firms pay the actual cost of water. However, if there are cross subsidies in the tariff (*i.e.*, firms pay more per m^3 so households can pay less) then it is possible that costs for firms will actually rise once the new water and sewer systems (and tariff) begin operation.

This Section has seven Sub-Sections. The first describes the range of coping strategies used by individual firms. These are defined in some depth to ensure a common understanding of their meanings.

The next three Sub-Sections discuss fixed, semi-variable and variable costs for individual firms at a summary level. The detailed calculations, Metrics and Data Elements in the micro-model are shown in Appendixes H, L and M. The following Sub-Section combines the costs into annual water and sewer costs.

The last Sub-Section describes the economic willingness of individual firms to switch to the new water and sewer systems. It calculates a ratio between current and future total water and sewer costs. The larger the ratio the more firms will save by switching and the higher the likelihood that they will actually switch.

6.2.1 Coping Strategies

Preparatory interviews with firms identified a broad range of coping strategies used by firms because they do not have municipal water 24/7. Nearly every firm has a coping strategy of one type or another. In many cases firms use more than one coping strategy at the same time. To the end, coping strategies are related to improving the municipal water supply (*e.g.*, storing municipal water for later use) or creating an alternative source of water (*e.g.*, a private water well), improving sewage arrangements or all three.

Given the nature of the business and the importance of water for efficient operations, firms make decision whether to develop an alternative source of water supply or rely only on municipal water and alternatively create a storage facility to smooth water consumption. Large hotels in Kobuleti, for example, use limited amounts of municipal water and utilize their own private water wells, while a brewery in Kutaisi depends only on municipal water since water from a private well can not be used for production purposes.

There are five broad Coping Need Areas with several methods within each as shown in the following chart. Textual comments about the features of each Coping Need Area follow along with an example of how hotels combine a number of coping methods.

61. <u>Coping Methods Used By Individual Firms</u>

COPING NEED AREA	METHODS	FEATURES
Water Supply	Municipal Water Connection	Municipal water connected to water storage tank, directly to firm or both
	Water Well	Private water well; electric well pumps
	Spring Or Other Distant Source	Headworks; long supply pipe; maybe transport pumps
	Tanker Truck Water	Water brought to firm in large increments; always placed in some type of water storage tank
	Bottled Water	Very low usage; for drinking purposes only
Water Storage	None	Reliable municipal water, private spring or other distant source can obviate the need for local water storage
	Elevated Water Storage Tank	Small to large tank; often requires pump at inlet to fill fill the tank from water source
	Ground-Level Water Storage Tank	Open or closed metal or concrete tank; requires some type of pressurizing pump at outlet
Water Filters	Wellhead Filters	Present at the wellhead; filters water coming from the well
	In-Line Filters	Present after all water sources converge; filters water from all sources
Water Distribution System	Gravity Fed System	Needs elevated water storage tank
	Pump-Pressurized System	Needed with ground-level water storage tanks; distribution pump to pressurize water as it exits from storage tank
	Distribution Piping	Pipes leading from water storage tank to a connection with the firm's internal water system
Sewer System	Municipal Sewer System Connection	Connection to municipal sewer system
	Sewer Outfall	Long pipe to river or sea; may require pump adjacent to firm or at outfall end-works
	Sewage Storage Tank	Steel or metal tank; distribution pumps and pipes
	Sewer Tank Truck	Connection for sewer truck to sewage storage tank

Source: RID IEP Analysis.

<u>Water Supply.</u> There are several potential sources of water including the municipal water system, water from a private water well, spring water, tanker truck water and bottled water. One or more of these water sources are used by firms. Technical means include private water wells, well pumps, head works and piping.

Water supply has a sense of obtaining a fixed volume of water each day without considering the temporal pattern of usage. Supply could be 24/7 or one hour every two days. In both cases the source and quantity of water supplied is what is important. The means of ensuring access to water 24/7 is discussed next in the context of water storage.

<u>Water Storage.</u> Firms use a variety of ways to store water on-site so they have access to water 24/7. Technical means include storage tanks (*e.g.*, elevated or ground tanks, steel or concrete tanks), pumps used for filling storage tanks or pressuring water for use and piping that connects the tank to the water supply.

<u>Water Filters.</u> To ensure the quality of water, firms use water filters. These incur a fixed cost at time of installation and continuing semi-variable costs to maintain and replace the filter. Firms utilizing private water wells usually use a filter to ensure that clean groundwater enters the distribution system or a tank. Firms also have another type of filter built in a tank, which requires cleaning from time to time.

<u>Water Distribution System.</u> The water distribution system utilized by the firm depends mainly on the water source and storage facility. Gravity fed systems use elevated tanks that require pumping water when tanks are being filled. Once the elevated tank is full, no additional pumping is required and water flows to the building or production facility with gravity flow.

Unlike elevated tank, ground-level water storage requires pumping when water exits the tank for consumption purposes. This is done to pressurize water for use. Pump-pressurized systems require little pumping while filling the water storage tank.

Regardless of the type of distribution system, firms need to set up pipes connecting water storage tanks with the internal water system.

Sewers. Another source of trouble for firms is the sewer network, especially for hotels. Due to insufficient capacity and outdated infrastructure, the sewer network is often out of order. Firms may have connections to the municipal sewer system, a private sewage storage tank or a private outflow pipe ending in a river or the sea. If the firm does not have a connection to the municipal sewage system then sewage tanker trucks are used to periodically empty the sewage storage tank.

Hotel Example. Hotels in Kobuleti, on the Black Sea coast, are an example of all of these coping strategy elements. Hotels are usually supplied with municipal water. However, this is done with limited schedules and low water pressure. To maintain high quality service, hotels install a tank, which stores water when the water supply is turned on by the water utility. Tanks vary in size, depending on the size of the hotel. In order for water to reach the tank, the hotel uses a tank filling pump, which ensures that low pressure municipal water reaches the storage tank. Once the tank is filled, another distribution pump (in the case where the tank is not elevated) ensures that water reaches high floors of the hotel with sufficient pressure.

During the peak season, water usage is very high and municipal water is not sufficient to ensure a sufficient amount of water, even with local water storage. For this reason, hotels have dug private water wells as an alternative source of supply. A water well pump is used to get the water from the well to the storage tank. The same distribution pump as for the municipal water, takes water to high floors.

All the pumping noted here is expensive. In addition, hotels have to hire a person who takes care of the water system and ensures that pumps are turned on and off properly.

6.2.2 Water And Sewer Fixed Cost

Fixed costs are costs incurred for building initial water and sewer infrastructure. Fixed costs are incurred only once and then they are sunk costs unless the firm makes a major capacity upgrade or a radical change in their coping strategy. Examples of these types of costs are fees to connect to the municipal water system, private water well construction costs and pump and tank purchase costs.

The following chart shows the fixed water and sewer costs that individual firms may incur. Not all individual firms incur all or even any of these costs. Generally, any fixed costs other than connection to the municipal water and sewer systems would be considered to be coping costs – costs incurred by the firm because there is not reliable water 24/7.

62. <u>Individual Firm Water And Sewer Fixed Cost</u>

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE
Total Non-Coping-Related Fixed Cost For Water And Sewer = Fixed Cost Of Municipal Water Connection + Fixed Cost Of Municipal Sewer Connection **Total Coping-Related Fixed Cost For Water = Fixed Cost Of Water Well System + Fixed Cost Of Spring Or Distant Water Source System + Fixed Cost Of Outside Water Storage System + Fixed Cost Of Water Distribution System + Fixed Cost Of Inside Water Storage System + Fixed Cost Of Buckets And Other Movable Water Storage Containers + Fixed Cost Of Water Filters** **Total Coping-Related Fixed Cost For Sewer = Fixed Cost Of Sewage Storage System + Fixed Cost Of Sewage Outfall System** **Total Fixed Cost Of Water And Sewer = Total Non-Coping-Related Fixed Cost For Water And Sewer + Total Coping-Related Fixed Cost For Water + Total Coping-Related Fixed Cost For Sewer**	Fixed Cost Of Municipal Water Connection	GEL	1 200
	Fixed Cost Of Municipal Sewer Connection	GEL	1 400
	Total Non-Coping-Related Fixed Cost For Water And Sewer	**GEL**	**2 600**
	Fixed Cost Of Water Well System	GEL	5 115
	Fixed Cost Of Spring Or Distant Water Source System	GEL	9 415
	Fixed Cost Of Outside Water Storage System	GEL	860
	Fixed Cost Of Water Distribution System	GEL	2 160
	Fixed Cost Of Inside Water Storage System	GEL	125
	Fixed Cost Of Buckets And Other Movable Water Storage Containers	GEL	50
	Fixed Cost Of Water Filters	GEL	300
	Total Coping-Related Fixed Cost For Water	**GEL**	**18 025**
	Fixed Cost Of Sewage Storage System	GEL	6 750
	Fixed Cost Of Sewage Outfall System	GEL	14 800
	Total Coping-Related Fixed Cost For Sewer	**GEL**	**21 550**
	Total Fixed Cost Of Water And Sewer	**GEL**	**42 175**

Source: RID IEP Analysis.

For this particular firm (a large hotel) the total fixed coping costs at the time the hotel was constructed was about 42 000 GEL, of which nearly 40 000 GEL would ***<u>not</u>*** have been incurred if municipal water was available 24/7. If a similar hotel was to be constructed after the new water and sewer system is in operation, the only remaining non-coping-related fixed costs would be 2 600 GEL. This represents a 40 000 GEL reduction in the barriers to entry for new large hotels. Interestingly, the existing hotel will be at a competitive disadvantage to the new hotel because the existing hotel has already spent the 40 000 GEL; it is a sunk cost and it cannot be recovered.[28]

Each of the fixed costs shown in the preceding chart is a Metric that is calculated from a number of Data Elements. The following chart shows an example of such a calculation for a water well.[29]

[28] In theory, some equipment could be sold. However, in the face of good access to municipal water it is likely that much existing equipment will have minimal value.

[29] In charts from the micro-models the green cells in the value column are numbers collected from individual firms or engineering firms (typically Data Elements to be collected) while yellow cells in the value column are numbers calculated by the micro-model (typically Metrics to be reported and analyzed further).

63. Individual Firm Fixed Cost Of Water Well

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE
Fixed Cost Of Water Wells = Number Of Water Wells * (Average Depth Of Water Wells * (Unit Water Well Lining Pipe Cost + Unit Water Well Digging And Well-Lining Installation Cost)) **Fixed Cost Of Water Well Pumps = Number Of Water Well Pumps * Unit Water Well Pump Cost** **Fixed Cost Of Water Well System = Fixed Cost Of Water Wells + Fixed Cost Of Water Well Pumps + Water Well Electrical Control System Cost + Testing Of Water At Startup Cost**	Year Of Constructing Wells		1960
	Number Of Water Wells		1
	Average Depth Of Water Wells	m	65
	Unit Water Well Lining Pipe Cost	GEL/m	5
	Unit Water Well Digging And Well-Lining Installation Cost	GEL/m	35
	Fixed Cost Of Water Wells	**GEL**	**2 600**
	Number Of Water Well Pumps		3
	Unit Water Well Pump Cost	GEL	700
	Fixed Cost Of Water Well Pumps	**GEL**	**2 100**
	Water Well Electrical Control System Cost	GEL	400
	Testing Of Water At Startup Cost	GEL	15
	Fixed Cost Of Water Well System	**GEL**	**5 115**

Source: RID IEP Analysis.

Appendix H shows the detailed calculations of all types of fixed costs for individual firms including related Metrics and Data Elements.

6.2.3 Water And Sewer Semi-Variable Cost

These types of costs are typically driven by either time (*e.g.*, well refurbishment) or a large volume of water obtained from a water source (*e.g.*, tank refurbishment). In all cases semi-variable costs are generally known to occur, but they occur infrequently. For example, replacement of pumps belongs to this cost category, because exploitation defines its frequency and they are replaced relatively infrequently.

For reporting purposes, semi-variable costs are annualized (*i.e.*, the semi-variable cost is divided by the expected number of years between incurring the cost).

The following chart shows annualized semi-variable water and sewer costs for an individual firm. Not all individual firms incur all or even any of these costs. Generally, all the shown semi-variable costs are coping costs – costs incurred by the firm because there is not reliable water 24/7.

64. Individual Firm Semi-Variable Water And Sewer Cost

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE
Total Annualized Semi-Variable Cost Of Water = Annualized Semi-Variable Cost Of Water Well System + ... Spring Or Distant Water Source System + ... Outside Water Storage System + ... Water Distribution System + ...Inside Water Storage System + ...Buckets And Other Moveable Water Storage Containers + ... Water Filter System + ... Water Testing **Total Annualized Semi-Variable Cost Of Sewer = Annualized Semi-Variable Cost Of Sewage Storage System + Annualized Semi-Variable Cost Of Sewage Outfall System** **Total Annualized Semi-Variable Cost Of Water And Sewer = Total Annualized Semi-Variable Cost Of Water + Total Annualized Semi-Variable Cost Of Sewer**	Annualized Semi-Variable Cost Of Water Well System	GEL/yr	950
	... Spring Or Distant Water Source System	GEL/yr	633
	... Outside Water Storage System	GEL/yr	765
	... Water Distribution System	GEL/yr	733
	...Inside Water Storage System	GEL/yr	246
	...Buckets And Other Moveable Water Storage Containers	GEL/yr	42
	... Water Filter System	GEL/yr	50
	... Water Testing	GEL/yr	30
	Total Annualized Semi-Variable Cost Of Water	**GEL/yr**	**3 449**
	Annualized Semi-Variable Cost Of Sewage Storage System	GEL/yr	627
	Annualized Semi-Variable Cost Of Sewage Outfall System	GEL/yr	2 375
	Total Annualized Semi-Variable Cost Of Sewer	**GEL/yr**	**3 002**
	Total Annualized Semi-Variable Cost Of Water And Sewer	**GEL/yr**	**6 451**

Source: RID IEP Analysis.

Each year the hotel in the preceding chart incurs 6 450 GEL of semi-variable costs related to water and sewer costs. These would be avoided if municipal water was available 24/7.

Each of the Metrics shown in the preceding chart is calculated from a number of Data Elements. The following chart shows an example of such a calculation for semi-variable costs for outside water storage systems.

65. Individual Firm Annualized Semi-Variable Cost For Outside Water Storage System

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE
Annualized Semi-Variable Cost Of Outside Water Storage Tanks = (Number Of Outside Water Storage Tanks * Unit Outside Water Storage Tank Replacement Or Refurbishment Cost) / Expected Time Between Outside Water Storage Tank Replacement Or Refurbishment	Expected Time Between Outside Water Storage Tank Replacement Or Refurbishment	yr	20
	Number Of Outside Water Storage Tanks		1
	Unit Outside Water Storage Tank Replacement Or Refurbishment Cost	GEL	5 000
Annualized Semi-Variable Cost Of Outside Water Storage Tank Filling Pumps = (Number Of Outside Water Storage Tank Filling Pumps * Unit Outside Water Storage Tank Filling Pump Replacement Or Refurbishment Cost) / Expected Time Between Outside Water Storage Tank Filling Pump Replacement Or Refurbishment	**Annualized Semi-Variable Cost Of Outside Water Storage Tanks**	**GEL/yr**	**250**
	Expected Time Between Outside Water Storage Tank Filling Pump Replacement Or Refurbishment	yr	2
	Number Of Outside Water Storage Tank Filling Pumps		2
Annualized Semi-Variable Cost Of Outside Water Storage Electrical System Replacement Or Refurbishment = Unit Outside Water Storage Electrical Control System Replacement Or Refurbishment Cost / Expected Time Between Outside Water Storage Electrical System Replacement Or Refurbishment	Unit Outside Water Storage Tank Filling Pump Replacement Or Refurbishment Cost	GEL	400
	Annualized Semi-Variable Cost Of Outside Water Storage Tank Filling Pumps	**GEL/yr**	**400**
	Expected Time Between Outside Water Storage Electrical System Replacement Or Refurbishment	yr	2
	Unit Outside Water Storage Electrical Control System Replacement Or Refurbishment Cost	GEL	230
Annualized Semi-Variable Cost Of Outside Water Storage System = Annualized Semi-Variable Cost Of Outside Water Storage Tanks + Annualized Semi-Variable Cost Of Outside Water Storage Tank Filling Pumps + Annualized	**Annualized Semi-Variable Cost Of Outside Water Storage Electrical System Replacement Or Refurbishment**	**GEL/yr**	**115**
	Annualized Semi-Variable Cost Of Outside Water Storage System	**GEL/yr**	**765**

Source: RID IEP Analysis.

Appendix H shows the detailed calculations of all types of semi-variable costs for individual firms including related Metrics and Data Elements.

6.2.4 Water And Sewer Variable Cost

Variable costs are costs incurred on a regular basis and depend on the volume of water obtained or amount of sewage produced. A typical variable cost is electricity to run a pump.

Variable costs include both coping-related costs (*e.g.*, running a private water well pump) and non-coping-related costs (*e.g.*, municipal water bill).

Water volumes and variable cost vary greatly by time of year for seasonable businesses (*e.g.*, hotels). Consequently, variable costs are separately calculated for the high, shoulder and low seasons and summed to an annual figure.

The following chart shows variable water and sewer costs for individual firms. Sewage fees are calculated in one of four ways for firms. The proper method will be used for each individual firm.

66. Individual Firm Water And Sewer Variable Cost

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE			
			SEASON			ANNUAL
			HIGH	SHOULDER	LOW	TOTAL
Total Annual Variable Coping Cost Of Water = Annual Variable Cost Of Water Well System + ... Spring Or Distant Water Source System + ... Outside Water Storage System + ... Water Distribution System + ... Inside Water Storage System + ... Tanker Truck Water + ... Coping Related Bottled Water + ... Manually Collected Water From Spring Or Other Water Source **Total Annual Variable Cost Of Water = Total Annual Variable Coping Cost Of Water + Annual Variable Cost Of Municipal Water** **Total Annual Variable Coping Cost Of Sewer = Annual Variable Cost Of Sewage Storage System + ... Sewer Outfall System + ... Sewage Tanker Truck** **Total Annual Variable Cost Of Sewer = Total Annual Variable Coping Cost Of Sewer + Annual Variable Cost Of Sewage Service** **Total Annual Variable Cost Of Water And Sewer = Total Annual Variable Cost Of Water + Total Annual Variable Cost Of Sewer**	Length Of Season	wks/yr	4,3	4,3	43,4	n.a.
	Annual Variable Cost Of Water Well System	GEL/yr	231	33	133	**398**
	... Spring Or Distant Water Source System	GEL/yr	231	33	133	**398**
	... Outside Water Storage System	GEL/yr	277	231	200	**709**
	... Water Distribution System	GEL	238	159	1 082	**1 478**
	... Inside Water Storage System	GEL/yr	166	139	120	**425**
	... Tanker Truck Water	GEL/yr	172	86	0	**258**
	... Coping Related Bottled Water	GEL/yr	60	22	174	**255**
	... Manually Collected Water From Spring Or Other Water Source	GEL/yr	36	24	122	**182**
	Total Annual Variable Coping Cost Of Water	**GEL/yr**	**1 412**	**726**	**1 963**	**4 102**
	Annual Variable Cost Of Municipal Water	GEL	61	33	17	**110**
	Total Annual Variable Cost Of Water	**GEL/yr**	**1 473**	**759**	**1 980**	**4 212**
	Annual Variable Cost Of Sewage Storage System	GEL/yr	192	131	1 162	**1 484**
	... Sewer Outfall System	GEL/yr	654	370	2 900	**3 924**
	... Sewage Tanker Truck	GEL/yr	400	100	100	**600**
	Total Annual Variable Coping Cost Of Sewer	**GEL/yr**	**1 246**	**601**	**4 161**	**6 008**
	Annual Variable Cost Of Sewage Service	GEL/yr	75	41	20	**136**
	Total Annual Variable Cost Of Sewer	**GEL/yr**	**1 320**	**642**	**4 182**	**6 144**
	Total Annual Variable Cost Of Water And Sewer	**GEL/yr**	**2 793**	**1 401**	**6 162**	**10 355**

Source: RID IEP Analysis.

The variable costs shown in the preceding chart will change when municipal water becomes available 24/7. Coping-related costs (*e.g.*, water tanker trucks) will fall or become zero. Other costs will rise, particularly the municipal water and sewer bills. It cannot be assumed, a priori, that total variable costs will fall once the new water and sewer systems go into operation.[30] The direction of change in these costs will affect the willingness of firms to switch to the new water and sewer systems.

Each of the Metrics shown in the preceding chart is calculated from a number of Data Elements. The following chart shows an example of such a calculation for variable costs for sewage storage systems.

[30] Costs could rise because consumption rises (with water 24/7 there is a temptation to use more water) or because tariffs rise at the same consumption rate, or both effects at the same time.

67. Individual Firm Variable Cost For Sewage Storage System

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE – SEASON – HIGH	VALUE – SEASON – SHOULDER	VALUE – SEASON – LOW	VALUE – ANNUAL TOTAL
Annual Sewage Storage Pump Operating Hours = Length Of Season * Number Of Sewage Storage Pumps Used * Number Of Days In A Week Sewage Storage Pumps Operate * Number Of Hours In A Day Sewage Storage Pumps Operate **Annual Variable Cost Of Sewage Storage Pumps = Annual Sewage Storage Pump Operating Hours * Effective Power Draw Of Each Sewage Storage Pump * Unit Electricity Cost** **Annual Variable Cost Of Sewer Systems Management Employees = Length Of Season * 12 / 52 * Number Of Employees Devoted To Sewer Systems * Monthly Gross Salary For One Employee** **Annual Variable Cost Of Sewage Storage System = Annual Variable Cost Of Sewage Storage Pumps + Annual Variable Cost Of Sewer Systems Management Employees**	Length Of Season	wks/yr	4,3	4,3	43,4	n.a.
	Number Of Sewage Storage Pumps Used		1	1	1	**n.a.**
	Number Of Days In A Week Sewage Storage Pumps Operate	days/wk	7	4	3	**n.a.**
	Number Of Hours In A Day Sewage Storage Pumps Operate	hr/day	5	3	2	**n.a.**
	Annual Sewage Storage Pump Operating Hours	**hr/yr**	**151**	**52**	**260**	**463**
	Effective Power Draw Of Each Sewage Storage Pump	kW	6	6	6	**n.a.**
	Annual Variable Cost Of Sewage Storage Pumps	**GEL/yr**	**92**	**32**	**160**	**284**
	Number Of Employees Devoted To Sewer Systems		1	1	1	**n.a.**
	Monthly Gross Salary For One Employee	GEL/mo	100	100	100	**n.a.**
	Annual Variable Cost Of Sewer Systems Management Employees	**GEL**	**99**	**99**	**1 002**	**1 200**
	Annual Variable Cost Of Sewage Storage System	**GEL/yr**	**192**	**131**	**1 162**	**1 484**

Source: RID IEP Analysis.

Firms typically hire staff to manage private water and sewer systems. Their responsibilities include maintenance and operation of the water and sewer infrastructure. In case the business is seasonal, the number of persons securing water supply increases. This is mainly the case with large hotels on the seaside who hire additional employees to handle the water supply system during the summer. Full-time workers devoted to water are mainly in water-intensive firms. Staff costs for managing sewer systems are shown in the previous chart.

Appendix H shows the detailed calculations of all types of variable costs for individual firms including related Metrics and Data Elements.

6.2.5 Annual Water And Sewer Cost

Each year individual firms face annualized semi-variable and annual variable costs for water and sewer services. The following chart shows Metrics related to these overall costs. These values are the actual amounts spent by individual firms on both water and sewer services today. Once the new water and sewer systems begin operation the coping-related costs will likely fall (perhaps to zero) while the municipal water and sewer costs will likely rise due to both quantity and tariff increases.

68. Individual Firms Annualized Semi-Variable And Annual Variable Water And Sewer Cost

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE – SEASON – HIGH	VALUE – SEASON – SHOULDER	VALUE – SEASON – LOW	VALUE – ANNUAL TOTAL
Total Annualized HH Semi-Variable And Annual Variable Cost Of Water = Annualized Semi-Variable Water Coping Cost + Variable Water Coping Cost + Municipal Water Bill **Total Annualized Semi-Variable And Annual Variable Cost Of Sewer = Annualized Semi-Variable Sewer Coping Cost + Variable Sewer Coping Cost + Municipal Sewer Bill** **Total Annualized Semi-Variable And Annual Variable Cost Of Water And Sewer = Total Annualized HH Semi-Variable And Annual Variable Cost Of Water + Total Annualized Semi-Variable And Annual Variable Cost Of Sewer**	Length Of Season	wks/yr	4,3	4,3	43,4	n.a.
	Annualized Semi-Variable Water Coping Cost	GEL/yr	285	285	2 879	**3 449**
	Variable Water Coping Cost	GEL/yr	1 412	726	1 963	**4 102**
	Municipal Water Bill	GEL/yr	61	33	17	**110**
	Total Annualized HH Semi-Variable And Annual Variable Cost Of Water	**GEL/yr**	**1 758**	**1 044**	**4 859**	**7 661**
	Annualized Semi-Variable Sewer Coping Cost	GEL/yr	248	248	2 505	**3 002**
	Variable Sewer Coping Cost	GEL/yr	1 246	601	4 161	**6 008**
	Municipal Sewer Bill	GEL/yr	75	41	20	**136**
	Total Annualized Semi-Variable And Annual Variable Cost Of Sewer	**GEL/yr**	**1 569**	**890**	**6 687**	**9 145**
	Total Annualized Semi-Variable And Annual Variable Cost Of Water And Sewer	**GEL/yr**	**3 327**	**1 934**	**11 545**	**16 806**

Source: RID IEP Analysis.

Appendix H shows the detailed calculation of the annual water and sewer cost including related Metrics and Data Elements.

6.2.6 <u>Economic Willingness To Switch To New Water And Sewer Systems</u>

Some companies in the RID target cities during interviews mentioned that if the price of municipal water is high then they will not switch completely to it. Rather, they will continue using their alternative sources of water supply. This issue is important since the majority of benefits of efficient water supply will be derived if (all) consumers will switch to alternative water supply and avoid coping costs undertaken currently.

If the annual cost shown in the preceding chart falls once the new water and sewer systems begin operation then it can be expected that individual firms will switch from their existing water and sewer arrangements to using (only) the municipal systems. The ratio of current cost over future cost indicates the motivation that individual firms will have to switch as shown in the following chart. The larger the ratio the more highly motivated will be the firm to switch to the new water and sewer systems.

For this example, it appears the firm will spend about 95 percent less using the new water and systems compared to existing arrangements. This is a deceptively large decrease because the representative firm shown in the micro-model uses all the (expensive) coping strategies causing their apparent spending to be quite high. In fact, firms do not use all the coping strategies and spend much less than is shown in these examples.

69. <u>Individual Firms Economic Willingness To Switch</u>

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE
Future Annual HH Municipal Water Bill = Volume Of Water Used Today * Water Tariff	Volume Of Water Used Today	**m^3/yr**	65
Future Annual HH Municipal Sewer Bill = Volume Of Water Used Today * Sewer Tariff	Water Tariff	**GEL/m^3**	1,7000
	Sewer Tariff	**m^3/yr**	2,1000
Future Annual HH Municipal Water And Sewer Bill = Future Annual HH Municipal Sewer Bill + Future Annual HH Municipal Water Bill	**Future Annual HH Municipal Water Bill**	**GEL/yr**	**110**
	Future Annual HH Municipal Sewer Bill	**GEL/yr**	**136**
	Future Annual HH Municipal Water And Sewer Bill	**GEL/yr**	**246**
Current Annualized HH Semi-Variable And Annual HH Variable Cost Of Water And Sewer = Current Annualized HH Semi-Variable And Annual HH Variable Cost Of Water + Current Annualized HH Semi-Variable And Annual HH Variable Cost Of Sewer	Current Annualized HH Semi-Variable And Annual HH Variable Cost Of Water	**GEL/yr**	**7 661**
	Current Annualized HH Semi-Variable And Annual HH Variable Cost Of Sewer	**GEL/yr**	**9 145**
	Current Annualized HH Semi-Variable And Annual HH Variable Cost Of Water And Sewer	**GEL/yr**	**16 806**
Likelihood To Switch For Water (larger is more likely to switch) = Current Annualized HH Semi-Variable And Annual HH Variable Cost Of Water / Future Annual HH Municipal Water Bill	**Likelihood To Switch For Water (larger is more likely to switch)**		**69,65**
	Likelihood To Switch For Sewer (larger is more likely to switch)		**67,30**
Likelihood To Switch For Sewer (larger is more likely to switch) = Current Annualized HH Semi-Variable And Annual HH Variable Cost Of Sewer / Future Annual HH	**Likelihood To Switch For Water And Sewer Combined (larger is more likely to switch)**		**68,35**

Source: RID IEP Analysis.

Appendix H shows the detailed calculation of the economic willingness to switch including related Metrics and Data Elements.

6.2.7 <u>Water Consumption</u>

All firms have water meters so it is possible to determine actual municipal water consumption. We will estimate consumption of water from alternative sources to give total water consumption.

The micro-model estimates overall water consumption by the firm as shown in the following chart. Based on preliminary interviews, it is expected that consumption of water from alternative sources will be very seasonal. The importance of alternative water sources will vary widely by firm and industry.

70. Individual Firms Water Consumption And Its Use

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE			
			SEASON			ANNUAL
			HIGH	SHOULDER	LOW	TOTAL
Total Annual Water Consumption For All Purposes = Water Consumption For Production + Water Consumption For Suport Of Production + Water Consumption For Potable Purposes + Water Consumption For Domestic Purposes + Water Consumption For Leaks	Length Of Season	days/yr	30	30	305	365
	Share Of Water Used Directly In Production		80%	80%	80%	n.a.
	Share Of Water Used To Support Product (e.g., cleaning production equipment)		10%	10%	10%	n.a.
	Share Of Water Used For Potable Purposes		5%	5%	5%	n.a.
	Share Of Water Used For Domestic Purposes		2%	2%	2%	n.a.
	Share Of Water Lost Through Leaks		3%	3%	3%	n.a.
	Annual Water Used Directly In Production	m^3/yr	230	125	50	406
	Annual Water Used To Support Production (e.g., cleaning equipment)	m^3/yr	29	16	6	51
	Annual Water Used For Potable Purposes	m^3/yr	14	8	3	25
	Annual Water Used For Domestic Purposes	m^3/yr	6	3	1	10
	Annual Water Lost Through Leaks	m^3/yr	9	5	2	15
	Total Annual Water Consumption For All Uses	m^3/yr	288	157	63	507
	Number Of Units Produced	widgets/yr	9 321	3 107	5 264	17 692
	Water Quantity Content Per Unit Produced	m3/widget	0,0308	0,0505	0,0119	0,0287
	Water Value Content Per Unit Produced	GEL/widget	1,0694	2,0629	2,9868	1,8144

Source: RID IEP Analysis.

At the bottom of the preceding chart are Metrics related to the importance of water in the production process. As before, the direction of movement in these Metrics once the new water system begins operation is not certain.

Appendix H shows the detailed calculation of water consumption including related Metrics and Data Elements.

6.3 BUSINESS ENABLERS IMPACT CATEGORY

This Section describes how the improved and more reliable water supply can influence the expansion of existing businesses and formation of new businesses. Based on the micro-models, the costs saved by existing businesses and decreases in fixed costs required to start a business can be used for forecasting the possible future size of existing companies and number of entrants on the market.

Generally, the case study analytic method will be used for this Impact Category.

6.3.1 Expanding Existing Business

The largest part of fixed costs invested by the companies in alternative water supply infrastructure can be considered as sunk costs, since they cannot be recovered. As a result, sunk costs by rational companies will not be taken into account while making their decisions on the future of the business.

However, some part of existing water-related assets can be sold, representing partial recovery of fixed costs. It will be not realistic to assume that companies will dispose of their water-related assets in the short-run, since based on the attitude of the companies interviewed, it will take more than a short while for water utility companies to regain confidence and reliability.

On the other hand, if companies switch to municipal water supply, which will be the case only if their water costs are lower with municipal water, they will save certain amounts of money to reinvest in their business. By estimating the savings made by improved water supply, it will be possible to infer whether this will be sufficient amount worth considering for future growth of the company.

A Metric called "opportunity cost of coping" calculates what would have been the value of the business, if fixed, semi-variable and incremental operating costs had been reinvested in the company at the weighted average cost of capital of the company. For example, if company invested 20 000 GEL in alternative water supply infrastructure 3 years ago and spent 1 000 GEL in semi-variable and operating coping costs, additional value of the business could be calculated as follows:

$20,000*(1+r)^3 + 1000 *(1+r)^3 + 1000*(1+r)^2 + 1000*(1+r)$

If r is 15 percent, then the increased value of the business today would be 34 410 GEL more than is the case today.

Given the fact that investment incurred in alternative water infrastructure is a sunk cost and in the future savings from improved water infrastructure can be reinvested minimum at weighted average cost of capital, the future value of savings after a certain period of time would be additional value of the company.

6.3.2 Entering New Business

Improved water infrastructure gives opportunity to decrease an entry barrier by a fixed cost required to set up reliable water infrastructure. While for some businesses the fixed cost compared to total investment can be insignificant, for other (mainly small, water intensive businesses) the saving can be important. For each business considered, initial investment should be estimated and fixed cost for setting up alternative water infrastructure should be contrasted. In case the share of fixed coping cost in total investment is insignificant, decrease in entry barrier will be irrelevant. However, a metric called "ease of starting business" can be calculated. This metric is a ratio between total fixed investment required to start a business before and after implementation of RID. If the ratio is more than one, investors will have higher incentive to start a new business. A ratio less than one suggests the opposite.

For some businesses, the decrease in the entry barrier will be a significant incentive to enter the market. For example, a hotel in Bakuriani had to build a more than two kilometer long pipe connecting the hotel with a natural spring, while the largest hotel in Kobuleti had to invest more than 120 000 EUR in establishing water supply and private sewer facility.

In order to identify the impact of the RID projects on entrepreneurial activity in the target cities, a set of potential investors and a list of businesses for which the improved water supply and sewer system could be a significant benefit will be identified. This can be real estate developers, who search for places where real estate prices are rising, or are expected to rise (it's been hypothesized and empirically observed that improved water supply and sanitation increases real estate prices), hotel business representatives, food and beverage producers, or small water intensive businesses such as car washes and laundry services. Once the final list of potential new businesses is determined, interviews with industry representatives and experts will be conducted. Based on the information, ease of starting business index can be defined for each industry and sub-industry.

7 WATER UTILITIES IMPACT GROUP

This Chapter describes how the RID IEP will determine the impact of the RID projects on water utilities in the RID cities.[31] Economy-wide impacts, including impacts on utilities, are part of the CGE analysis discussed in Chapter 9.

Impact areas for water utilities are divided into two Impact Groups: operations and finance. Operations is further divided into supply, demand and water quality Sub-Categories, while finance is further divided into cost structure, financial viability and efficiency Sub-Categories.

The following chart shows the Impact Hierarchy for the water utilities Impact Group along with representative Metrics for each Sub-Category.

71. Impact Hierarchy For The Water Utilities Impact Group

IMPACT GROUP	IMPACT CATEGORY	IMPACT SUB-CATEGORY	REPRESENTATIVE METRIC FOR IMPACT SUB-CATEGORY ("Change in ...")
Water Utilities	Operations	Supply	Average Duration (hr/day) And Frequency Of Water Provision (days/wk) In Last Month
		Demand	Water Delivered To Customers
		Water Quality	Water Test Failure Ratio
	Finance	Cost Structure	Electricity Cost As Percentage Of Total Water-Related Costs
		Financial Viability	Collection Rate From Households
		Efficiency	Employees Per 1 000 Customers

Source: RID IEP Analysis.

As noted in Chapter 2, two of the six analytical methods will be used for the water utilities Impact Group as shown in the following chart. The use of the water utility micro-model is described in this Chapter. Each RID city has a single water utility, as do the control cities. We will do in-depth interviews with each utility as well as completing the water utility micro-model.

72. Analytical Methods Used For The Water Utilities Impact Group

IMPACT GROUP	IMPACT CATEGORY	IMPACT SUB-CATEGORY	ANALYTICAL METHOD USED: BASLINE AND EX-POST SURVEY	TREATMENT AND CONTROL	MICRO-MODELS	SAMs AND CGE	MICRO-SIMU-LATION	CASE STUDIES
Water Utilities	Operations	Supply			√			√
		Demand			√			√
		Water Quality			√			√
	Finance	Cost Structure			√			√
		Financial Viability			√			√
		Efficiency			√			√

Source: RID IEP.

This Chapter has three Sections. The first Section describes three overall Metrics for the water utility Impact Group. There are many Metrics related to impact on water utilities. However, the three Metrics discussed in the first Section are representative of what will be in the executive summary of the final report of the RID IEP.

[31] The companies also provide sewer services. Nevertheless, in this Chapter they are typically referred to as water utilities or utilities.

The next Section concerns the operations Impact Category (*i.e.*, water supply, demand and quality). As in past Chapters, representative Metrics and Data Elements in these areas are shown as part of the utility micro-model. Since data is collected directly from the water utilities, and since the utilities typically keep records in many of the Metrics of interest, there are somewhat fewer calculations in the utility micro-model than is the case for the individual household and individual firm micro-models.[32] As in the other micro-models, the green cells in the charts are Data Elements (although some may be Metrics as well), while the yellow cells show the calculation of Metrics to report.

The third and final Section in the Chapter turns to the finance Impact Category (*i.e.*, cost structure, financial viability and efficiency).

7.1 OVERALL IMPACT FOR WATER UTILITIES GROUP

Water utilities are one of six Impact Groups in which overall impact from the RID projects will be reported. Considering the Key Research Questions and what the RID IEP knows about the impact of new water and sewer systems on water utilities, the RID IEP will report the summary Metrics (impacts) for the water utility Impact Group that are shown in the following chart.

Additional Metrics will be reported in the Executive Summary of the final RID IEP report as needed. Note that many more Metrics related to the water utilities Impact Group are discussed in the remainder of this Chapter.

73. Summary Metrics For The Water Utilities Impact Group

SUMMARY METRIC (Change In ...)	MEAN FOR REPORTING GROUP		
	OVERALL	CITY X	OTHERS AS DESIRED
Water Loss Ratio (NRW to water delivered to network ratio)			
Overall Collection Rate			
Operating Cost Per m^3 Delivered To Customers			

Source: RID IEP Analysis.

We will also report confidence intervals for the mean of each reporting group.

Each of the summary Metrics is described further in the following paragraphs.

Water Loss Ratio. The first summary Metric is the ratio of Non-Revenue-Water (NRW) to total water provided to the network. This ratio is the key measure of the losses in the system due to leaks; the lower the ratio the less water that is NRW.[33] Replacement of pipes as part of the RID projects should significantly reduce the water loss ratio.

The pre-post change in this summary Metric will represent the reduction in NRW due to the RID projects.

[32] Said differently, the distinction between the baseline and ex-post survey analytical method and the micro-model analytical method is somewhat blurred for water utilities.
[33] There are other types of NRW besides leaks, but leaks represent the overwhelmingly portion.

<u>Overall Collection Rate.</u> The financial health of the utility depends on the effectiveness of its bill collection. Collection rates among businesses are generally high today since most businesses have a water meter and the utility can shut off the water supply if bills are not paid. Collection rates among individual households are very poor since most households do not have individual meters.

The pre-post change in this summary Metric represents improvements in the quality of service (hence people are more willing to pay) and the ability of the utility to directly track water consumption at the household level.

<u>Operating Cost Per m^3 Water Delivered To Customers.</u> This is a measure of the overall efficiency of the utility. Reportedly, the operating cost per m^3 today is very high due to water losses and inefficient equipment.

The pre-post change in this summary Metric will reflect lower costs for the utility more efficient equipment, specifically pumps, enters service.

7.2 <u>OPERATIONS IMPACT CATEGORY</u>

This Section describes water supply, demand and quality for the water utilities. In each Sub-Section one or more charts are shown with representative Metrics. The full micro-model for water utilities is shown in Appendix I.

7.2.1 <u>Supply</u>

Several RID cities have problems with providing sufficient water to the city due to inadequate wells, filtering or main-line capacity. All RID cities have problems with water leaks leading to very high water loss ratios. These factors cause supply to be much less than 24/7 in most parts of the RID cities. There are similar capacity problems in the sewer system as well.

The following two charts show a number of Metrics related to water supply and capacity utilization of water and sewage services. Leaks cause high levels of NRW. NRW is a pure loss for the utility (costs incurred with zero related revenue) and is a key measure of the overall efficiency of the water system. Comparisons of pre- and post-survey data will permit the RID IEP to estimate how NWR has been reduced because of the new water systems.

Utility records will be used to calculate these Metrics. It is known that the reliability of the utility data is not always good because there are relatively few volume measurement points. Nevertheless, the data supplied by the utilities is the best available. Where possible, the RID IEP will prepare Metrics for individual neighborhoods of the RID cities; feasibility depends on where the water utilities have reliable system meters in place.

74. Metrics Related To Water Supplied To Network And Delivered To Customers

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE მნიშვნელობა
	Water Delivered To Network	m^3/yr	2 628 000
Water Delivered To Network = Water Delivered To Network / 365	**Water Delivered To Network**	**m^3/day**	**7 200**
	Water Delivered To Customers	m^3/yr	1 084 219
Water Delivered To Customers = Water Delivered To Customers / 365	**Water Delivered To Customers**	**m^3/day**	**2 970**
	Water Losses - NRW (non revenue water)	m^3/yr	1 543 781
Water Losses - NRW (non revenue water) = Water Losses - NRW (non revenue water) / 365	**Water Losses - NRW (non revenue water)**	**m^3/day**	**4 230**
Water Loss Ratio (NRW to water delivered to network ratio) = (Water Delivered To Network - Water Delivered To Customers) / Water Delivered To Network	**Water Loss Ratio (NRW to water delivered to network ratio)**		**59%**
	Sewage Received	m^3/yr	758 953
Sewage Received = Sewage Received / 365	**Sewage Received**	**m^3/day**	**2 079**

Source: RID IEP Analysis.

75. Metrics Related To Capacity Utilization

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE მნიშვნელობა
	Annual Water Supply Capacity	m^3/yr	3 000 000
	Daily Water Supply Capacity	m^3/day	8 219
	Daily Water Supply Capacity During High Season	m^3/day	7 000
	Daily Water Supply Capacity During Shoulder Season	m^3/day	7 000
	Daily Water Supply Capacity During Low Season	m^3/day	7 000
	Water Capacity Utilization Rate		**88%**
	Annual Sewage Treatment Capacity	m^3/yr	1 000 000
	Daily Sewage Treatment Capacity	m^3/day	2 740
	Daily Sewage Treatment Capacity During High Season	m^3/day	1 200 000
	Daily Sewage Treatment Capacity During Shoulder Season	m^3/day	
	Daily Sewage Treatment Capacity During Low Season	m^3/day	
Sewage Capacity Utilization Rate = Sewage Received / Daily Sewage Treatment Capacity	**Sewage Capacity Utilization Rate**		**76%**

Source: RID IEP Analysis.

The schedule of water supply is different among the RID cities and even within cities. The following chart shows Metrics related to duration and frequency of supply to one region of one city over the past year. These Metrics will be determined for several regions of each city based on utility records and for the both the previous month and previous year.

76. Metrics Related To Water Supply Schedule And Reliability Of The Schedule

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE / მნიშვნელობა REGION 1 რეგიონი 1
Water Supply Schedule = Hours Per Day / Days Per Week	Region Name		
	Water Delivered To Network	m^3/day	1 000
	Average Length Of Water Supply In Last Month	hr/day	5:00
	Minimum Length Of Water Supply In Last Month	hr/day	3:00
	Maximum Length Of Water Supply In Last Month	hr/day	11:00
	Average Frequency Of Water Supply In Last Month	days/wk	5
	Minimum Frequency Of Water Supply In Last Month	days/wk	3
	Maximum Frequency Of Water Supply In Last Month	days/wk	7
	Average Duration And Frequency Of Water Provision In Last Month	**hr / days**	**5,0 / 5**
	Minimum Duration And Frequency Of Water Provision In Last Month	**hr / days**	**3,0 / 3**
	Maximum Duration And Frequency Of Water Provision In Last Month	**hr / days**	**11,0 / 7**
	Average Length Of Water Supply In Last Year	hr/day	5:00
	Minimum Length Of Water Supply In Last Year	hr/day	3:00
	Maximum Length Of Water Supply In Last Year	hr/day	11:00
	Average Frequency Of Water Supply In Last Month	days/wk	5
	Minimum Frequency Of Water Supply In Last Year	days/wk	3
	Maximum Frequency Of Water Supply In Last Year	days/wk	7
	Average Duration And Frequency Of Water Provision In Last Year	**hr / days**	**5,0 / 5**
	Minimum Duration And Frequency Of Water Provision In Last Year	**hr / days**	**3,0 / 3**
	Maximum Duration And Frequency Of Water Provision In Last Year	**hr / days**	**11,0 / 7**

Source: RID IEP Analysis.

Appendix I shows the full list of Metrics and related Data Elements for supply of water by water utilities. It also shows quantities of sewage received.

7.2.2 Demand

Demand is reflected in both water consumption and revenue paid by customers. Customers fall into three categories: households, businesses and other organizations (including Governmental institutions). Households are further divided into households in private houses and households in apartment blocks.

The following chart shows several Metrics related to water demand from the perspective of the water utility. Other Metrics related to demand for water based on a water audit are part of the individual household Impact Group.

77. **Metrics Related To Water Demand From Perspective Of Water Utilities**

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE მნიშვნელობა
Average Water Consumption By Tourists And Visitors = Water Delivered To Tourists And Visitors / Number Of Tourists And Visitors To City / 365	Water Delivered To Households	m^3/yr	810 300
	Water Delivered To Businesses	m^3/yr	113 910
	Water Delivered To Other Organizations	m^3/yr	80 000
	Water Delivered To Tourists And Visitors	m^3/yr	80 000
	Average Household Size In Private Houses (individuals)		2,3
	Average Household Size In Apartment Blocks (individuals)		1,6
	Water Consumption Per Capita Among All Households (excluding water delivered to tourists and visitors)	**m^3/day**	**0,070**
	Water Consumption Per Capita In Metered Households	**m^3/day**	
	Water Consumption Per Capita In Households With Shared Meters	**m^3/day**	
	Average Water Consumption By Businesses	**m^3/day**	**2,081**
	Average Water Consumption By Other Organizations	**m^3/day**	**6,849**
	Average Water Consumption By Tourists And Visitors	**m^3/day**	**0,005**

Source: RID IEP Analysis.

Metrics related to revenue paid by customers are discussed in the Finance Sub-Section later in this Chapter.

Individual meters on firms and households are a key tool to manage demand (water consumption). The following chart shows Metrics related to meter penetration (*i.e.*, percentage of users who have an individual meter). Generally, the greater the meter penetration the more controlled is demand and the better is bill collection.

78. **Metrics Related To Meter Penetration**

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE მნიშვნელობა
Share Of Other Organizations That Are Metered = Number Of Meters In Other Organizations / Number Of Other Organizations Served	Number Of Households Served In Private Houses		12 900
	Number Of Households Served In Apartment Blocks		5 600
	Number Of Businesses Served		150
	Number Of Other Organizations Served		32
	Number Of Tourists And Visitors To City	#/yr	40 000
	Number Of Meters In Private Houses		0
	Number Of Meters In Apartment Blocks With Individual Meters		0
	Number Of Meters In Apartment Blocks With Common Meters		
	Number Of Meters In Businesses		4
	Number Of Meters In Other Organizations		0
	Share Of Households In Private Houses That Are Metered		**0%**
	Share Of Households In Apartment Blocks With Individual Meter		**0%**
	Share Of Households In Apartment Blocks With Shared Meter		**100%**
	Share Of Businesses That Are Metered		**3%**
	Share Of Other Organizations That Are Metered		**0%**

Source: RID IEP Analysis.

Appendix I shows the full list of Metrics and related Data Elements for demand of water.

7.2.3 Water Quality

The water utilities regularly test water provided to the distribution system using their own laboratories. Based on the records of the laboratory tests, inferences can be made about the quality of the water. A Metric which captures the hazard of contamination is the Water Test Failure Ratio as shown in the following chart.

79. Metrics Related To Water Quality Testing

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE მნიშვნელობა
Water Test Failure Ratio = Number Of Water Test Failures / Number Of Water Tests Conducted	Number Of Water Tests Conducted	#/yr	1 245
	Number Of Successful Water Tests	#/yr	1 238
	Number Of Water Test Failures	#/yr	7
	Water Test Failure Ratio		**1%**
	Share Of Water Disinfected (chlorinated)		**98%**

Source: RID IEP Analysis.

The RID IEP will rely on existing records to assess water quality. Evaluating the impact of the RID projects on water quality should be straightforward if the testing schemes used by the utilities are sound.[34] However one complication is that laboratory equipment is planned to be renewed as part of the RID projects. As a result, water samples that would have been graded as good in the past might not meet required standards when tested using new laboratory instruments, or vice-versa. This may cause water test failures to actually rise after the new water systems begin operation. It should be kept in mind that if this happens then it is almost certainly an artifact of the improved testing methods.

Appendix I shows the full list of Metrics and related Data Elements for the quality of water as determined by the water utilities.

7.3 FINANCE IMPACT CATEGORY

The effects of the RID projects are expected to be reflected in the financial conditions of the water utilities. Currently, most of the utilities are subsidized by the Government; those that do not receive sufficient subsidies have serious financial problems and accumulated losses.

The impact of the RID projects on the financial condition of the water utilities in the RID cities will be evaluated using Metrics in three broad areas: cost structure, financial viability and efficiency. Each of these Impact Sub-Categories is discussed in the following Sub-Sections.

As in other areas, the discussion revolves around the utility micro-model.

7.3.1 Cost Structure

The largest share of expenses for water utilities comes from electricity consumption. Outdated and energy inefficient water pumps makes it very costly for the water utilities to supply water to households. High electricity cost, largely driven by leaks in the water system, is one of the

[34] The RID IEP is not setting up new testing regimes for the utilities. We will rely exclusively on their internal testing results.

most important reasons for constrained water supply. Apart from electricity costs, outdated water and sewer infrastructures require high and increasing repair and maintenance expenses.

It is expected that the cost structure of the utilities will greatly change as a result of the RID projects. The following chart shows the Metrics and Data Elements that the RID IEP will use to assess the impact of the RID projects on the cost structure of the water utilities in the RID cities. To the maximum extent possible, given existing utility records, costs related to the water and the sewer systems will be separated.

80. <u>Metrics Related To Utility Cost Structure</u>

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE მნიშვნელობა
	Number Of Employees	FTE	24
	Number Of Technical Workers	FTE	13
	Electricity Cost	GEL/yr	187 894
	Net Price Of Electricity	GEL/kW-hr	0,0500
	Electricity Consumed	kW-hr	3 757 880
	Repair And Maintenance Cost	GEL/yr	55 000
	Salary Expense	GEL/yr	127 000
Share Of Water Related Costs In Total Costs 0.45	Other Operating Expense	GEL/yr	28 500
Share Of Sewer Related Costs In Total Costs = 1 - Share Of Water Related Costs In Total Costs	Total Operating Cost	GEL/yr	398 394
	Share Of Water Related Costs In Total Costs		**45%**
Operating Cost For Water Network = (Electricity Cost For Water Network + Repair And Maintenance Cost For Water Network + Salary Expense For Water Network + Other Operating Expense For Water Network)	**Share Of Sewer Related Costs In Total Costs**		**55%**
	Electricity Cost For Water Network	GEL/yr	84 552
Operating Cost For Sewer Network = (Electricity Cost For Sewer Network + Repair And Maintenance Cost For Sewer Network + Salary Expense For Sewer Network + Other Operating Expense For Sewer Network)	Repair And Maintenance Cost For Water Network	GEL/yr	24 750
	Salary Expense For Water Network	GEL/yr	57 150
	Other Operating Expense For Water Network	GEL/yr	12 825
	Operating Cost For Water Network	**GEL/yr**	**179 277**
	Electricity Cost For Sewer Network	GEL/yr	103 342
	Repair And Maintenance Cost For Sewer Network	GEL/yr	30 250
	Salary Expense For Sewer Network	GEL/yr	69 850
	Other Operating Expense For Sewer Network	GEL/yr	15 675
	Operating Cost For Sewer Network	**GEL/yr**	**219 117**

Source: RID IEP Analysis.

The full list of Metrics and related Data Elements related to cost structure of utilities is shown in Appendix I.

7.3.2 <u>Financial Viability</u>

The financial viability of water utilities primarily depends on three factors: collection rates, tariff levels and overall financial performance. These three factors are discussed in the following paragraphs.

<u>Collection Rate.</u> One of the most serious problems of the water utilities in the RID cities is low collection rates from individual households. In cities where most businesses are metered, collection rates from businesses are high, since the water utility can effectively threaten to turn off the water supply if bills are not paid. The situation is different for individual households where there are no water meters and it is difficult to cut off the water supply.

The following chart shows Metrics related to collection rates. The pre- to post- change in these Metrics will largely reflect the impact of individual meters.

81. Metrics Related To Collection Rates

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE მნიშვნელობა
Collection Rate From Households = Bills Paid By Households / Bills Charged To Households **Collection Rate From Businesses = Bills Paid By Businesses / Bills Charged To Businesses** **Collection Rate From Other Institutions = Bills Paid By Other Institutions / Bills Charged To Other Organizations** **Overall Collection Rate = Revenue Collected (bills paid) / Total Revenue (bills charged)**	Bills Charged To Households	GEL/yr	230 742
	Bills Paid By Households	GEL/yr	62 360
	Collection Rate From Households		**27%**
	Bills Charged To Businesses	GEL/yr	45 558
	Bills Paid By Businesses	GEL/yr	43 097
	Collection Rate From Businesses		**95%**
	Bills Charged To Other Organizations	GEL/yr	105 766
	Bills Paid By Other Institutions	GEL/yr	81 874
	Collection Rate From Other Institutions		**77%**
	Total Revenue (bills charged)	GEL/yr	382 066
	Revenue Collected (bills paid)	GEL/yr	187 331
	Overall Collection Rate		**49%**

Source: RID IEP Analysis.

Tariffs. The tariff structure in each RID city has three important aspects: the level of tariffs, the method of calculating bills and the cross-subsidy between different types of customers.

The following chart shows the Data Elements and Metrics in these areas. Presently there is an implicit water and sewer price for individual households. This is based on an assumed standard volume of water used per person and an implicit tariff (equals the fixed fee per person divided by the assumed standard volume of water used). This calculation scheme will change once meters are installed. The RID IEP will report changes in tariffs in a comparable form.

The following chart also shows the calculation of the cross-subsidies that occur from businesses to other organizations and households. Setting the tariff is beyond the scope of the RID IEP. However, the RID IEP will provide data and analysis that can be used to evaluate different tariff schemes if the water utilities and their regulators were to so choose. In particular, the results of the CGE analysis may well show that having zero cross-subsidy from businesses to households actually increases household income compared to a situation where there is a cross-subsidy.[35]

[35] This counter-intuitive result from no cross-subsidies is because overall economic activity (and household incomes) will increase due to lower water bills being put onto businesses.

82. Metrics Related To Water And Sewer Tariffs

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE მნიშვნელობა
Implicit Water Consumption Per Household Member = Standard Water Consumption Per Household Member * 365 / 12	Water Tariff For Businesses	GEL/m^3	1,7000
	Water Tariff For Other Organizations	GEL/m^3	1,3000
Implicit Water Price For Households = Water Tariff Per Household Member / Implicit Water Consumption Per Household Member	Water Tariff Per Household Member	GELmo	0,8000
	Standard Water Consumption Per Household Member	m^3/day	0,120
Implicit Sewage Discharged Per Household Member = Standard Sewage Discharged Per Household Member * 30	**Implicit Water Consumption Per Household Member**	**m^3/mo**	**3,650**
	Implicit Water Price For Households	**GEL/m^3**	**0,219**
Implicit Sewage Price For Households = Sewer Service Tariff Per Household Member Based On Municipal Water Used / Implicit Sewage Discharged Per Household Member	Sewer Service Tariff For Businesses Based On Municipal Water Used	GEL/m^3	2,3000
	Sewer Service Tariff For Other Organizations Based On Municipal Water Used	GEL/m^3	1,7000
Cross-Subsidy Level (from businesses to households) = (Water Tariff For Businesses + Sewer Service Tariff For Businesses Based On Municipal Water Used) / (Implicit Water Price For Households + Implicit Sewage Price For Households)	Sewer Service Tariff Per Household Member Based On Municipal Water Used	GEL/m^3	1,0000
	Standard Sewage Discharged Per Household Member	m^3/day	0,08
	Implicit Sewage Discharged Per Household Member	**m^3/mo**	**2,520**
Cross-Subsidy Level (from businesses to other organizations) = (Water Tariff For Businesses + Sewer Service Tariff For Businesses Based On Municipal Water Used) / (Water Tariff For Other Organizations + Sewer Service Tariff For Other Organizations Based On Municipal Water Used)	**Implicit Sewage Price For Households**	**GEL/m^3**	**0,397**
	Cross-Subsidy Level (from businesses to households)		**6,493**
	Cross-Subsidy Level (from businesses to other organizations)		**1,333**
Cross-Subsidy Level (from other organizations to	**Cross-Subsidy Level (from other organizations to households)**		**4,870**

Source: RID IEP Analysis.

Financial Performance. Financial statements provide valuable information for analyzing the impact of the RID projects on water utilities. Based on existing financial statements, financial performance ratios in four areas will be calculated and reported by the RID IEP as shown in the following chart.

83. Measures Of Financial Performance For Water Utilities

RATIO	DEFINITION OF RATIO	UNIT	VALUE მნიშვნელობა
Profitability Ratios / მომგებიანობის კოეფიციენტები			
Return On Assets (ROA)	Net Income After Tax / [(Beginning Total Assets + Ending Total Assets) / 2]		
Return On Equity (ROE)	Net Income After Tax / [(Beginning Equity + Ending Equity) / 2]		
Net Profit Margin	Net Income After Tax / Revenue		
EBITDA	Net Income Before Tax + Interest Expense + Operating Depreciation + G&A Depreciation		
EBITDA	EBITDA / Revenue		
Liquidity Ratios / ლიკვიდურობის კოეფიციენტები			
Current Ratio	Current Assets / Current Liabilities		
Quick Ratio	(Current Assets - Restricted Cash - Inventories) / Current Liabilities		
Net Working Capital	(Current Assets - Current Liabilities) / Total Assets		
Activity Ratios / აქტივობის კოეფიციენტები			
Asset Turnover Ratio	Revenue / [(Beginning Total Assets + Ending Total Assets) / 2]		
Account Receivable Turnover Ratio	Revenue / [(Beginning Accounts Receivable + Ending Accounts Receivable) / 2]		
Average Collection Period	Accounts Receivable / Revenue * 365		
Financing Ratios / დაფინანსების კოეფიციენტები			
Debt To Equity Ratio	Total Liabilities / Total Equity		
Long-Term Debt To Equity Ratio	Debt / Total Equity		
Interest Coverage Ratio	(Net Income Before Tax + Interest Expense) / Interest Expense		
Debt Service Coverage Ratio	(Net Income Before Tax + Interest Expense) / (Interest Expense + Principal Repayment)		

Source: RID IEP Analysis.

Appendix I shows a full list of Metrics and Data Elements related to cost structure, tariffs and financial performance.

7.3.3 Efficiency

The RID IEP will report on a wide range of efficiency measures for water utilities as shown n the following chart. There are Metrics related to labor productivity, energy efficiency, unit operating costs and so forth. The RID projects will positively influence many of these Metrics, but continued improvement in all of them will require new management methods in the utilities.

84. Metrics Related To Efficiency Of Water Utilities

CALCULATION	DATA ELEMENT / METRIC	UNIT	VALUE მნიშვნელობა
Number Of Employees Per 1 000 Inhabitants = ((Number Of Households Served In Private Houses * Average Household Size In Private Houses (individuals) + Number Of Households Served In Apartment Blocks * Average Household Size In Apartment Blocks (individuals)) / 1000) / Number Of Employees Energy Cost Per Cubic Meter Of Water Supplied To Customers = Electricity Cost For Water Network / (Water Delivered To Households + Water Delivered To Businesses + Water Delivered To Other Organizations + Water Delivered To Tourists And Visitors) Energy Required Per Cubic Meter Of Water = Energy Cost Per Cubic Meter Of Water Supplied To Customers / Net Price Of Electricity Revenue (bills charged) Per Full-Time Employee = Total Revenue (bills charged) / Number Of Employees Revenue (bills charged) Per Cubic Meter Of Water Delivered To Customers = Total Revenue (bills charged) / Water Delivered To Customers Average Revenue (bills charged) Per Customer = Total Revenue (bills charged) / ((Number Of Households Served In Private Houses + Number Of Households Served In Apartment Blocks + Number Of Businesses Serv Water Operating Cost Per Cubic Meter Of Water Delivered Water Operating Cost Per Cubic Meter Of Water Delivered	Number Of Repairs Per Technical Worker Per Year	#/yr	18
	Number Of Employees Per 1 000 Inhabitants	FTE	1,6
	Energy Cost Per Cubic Meter Of Water Supplied To Customers	GEL/m^3	0,08
	Energy Required Per Cubic Meter Of Water	kW-hr/m^3	1,6
	Revenue (bills charged) Per Full-Time Employee	GEL/FTE	15 919
	Revenue (bills charged) Per Cubic Meter Of Water Delivered To Customers	GEL/m^3	0,4
	Average Revenue (bills charged) Per Customer	GEL	20,5
	Water Operating Cost Per Cubic Meter Of Water Delivered To Network	GEL/m^3	0,07
	Water Operating Cost Per Cubic Meter Of Water Delivered To Customers	GEL/m^3	0,18
	Sewer Operating Cost Per Cubic Meter Of Sewage Treated	GEL/m^3	0,29
	Electricity Consumption Per Cubic Meter Of Water Delivered To Network	kW-hr/m^3	0,64
	Electricity Consumption Per Cubic Meter Of Water Delivered To Customers	kW-hr/m^3	1,56
	Electricity Cost Per Cubic Meter Of Water Delivered To Network	GEL/m^3	0,03
	Electricity Cost Per Cubic Meter Of Water Delivered To Customers	GEL/m^3	0,08
	Electricity Consumption Per Cubic Meter Of Sewage	GEL/m^3	2,72
	Electricity Cost Per Cubic Meter Of Sewage	GEL/m^3	0,14
	Operating Cost Per 1 000 Customer	GEL	21 325
	Operating Cost Per 1000 GEL Revenue	GEL	1 043

Source: RID IEP Analysis.

Appendix I shows a full list of Metrics and Data Elements related to the efficiency of water utilities.

8 GOVERNMENT INSTITUTIONS IMPACT GROUP

Within the RID cities there are a number of important Governmental institutions that do not fit within other Impact Groups (*i.e.*, individual households, individual firms, water utilities, overall economy, complementary activities), specifically military bases, prisons and the public health system. The unique features of these institutions necessitate a custom approach for each to assess the impact of the RID projects. These custom approaches are described in this Chapter.

The following chart shows the structure of the Governmental institutions Impact Group as well as the analytical methods to be applied to each. Case studies will be used for the public health system and micro-models will be used for other budgetary institutions. Defense is also a productive sector in the CGE analysis so there will be additional estimates of impact from there.

85. Impact Hierarchy For Governmental Institutions Impact Group

IMPACT GROUP	IMPACT CATEGORY	IMPACT SUB-CATEGORY	REPRESENTATIVE METRIC FOR IMPACT SUB-CATEGORY ("Change in ...")
Governmental Institutions	Public Health System	Institutional Arrangements	Allocation Of Staff Among Health Hazards (e.g., water vs. infant mortality)
		Water Borne Disease Incidence	Number Of Disease Outbreaks Caused By Municipal Water
	Other Budgetary Institutions	Prisons	Money spent on electricity to run well pumps
		Military Bases	Money spent on transporting water by tanker truck

Source: RID IEP Analysis.

86. Analytical Methods For The Governmental Institutions Impact Group

IMPACT GROUP	IMPACT CATEGORY	IMPACT SUB-CATEGORY	ANALYTICAL METHOD USED: BASLINE AND EX-POST SURVEY	TREATMENT AND CONTROL	MICRO-MODELS	SAMs AND CGE	MICRO-SIMU-LATION	CASE STUDIES
Governmental Institutions	Public Health System	Institutional Arrangements						√
		Water Borne Disease Incidence						√
	Other Budgetary Institutions	Prisons			√			
		Military Bases			√	√		

Source: RID IEP Analysis.

This Chapter has two Sections. The public health system is discussed in the first Section and other budgetary institutions are discussed in the second Section.

8.1 PUBLIC HEALTH SYSTEM

In contrast with individual doctors, ambulatory clinics and hospitals, the *public health system* is aimed at decreasing the burden of illness and injury in populations, rather than on individuals. Public health agencies use epidemiologic investigation, laboratory testing, information technology, public and provider education and other tools to support their mission.

The RID IEP distinguishes between 1) the health of individuals; 2) individual doctors, clinics and hospitals and 3) the public health system. The impact of the RID projects on the first group (i.e., individuals) will be assessed as part of the individual household Impact Group

(Chapter 5). Members of the second group (i.e., individual doctors, clinics and hospitals) are treated by the RID IEP Design as individual firms (Chapter 6).[36]

The third group, the public health system is the subject of this Section. First the elements of public health systems generally are described. This is followed by a discussion of how the Georgian public health system is organized. The last Sub-Section shows how the RID IEP will assess the impact of the RID projects on the public health system.

8.1.1 Elements Of Public Health Systems

Generally speaking, public health systems include elements of three groups.

Public Health Workforce. Typically this includes individuals employed in Governmental public health, though this group interacts with individuals employed in the healthcare sector, in academia and in volunteer organizations.

Healthcare Sector. This includes hospitals, clinics, pharmacies, emergency medical services, a host of ancillary services, and a diverse healthcare workforce. The public health system includes these players *only to the extent that they participate in public health initiatives*.

National And Local Laboratories. Laboratories function on three levels: 1) clinical laboratories, that conduct testing on individual patients within the healthcare system; 2) public health laboratories, that conduct testing to support population-based programs and may involve testing of individuals as well as environmental assessment during a public health event and 3) research laboratories, that study biological agents, the effects of treatments or other pursuits not directly linked to detection and response to specific incidents but which provide the scientific basis to guide ongoing and future response efforts. Only the second group – testing to support population-based programs is included in the public health system.

8.1.2 Georgian Public Health System

The Georgian public health system (as related to water) used to be concentrated within the Ministry of Labor, Health and Social Affairs. The Sanitary and Epidemiological Division of the Ministry was responsible for ensuring that water supplied to households met required standards. Currently, this responsibility has been divided among three organizations.

Ministry Of Agriculture, Food Safety Agency. This Agency is responsible for monitoring the quality of water. Their responsibility is to ensure that drinkable water complies with required standards. Private laboratories, selected through open tender, test water quality on a regular basis.

Ministry Of Environment Protection And Natural Resources. This Ministry is responsible for controlling the quality of water in rivers, lakes the sea and checks the compliance of water quality with determined standards.

[36] We understand that most cases of gastrointestinal disease are self medicated and, in any case, doctors do not systematically report incidents to public health authorities. Consequently, surveying doctors to quantify prevalence of water borne disease is not reliable. Nevertheless, some individual doctors, clinics and hospitals do have important opinions about the impact of water on public health generally. In this context, these doctor, clinics and hospitals are part of the public health system discussed further in this Section.

National Center For Disease Control And Public Health (NCDC). The NCDC is mainly responsible for controlling the health level of population, account for the number of disease outbreaks, research the causes of outbreaks and analyze the results. NCDC also assists health sub-divisions of local municipalities in doing health research.

The role of NCDC is particularly interesting given the objectives of the RID IEP. NCDC is responsible for conducting research on disease outbreaks, analyzing the results and identifying the causes. Based on their information, RID target cities used to be (and some of them still are) vulnerable in terms of water-borne diseases and presence of risk factors that might affect the health level of population. NCDC also possesses statistical information on every outbreak in Georgia. By doing household surveys and analyzing results they are able to determine the cause of a certain outbreak. However, the surveys are done soon after the outbreak, which is a part of the methodology.

8.1.3 Case Studies To Determine Impact Of The RID Projects

The impact of the RID projects on each of the elements of the public health system, mentioned above, will be estimated by the RID IEP through a number of case studies. We will perform preparatory desk research and then interview a broad range of participants in the public health system. The objective will not be to quantify the impact of the new water systems on individual health. Rather, the objective will be to understand the likely implications of the new water systems on the public health system. For example, will a reduction in water borne diseases permit the NCDC to reallocate staff from water-supply to other health areas (*e.g.*, infant mortality).

The case study approach is particularly appropriate given other public health initiatives that will occur in the next while, particularly related to food safety. It is entirely likely that the incidence of disease form improved food safety will outweigh improvements from better water; this is because the populace knows the potential dangers of poor water and regularly takes steps to cope with those dangers. The situation with contaminated food is very different since the contamination typically is not knowable by the consumer and, therefore, the consumer cannot take steps to cope with the danger.

During meetings with public heath officials we will collect existing statistics on the following to the extent they already exist for the RID cities.

87. Existing Public Health Statistics To Be Gathered

AREA	DESCRIPTION
Number Of Disease Outbreaks	Number Of Disease Outbreaks Observed In A City Of Interest During A Given Year
Number Of Disease Outbreak Cases Investigated	Number Of Disease Outrbreak Cases Investigated During A Year In A Given City Of Interes
Number Of Disease Outbreaks Cauesed By Municipal Water	Number Of Disease Outbreaks Investigated Where Poor Quality Of Municipal Water Was Named As A Cause Of Outbreak
Total Number Of People Infected	Total Number Of People Infected By A Disease In A Given City During A Given Year
Total Number Of People Infected By Poor Quality Of Municipal Water	Total Number Of People Infected In A Given City During A Given Year By A Poor Quality Municipal Water
Share Of Water Caused Disease Outbreaks	Share Of Disease In Total Outbreaks Caused By Municipal Water
Number Of Lethal Cases Caused By Municipa Water	Number Of People Who Died Due To Poor Quality Municipal Water
Water Borne Disease Hazard Index	Hazard Index Includes Evaluation Of Risk Factors That Might Cause A Water-Related Disease Outbreak. Public Health Experts Respond To Index-Related Questions.

Source: RID IEP Analysis.

8.2 OTHER BUDGETARY INSTITUTIONS

Military bases and prisons in some of the RID cities are among the top water users as well as having a high concentration of potential beneficiaries of the RID projects. Their coping costs and other water- and sewer-related expenses are higher than that of other Governmental institutions that primarily consume water for office use.

8.2.1 Number And Type Of Other Budgetary Institutions

There are six military bases located in the RID cities: two in Kutaisi, one in Kobuleti and three in Poti. In addition, one military base in Senaki is supplied with water by the Poti water utility[37].

Another Government institution significantly influenced by the RID projects is one prison in Kutaisi (the only prison in the RID cities); the prison is one of the largest water users in the city.

Although soldiers and prisoners might not be permanent residents of the RID cities, they will still be counted while estimating the total number of population affected by the RID projects. This is because the population at each military base or prison is relatively constant even though individual soldiers and prisoners come and go.

8.2.2 Micro-Models For The Other Budgetary Institutions

The military bases will be included in the local and national SAMs and consequently the CGE analysis will capture overall economic impact of the RID projects on the military bases. However, as with individual firms, the CGE analysis will not illuminate the military-base- or prison-level direct effects of the RID projects. Customized micro-models are needed for this purpose.

[37] Recently, Poti utility took control over the Senaki water utility.

At the micro-level, direct effects are measured by micro-models. This same approach will be used for the military bases and the prison, keeping in mind some important distinctions from the typical firm: there are no prices, entry and exit, production output and military bases and prisons are fully financed by the Government.

The RID IEP has chosen to prepare custom micro-models for each military base and prison. These will generally follow the form of the individual firm micro-models. However, the low number of respondents (six military bases, one prison) suggests that a one-size-fits-all micro-model is not needed. The RID IEP has not yet prepared these models because the military bases and prison have not yet been visited. Each micro-model will be different from the others.

To construct these special micro-models the RID IEP will conduct in-depth interviews to understand the nature of the organization, details of water coping strategy and costs, number of people permanently living on the bases or in the prison and so forth. A custom micro-model will then be prepared for each military base and prison.

8.2.3 Security Issues

The use by the RID IEP of the approach described above (i.e., military bases and prisons included in local SAM – business expenditure – survey and micro-models) is contingent on receiving suitable permissions from the Georgian military and prison authorities. It is possible that the military or the prison authorities may deny permission to collect this data for security reasons. In this event, the RID IEP will try to prepare case studies on each military base and prison. The precise outcomes of these negotiations and the final analytic method to use for the military bases and the prison are not yet known.

9 OVERALL ECONOMY IMPACT GROUP

The Chapter 4 described CGE analysis in general terms with little reference to the RID IEP specifically. This Chapter, by contrast, includes the details of the CGE analysis methods that will be used for the RID IEP.

There are four Sections in the Chapter. First, the overall CGE analysis approach for the RID IEP is described. Then, nine key design issues and decisions about the CGE analysis approach are discussed at a summary level; decisions on these key design issues are discussed in detail in Appendix J.

The third Section describes the micro-simulation approach that the RID IEP will use to estimate the impact of the RID projects on poverty (*i.e.*, distributional issues). Additional details on micro-simulation are shown in Appendix K.

The last Section of the Chapter describes how the CGE models created for the RID IEP can be used for other purposes in Georgia, if so wished.

9.1 OVERALL APPROACH

This Section discusses the overall CGE approach for the RID IEP. It starts by revisiting the Impact Hierarchy with particular emphasis on economy-wide impacts. Each of the impact areas is described. The second Sub-Section discusses the development process that will be followed to create a range of different SAMs and CGE models.

9.1.1 Impact Hierarchy Of The Overall Economy Impact Group

The Impact Hierarchy for the overall economy Impact Group is shown in the following chart. Overall economy effects include direct, indirect and induced effects. Each of the impact areas in the overall economy Impact Group is briefly described below.

Unlike some other Impact Groups, classifying a particular Metric in a particular Impact Sub-Category is not always clear. For example, is a change in employment of women a poverty issue (size of labor force) or an inequality issue (relative size of male and female work forces)? This is a natural outgrowth of the integrated way in which CGE analysis is performed (*i.e.*, one model produces results for the entire economy, not just one aspect of the economy).

Output. This Impact Category includes economic growth indicators such as overall GDP changes (at national level and city levels), per-capita GDP growth and capital productivity. Metrics in this Impact Category will quantify the total direct, indirect and induced impacts of the RID projects.

Prices. We are interested in effects on prices in terms of level (by sector) and inflation (overall changes in prices). The two main Metrics chosen for this purpose are changes in real prices and nominal prices (as reflected in the consumer price index). Metrics in this Impact Category will quantify the effect of the RID projects on prices.

88. Impact Hierarchy For Overall Economy Impact Group

IMPACT GROUP	IMPACT CATEGORY	IMPACT SUB-CATEGORY	REPRESENTATIVE METRIC FOR IMPACT SUB-CATEGORY ("Change in …")
Overall Economy	Output	GDP	National GDP And GDP In Each RID City
		Productivity Of Labor	GDP Per Capita
		Productivity Of Capital	GDP Per Investment Level
	Prices	Real prices	Real Price In Each Sector
		Inflation	Consumer Price Index (CPI)
	Poverty	Employment Level	Size Of Labor Force
		Wages	Real Wages
		Expenditures	Total Consumption
	Inequality	Household Expenditures	Distribution Of Household Expenditures (Gini index)
		Gender	Relative Sizes Of Male And Female Labor Force
		Wealth	Distribution Of Wealth (Gini index)
	National Accounts	Current Account	Net Exports
		Capital Account	Net Foreign Direct Investment
		Public Finance	Water Utility Subsidy

Source: RID IEP Analysis.

Poverty. Impact on poverty includes changes in employment, wage levels and expenditures of households. These are economy-wide averages; the distribution of changes among different household groups, for example, is an inequality issue, not a poverty issue. Metrics in this Impact Category will quantify the impact of the RID projects on poverty.

Inequality. We will estimate the impact of the RID projects on the distribution of income (e.g., change in the percentage of households with expenditures under a certain poverty line), distribution of wealth and differential impacts on women and men. Metrics in this Impact Category will quantify the impact of the RID projects on inequality.

National Accounts. This broad area measures effects on components of accounts at the national level such as the current account balance, foreign direct investment and public finance (both taxes and spending in water-related areas). Metrics in this Impact Category will quantify the impact of the RID projects on national accounts.

Metrics in nearly all Impact Sub-Categories will come from the SAMs and CGE analysis. Inequality impacts will be further assessed using micro-simulation analysis. Some public finance issues (*e.g.*, subsidies of water utilities) will come from the utility micro-models. The following chart shows the analytic methods that will be used for the different Impact Sub-Categories in the overall economy Impact Group.

89. Analytical Methods Used For Overall Economy Impact Group

IMPACT GROUP	IMPACT CATEGORY	IMPACT SUB-CATEGORY	ANALYTICAL METHOD USED: BASLINE AND EX-POST SURVEY	TREATMENT AND CONTROL	MICRO-MODELS	SAMs AND CGE	MICRO-SIMU-LATION	CASE STUDIES
Overall Economy	Output	GDP				√		
		Productivity Of Labor				√		
		Productivity Of Capital				√		
	Prices	Real prices				√		
		Inflation				√		
	Poverty	Employment Level				√		
		Wages				√		
		Expenditures				√		
	Inequality	Household Expenditures				√	√	
		Gender				√	√	
		Wealth				√	√	
	National Accounts	Current Account				√		
		Capital Account				√		
		Public Finance			√	√		

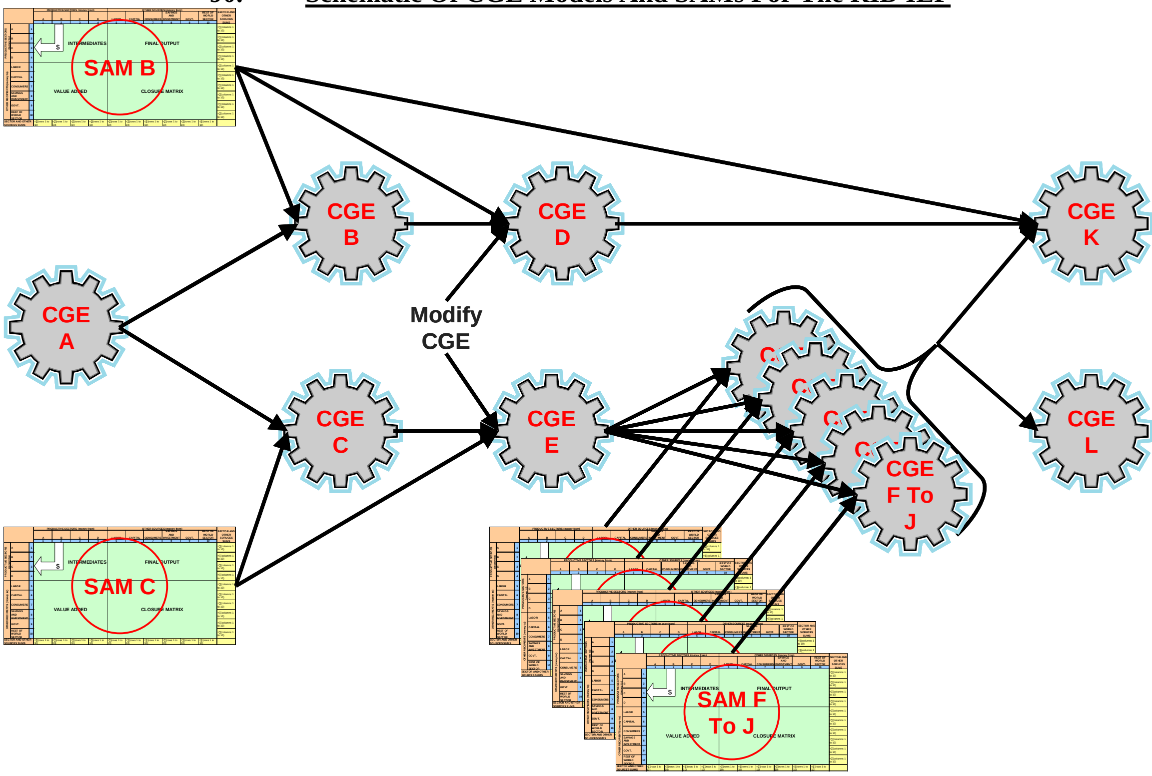
Source: RID IEP Analysis.

9.1.2 CGE Model And SAM Development Process

In the context of the Impact Hierarchy, the "economy" includes not only the national economy but the five city-level economies in the five RID cities. Consequently, the Impact Evaluation Design includes several sets of CGE models and SAMS.

The following chart shows a schematic of the 12 CGE models and 7 SAMs needed for the RID IEP. The second chart defines the different CGE models and SAMs. Although there are a great number of CGE models and SAMs, they are all related to one-another so the analytical problems of dealing with so many items will be manageable.

90. Schematic Of CGE Models And SAMs For The RID IEP



Source: RID IEP Analysis.

91. Descriptions Of SAMs And CGE Models That Are Included In The RID IEP

ITEM	DESCRIPTION
CGE A	Starting CGE Model; Perfect Competition
SAM B	National SAM Using DS Data; SACE Standard Sectors
CGE B	Calibrated National CGE; Perfect Competition; SACE Standard Sectors
SAM C	National SAM Using DS Data; RID IEP-Specific Sectors
CGE C	Calibrated National CGE; Perfect Competition; RID IEP-Specific Sectors
CGE D	Calibrated Modified National CGE; Imperfect Competition; SACE Standard Sectors
CGE E	Calibrated Modified National CGE; Imperfect Competition; RID IEP-Specific Sectors
SAMs F To J	Local SAMS Using RID IEP Primary Data; One Per RID City; RID IEP-Specific Sectors
CGEs F To J	Calibrated Modified Local CGEs; Imperfect Competition; RID IEP-Specific Sectors
CGE K	Calibrated National CGE; Imperfect Competition; SACE Standard Sectors
CGE L	Calibrated National CGE; Imperfect Competition; RID-Specific Sectors

Note: CGE models A, B and C are based on the starting CGE model with perfect competition. CGE models D through L have been modified into monopolistic competition with heterogeneous firms (*i.e.*, moving from CGE model B to model D and moving from CGE model C to model E). CGE models B, D and K are based on SACE.[38] CGE models C, E, F through J and L are based on RID IEP-specific sectors.

Source: RID IEP Analysis.

The suite of CGE models and SAMs needed for the RID IEP, shown in the previous two charts, will go through an organized development process. That process is described in the following paragraphs.

Starting CGE Model. RID IEP CGE modeling work begins with a standard CGE model (CGE A) incorporating perfect competition. This particular CGE model has been used by Team members for a variety of purposes over the past while. Consequently, the RID IEP is well familiar with the details of this starting CGE model. Details on using this particular model as the starting model for the CGE analysis is discussed as one of the key design decisions in a later Section of this Chapter.

National CGE And SAMs. Under the guidance of the RID IEP, DS staff will create two national SAMs. The first (SAM B) will follow the SACE standard design of sectors and level of disaggregation. The second (SAM C) will be based on the sectors specified by the RID IEP. The base data will be the same for the two SAMs; only the aggregation schemes will differ.

The two national SAMs will be used to calibrate two national CGE models. CGE B is a CGE model of the national economy, expressed in the SACE standard framework. CGE C is a CGE model that is customized to the needs of the RID IEP. Both CGE B and CGE C are perfect competition models.

Modify National CGEs As Needed For RID IEP. CGE models B and C will then be modified to reflect requirements for the RID IEP. In particular, we will introduce imperfect competition in many sectors, disaggregate household income, disaggregate labor, incorporate

[38] SACE: Statistical Classification of Economic Activities in the European Community.

labor mobility (though limited at the national level this will be significant for the local CGE models) and a variety of other changes to better reflect RID IEP requirements.

The modifications will be similar in each model, though details will vary because of the different sectors used in CGE B and C models and SAMs B and C. The output of these modifications will be two CGE models with monopolistic competition with heterogeneous firms. CGE model D will be based on the SACE standard sectors while CGE model E will be based on the RID IEP-specified sectors.

Local RID City SAMs. RID IEP surveys will be done and SAMs will be prepared for each RID city (SAMs F through J). Where necessary we will use inputs from CGE E and SAM E to supplement the primary data collected by the RID IEP. The Cross-Entropy method will be used for this purpose to balance the SAMs. We will also use the results of the micro-models described in previous Chapters.

Local CGE Models. The five city-level SAMS will then be used to calibrate five city-level CGE models (F through J). These CGE models will be the primary source of city-level economy-wide impact from the RID projects.

Recalibrate National CGE Models. The five city-level CGE models will then be used to adjust the two national CGE models (converting CGE D and E to CGE K and L). CGE K will be based on the SACE standard sectors while CGE L will be based on the RID IEP-specified sectors.

Estimate Impact. As described previously, each calibrated CGE model will be affected by a shock (*i.e.*, the new water and sewer systems) and allowed to re-equilibrate. The changes in the SAMs (pre- and post-shock) will estimate the impact of the new water and sewer systems.

9.2 KEY DESIGN ISSUES AND DECISIONS

This Section describes eleven key design issues that the RID IEP wrestled with during design of the economic analysis part of the Impact Evaluation Design. These issues, and the resulting decisions, affect not only the scope of answers that can be given at the end of the RID IEP (*e.g.*, level of disaggregation of household income) but also the realism of the CGE models (*e.g.*, imperfect competition with barriers to entry).

As a general rule we have always decided matters in a way that improves disaggregation possibilities and that improves realism. Usually, this has been at the expense of adding an additional level of complexity to the CGE models. However, we have always been careful to ensure that all of our key design decisions have been implemented before by other CGE modelers. We have access to papers from a broad range of authors in each of these key design areas and do not see any particular problems other than just the amount of analytic work that will be required.

Each design issue and decision is discussed separately at a summary level. A more complete discussion of each design issue is in Appendix J.

9.2.1 Disaggregation Of Households

Often a single representative household is used in SAMs and CGE models. In a practical sense this means that all households have similar consumption functions (*i.e.*, the mix of products purchased is similar). However, in reality households are very different; they have different incomes, preferences and so forth. In addition a particular change, such as a new water system, will likely affect different types of households differently (*e.g.*, poor households will likely be more affected by reductions in water coping costs than will be wealthier households).

Over the past while CGE modelers have increasingly used multiple representative household types. This ranges from two or three types up to literally thousands of household types when CGE analysis is combined with further household-level analyses.

We have chosen to disaggregate households into three types for the purpose of the CGE models and SAMs.[39] At present, the three household types are imagined as follows.

- Lower income wage earners; sometimes called the working poor, these households spend only what is received in wages (plus some income from the informal economy)

- Professional wage earners; these are households that include professionals or managers; these households spend only what is received in wages (plus some income from the informal economy)

- Owners of capital; these are households that include professionals or managers; income includes wages plus returns on capital.[40]

One way to disaggregate households is using just their income levels. However, after running a simple CGE model (CGE for Poets) we found out that real wages after water and sanitation intervention went up, but the gap between those who have income from both labor and capital and who has income only from labor increased. In other words capital owners benefited more from the intervention than those who earn income through labor alone. As a result we decided to look at this issue from a different perspective and include ownership of capital (and capital income) as separate criteria while distinguishing households.

During the evaluation Design discussion stage MCG raised a question about households with only transfers and households who have mixed income (*i.e.*, income both from capital and labor, but who might belong to a lower income group). In the SAM, rows and columns are devoted to government transfers to households and foreign transfers to Georgian households. This means that we will be able to identify the amount of transfers that have been executed to each type of household we have included in SAM. By doing so, we will be able to capture the effect of transfers and distinguish it from income from labor and capital. This is needed because RID intervention is expected to affect labor and capital income rates directly, while it might only indirectly influence government transfers and then only in the medium- to long-term. No direct or indirect link can be identified between RID and foreign transfers.

Separate columns in the SAM are devoted to labor and capital and therefore income from these two factors of production. These rows represent inflows and outflows of money on this markets and changes in quantities used, while the impact on individuals should be shown in a different manner. We have data on household income from DS for 6 000 households and we

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[39] It should be noted that decisions about household income for the purposes of the CGE models do not affect how results are reported (disaggregated) for non-CGE model Metrics.

[40] In Georgia professionals generally fall into two groups. Those who receive a generally fixed wage only and those who have a generally fixed wage plus a share of profit (a bonus) even though they are not the official owner of the capital.

can track down from what sources these households have incomes. First we will break down income levels into three groups (three types of households) and different income levels will be primary criteria for household disaggregation (DS will provide us with possible ranges for income disaggregation and then we will decide which ranges to choose and also will agree on this with MCG). After this step, we will be able to see the share of households that belong to each category and we will also see from which sources (from labor, capital or both) households have at each level of income. This way of presenting sources of income solves the problem of mixed income.

Income from the informal economy is also very important issue and given the size of the shadow economy in Georgia (although it has decreased significantly) it can not be ignored. DS has a special survey on informal economy, which estimates its size. Size of the informal economy is part of GDP (*i.e.*, while calculating GDP the informal economy is included). We will use the methodology and experience of DS to estimate the size of the informal economy in the RID cities.

9.2.2 <u>Disaggregation Of Labor</u>

The RID IEP will study the effects of the RID projects on labor with different skills. During site visits we observed that in large hotels one or more people are devoted to deal with water problems; they are always blue-collar workers. When a 24/7 water supply is available, these hotel water-specialists could be laid off. This means that productivity of hotels goes up (less spending for a given level of output) and hotel owners receive more profits while unemployment increases. This widens inequality between skilled and unskilled labor.

Education, experience and position in the company will be used as a criterion for labor disaggregation into three types:

- Blue-collar workers; workers with secondary-school-level, or lower education (*i.e.*, people employed as “workers”, with limited or no intellectual input)
- White-collar workers; workers with higher than secondary-school-level education (*i.e.* employed as “office workers” with certain level of intellectual input)
- Managers; employees, who run their own businesses, or are appointed as managers in various enterprises, without knowing the level of education.

By disaggregating labor the RID IEP will be able to estimate the effects of the new water systems on workforces with different skills. Differential impact will be studied at the level of the individual RID city; the same disaggregation cannot be done for the national-level SAMs and CGEs.

9.2.3 <u>Selection Of Starting CGE Model</u>

The selection of the starting CGE model for the RID IEP was a key design decision. CGE models usually are not developed from scratch; rather, an existing CGE model is chosen and then modified to meet the particular needs of the moment. Starting CGE models exist in a wide variety of forms, each with particular features, advantages and disadvantages. The RID IEP evaluated a range of alternative starting CGE models to select the one that is best for the RID IEP. This selection process is briefly described in this Sub-Section; additional details are shown in Appendix J.

Static Or Dynamic Model. The first key decision in this area was whether to use a static or dynamic CGE model. Static CGE models incorporate only one period, with no inter-temporal decisions. This means that economic agents in the economy optimize their decisions only considering one period and they do it once and for all. With a static CGE model the modeler must make many forecasts (scenarios) to forecast results; this complicates model use. On the other hand, static CGE models can include many sectors, they are well behaved and they are empirically well-tested and understood in the literature.

Dynamic CGE models, on the other hand, explicitly consider inter-temporal decisions. Economic agents optimize their decisions in each period of time considering current income and expected incomes for all future periods. These types of models cannot include many sectors and they are considered experimental rather than empirically well-tested in the literature. The main advantage of dynamic CGE models is their ability to illuminate how changes occur over time.

Static and dynamic CGE models were evaluated against four criteria; the detailed evaluation is shown in Appendix J. On balance, the RID IEP concluded that static CGE models are more suitable for use for the RID IEP.

Market Structure. Market structure within a CGE model reflects the type of competition that exists among firms. There are four main competition types that could be used for the RID IEP:

- Perfect competition
- Oligopoly competition
- Monopolistic competition with homogeneous firms
- Monopolistic competitive with heterogeneous firms.

Firms in *perfect competition* CGE models are price takers. Markets clear and prices are set. Many firms are on the market. There are no barriers to entry for new firms; new firms enter until profits of all firms become zero, meaning that their price equals to their marginal cost (P=MC). Firms are perfect competitors and substitutes of each other, which mean they have identical products and are not distinguished from each other. The size of firms, defined by their cost function, is uncertain.

Perfect competition CGE models are the oldest theoretical thinking in economics with regards to market structure. Its name “perfect” also emphasizes the fact that it does not resemble real-life situations which are far from being perfect and are more heterogeneous rather than homogeneous. Nevertheless, because of the popularity of the model there are many authors providing manuals of their work regarding perfect competition.

Oligopoly competition CGE models have only several firms with monopoly power that enables them to set price. Because of the small number of firms on the market there is strategic interaction among markets participants, which means every price or quantity decision of each firm, influence the decisions of other firms and the other way around. Products of the firms are different but firms themselves can be either homogeneous or heterogeneous. The size of each type of firm is not determined. The presence of barriers to entry for new firms produces positive profits to existing firms which means they set their price more than marginal cost (*i.e.*, P>MC).

Compared to perfect competition CGE models, oligopolistic competition CGE models are more difficult to structure mathematically and involve more effort to calibrate. However, they enable customizations to better resemble real-life in terms of heterogeneity of firms and products. Factor mobility and different types of households and labor can be included in this type of CGE model. Future periods can also be easily anticipated. From an academic point of view, oligopolistic competition CGE models are not new to the world and there is readily available code.

Monopolistic competition with homogeneous firms CGE model is similar to oligopolistic competition in the sense that firms acquire monopolistic power to set price on their different products. However, the existence of a large number of market participants limits strategic interaction among them; there is no influence of one firm's decisions on other firms. Firms are homogeneous on the market and their size is determined. There are barriers to entry for new firms which enables existing firms to earn positive profits by setting a so-called monopoly price (*i.e.*, P>MC).

Monopolistic competition CGE models are moderately difficult mathematically and to calibrate. They have only a moderate level of intellectual novelty and less resemblance to real-life market structures. These CGE models are able to forecast future periods easily and to incorporate economy features such as factor mobility and different types of households and labor. Also, code is readily available for monopolistic models.

Monopolistic competition with heterogeneous firms CGE models have the same features as monopolistic competition with homogeneous firms with two important exceptions: firms are different from each other and not all of them necessarily earn positive profits. In the context of the RIP projects, these types of CGE models permit the consideration of old and new firms in an industry.[41] Although these models are difficult to structure mathematically and also to calibrate, they best resemble real markets. These CGE models are able to forecast the future easily and are easily customized. One of the main advantages of this model compared to others described above is that they have a high level of intellectual novelty and reflect the most up-to-date economic thought. Factor mobility and household and labor disaggregation can be incorporated within the model. CGE software code is readily available.

The RID IEP used four criteria to select the best market structure; details are shown in Appendix J. On balance, the RID IEP concluded that *monopolistic competition with heterogeneous firms* is most suitable for use for the RID IEP.

Actual Starting CGE Model. At this point the RID IEP had decided to use a monopolistic competition with heterogeneous firms CGE model. This was the overall goal. As we reflected on how best to reach that point there were two options. The first was to take such a model "off the shelf" from authors who are not part of the RID IEP team. The second option was to use an existing perfect competition model extensively used by members of the RID IEP team (Professor M. Alejandro Cardenete) and then modify it to reflect RID IEP requirements.

To the end, the RID IEP felt that it was less risky to take an existing very-well-known model and then modify it for RID IEP purposes. This modification will be done during fieldwork.

[41] A new water system reduces barriers to entry (*i.e.*, fixed costs to create a private water system). This puts old firms at a competitive disadvantage compared to new firms. This effect can be analyzed with monopolistic competition with heterogeneous firms.

9.2.4 Selection Of CGE Solver Software

The RID IEP will use GAMS (General Algebraic Modeling System) as the CGE model solver. As noted previously, a CGE model is a large non-linear system of simultaneous equations, such as the following, with many parameters to solve for.

$$U(C_h, C_g, S) = \ln\left(\theta \int C_h{}^{\rho} dh + C_g{}^{\rho}\right) + \gamma \ln W$$

GAMS is specifically designed to help create the model (structure it) and then solve the system of linear, nonlinear and mixed integer equations. GAMS is especially useful for handling large, complex, one-of-a-kind problems which may require many revisions to establish an accurate model. GAMS is widely used in general equilibrium type economic models.

There are good reasons why GAMS is one of the most widely used software for CGE modeling. GAMS lets the user concentrate on modeling. Models are described in concise algebraic statements which are easy for both humans and machines to read. GAMS is flexible and powerful; many model types are available. Models are fully portable from one computer platform to another. GAMS facilitates sensitivity analysis and models are developed and documented simultaneously.

9.2.5 Selection Of Productive Sectors

The upper left quadrant of the SAM comprises the productive sectors of the Studied Economy. The quadrant comprises an equal number of columns (money from) and rows (money to). Each column or row is one productive sector. The CGE analysis, based on the SAM, creates results (*i.e.*, assesses impact) for each of the productive sectors, in addition to results in all the other parts of the SAM.

A key CGE analysis decision is what productive sectors to use in the CGE analysis. There are several factors that influence this decision. The total number of productive sectors in the SAM (and the CGE model) should be from 30 to 40. On the one hand, having many sectors makes the CGE analysis more informative; some researchers have created CGE models with more than 100 sectors with estimates of impact in all 100 sectors.

To the end, the RID IEP SAM has 37 productive sectors as shown in the following chart. Several criteria were considered while finalizing the list of sectors:

- The list of productive sectors – as a whole – should be suitable for answering the Key Research Questions

- Selected productive sectors should be intensive water users; intensity of use can come from either 1) the production process used (*e.g.*, the beverage sector needs much water to produce beverages) or 2) the co-location of many people with mostly domestic water needs and (probably) a single water meter (*e.g.*, prisons, military bases, hospitals)

- Productive sectors should be important to the Studied Economy (*i.e.*, the number of firms or shares of GDP should be more than a little); productive sectors can be important at the local RID city level or nationally

- The list of productive sectors should be the same for all national and city-level SAMs; this means that many rows and columns will be close to zero in many SAMs as not all sectors are important in all RID cities

- Sectors that do not meet the previous four criteria can be aggregated into “other” productive sectors.

- Suitable business expenditure data (intermediate consumption) and household expenditure data (final consumption) should be available at the national level.[42]

The evaluation of candidate sectors against these criteria is shown in Appendix J.

92. Productive Sectors In The RID IEP SAM

SECTOR GROUP	#	SECTOR
Agriculture	1	Grains, Fruits, Vegetables And Crops
	2	Fishing
	3	Forestry
	4	Irrigation
	5	Other Agriculture
Mining And Quarrying	6	Mining And Quarrying
Manufacturing	7	Beverages
	8	Other Food Manufacturing
	9	Other Light Manufacturing
	10	Manufacturing Of Construction Materials
	11	Other Heavy Manufacturing
Electricity, Gas, Steam And Hot Water Supply	12	Production And Distribution Of Electricity
	13	Production And Distribution Of Gas
	14	Production And Distribution Of Water*
Tourism	15	Big Hotels
	16	Small Hotels
	17	Guesthouses**
	18	Restaurants
	19	Other Tourism Services
Transport And Logistics	20	Transport Via Railways
	21	Sea Transport And Ports
	22	Other Transport
	23	Logistic Services
Post And Telecommunications	24	Post And Telecommunications
Trade	25	Retail Trade***
	26	Car Washes
	27	Other Trade
Construction	28	Construction
Financial Intermediation	29	Financial Intermediation
Commercial Services	30	Other Washing Services
	31	Other Commercial Services
Education	32	Education
Health Care And Social Assistance	33	Hospitals And Other Health Services
Communal, Social And Personal Services	34	Sewer Services
	35	Other Communal, Social And Personal Service
Activities Of Exterritorial Organizations and Bodies	36	Activities Of Exterritorial Organizations and Bodies
Government Institutions	37	Public Defense

Source: RID IEP Analysis.

9.2.6 Selection Of Non-Productive Sectors

The rest of a SAM includes a number of non-productive sectors. The RID IEP selected these sectors on the basis of the decisions noted in other Sub-Sections (*e.g.*, three types of households). The final list of 17 non-productive sectors is shown in the following chart.

[42] This criterion applies only to the national SAM using existing DS data. The RID IEP surveys will collect whatever local data is needed.

93. Non-Productive Sectors In The RID IEP SAM

	NON-PRODUCTIVE SECTORS
38	Labor (Male)
39	Labor (Female)
40	Capital
41	HHs With Low Expenditure
42	HHs With Medium Expenditure
43	HHs With High Expenditure

	NON-PRODUCTIVE SECTORS
44	Government
45	Personal Income Tax
46	Dividend Income Tax
47	Corporate Profit Tax
48	Property Tax
49	VAT Tax
50	Excise Tax
51	Other Taxes
52	Import Tariffs
53	Savings/Investment
54	Foreign Sector

Source: RID IEP Analysis.

As noted previously, a second SAM will be constructed using the standard SACE design. The productive and non-productive sectors for this SAM are shown in the following chart.

94. Sectors In The SACE Standard SAM

	PRODUCTIVE SECTORS
1	Agriculture
2	Mining And Quarrying
3	Manufacturing
4	Electricity, Gas, Steam And Hot Water Supply
5	Tourism
6	Transport And Logistics
7	Post And Telecommunications
8	Trade
9	Construction
10	Financial Intermediation
11	Commercial Services
12	Education
13	Health Care And Social Assistance
14	Communal, Social And Personal Services
15	Activities Of Exterritorial Organizations and Bodies
16	Government Institutions

	NON-PRODUCTIVE SECTORS
17	Labor (Male)
18	Labor (Female)
19	Capital
20	HHs With Low Expenditure
21	HHs With Medium Expenditure
22	HHs With High Expenditure
23	Government
24	Personal Income Tax
25	Dividend Income Tax
26	Corporate Profit Tax
27	Property Tax
28	VAT Tax
29	Excise Tax
30	Other Taxes
31	Import Tariffs
32	Savings/Investment
33	Foreign Sector

Source: RID IEP Analysis.

9.2.7 SAM Balancing

The quality and internal consistency of data in a SAM is an important driver of the quality of a CGE analysis. Typically, data in a SAM comes from a variety of sources with different meanings of questions and different time frames. It is also common to have to update a SAM with new data for only a portion of the SAM cells.

A key feature of SAMs is that the sum of a particular column (money spent by an economic player) must equal the sum of the matching row (money received by the same economic player). Not surprisingly, when data comes from a variety of sources the column sums usually do not equal the row sums. This necessitates adjustments to the data so that the columns and rows balance. This Sub-Section briefly discusses how SAMs will be balanced for the RID IEP. More details are in Appendix J.

SAM balancing is a very common problem facing CGE modelers. As a result, well established methods exist for performing the balancing. There are even some very practical how-to guides for balancing SAMs.[43] In fact, the SAM balancing or updating problem is nothing but a particular case of the well-known matrix balancing problem of the linear algebra literature (Rothblum and Schneider 1989, and Schneider and Zenios 1990).

[43] *Balancing A Social Accounting Matrix: Theory And Application*; Fofana, Lemelin and Cockburn (2005).

The RID IEP will use the Cross-Entropy method to adjust or calculate missing values in the SAMs. This method minimizes the distance between a known SAM and a projected (unknown) one. It does it by minimizing the squared-difference between each cell in both of them, weighting that difference by the relative importance of each entry in the known SAM. The minimization is subject to the constraints imposed by (updated) aggregate data in the projected SAM. This method can be used to help construct local SAMs from national ones, update national SAMs from local ones or to build future SAMs from current ones based on forecasts for some aggregate variables.

Before applying the Cross-Entropy method to the SAM balancing problem some direct adjustment might be necessary. In general, the idea is to evaluate the quality of different cells in the SAM separately, based on the reliability of the sources used. Adjustment is made on less reliable cells, while keeping the sum of rows and columns equal.

Another approach is more specific and refers to the balance between the incomes and expenses of institutions (*i.e.*, firms, government, households). In case of institutions having more incomes rather than expenses, the difference between these two is considered as saving for the same period. In the reverse case, it is considered that the difference is the demand on credit products for the same period. In general, it is very common to use saving /investment account for balancing purposes. There are some special cells used for balancing the differences. Apart from savings/investments account economists often use public deficit and foreign deficit for balancing the SAM.

9.2.8 Calibration Methods

Calibration comprises determining a set of coefficients and parameters that, under the first order conditions derived from the optimization problems of agents, allows the CGE model to replicate the database as a benchmark equilibrium of the economy.

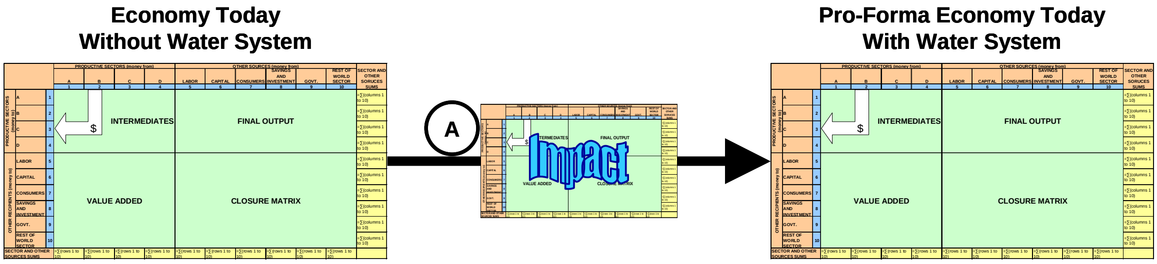
After calibration we obtain the following set of parameters: 1) the technical coefficients of production sectors, both domestic and foreign; 2) the technical coefficients for primary factors that produce unitary value-added; 3) the share coefficients of the utility functions for consumers and 4) the tax parameters which allow us to define the effective tax rates for all taxes, both the direct and the indirect ones.

9.2.9 Forecasting Impact

In order to assess the impact of the RID projects in the medium- to long-term the RID IEP will use a standard forecasting technique for CGE models. This Sub-Section describes how the RID IEP will do this.

A – Immediate Impact. The usual way to estimate impact is to start with a balanced SAM (without a new water system), calibrate a CGE model to the SAM, introduce new technology into the CGE model (*i.e.*, the new water system), let the SAM rebalance using the new technology to create an updated SAM (with a new water system) and, finally, compare the two SAMs (without and with the new water system) to estimate impact. This is shown schematically in the following chart where the immediate impact is shown as A (the differences between the two SAMs).

95. Schematic Of Estimating Impact From RID Project

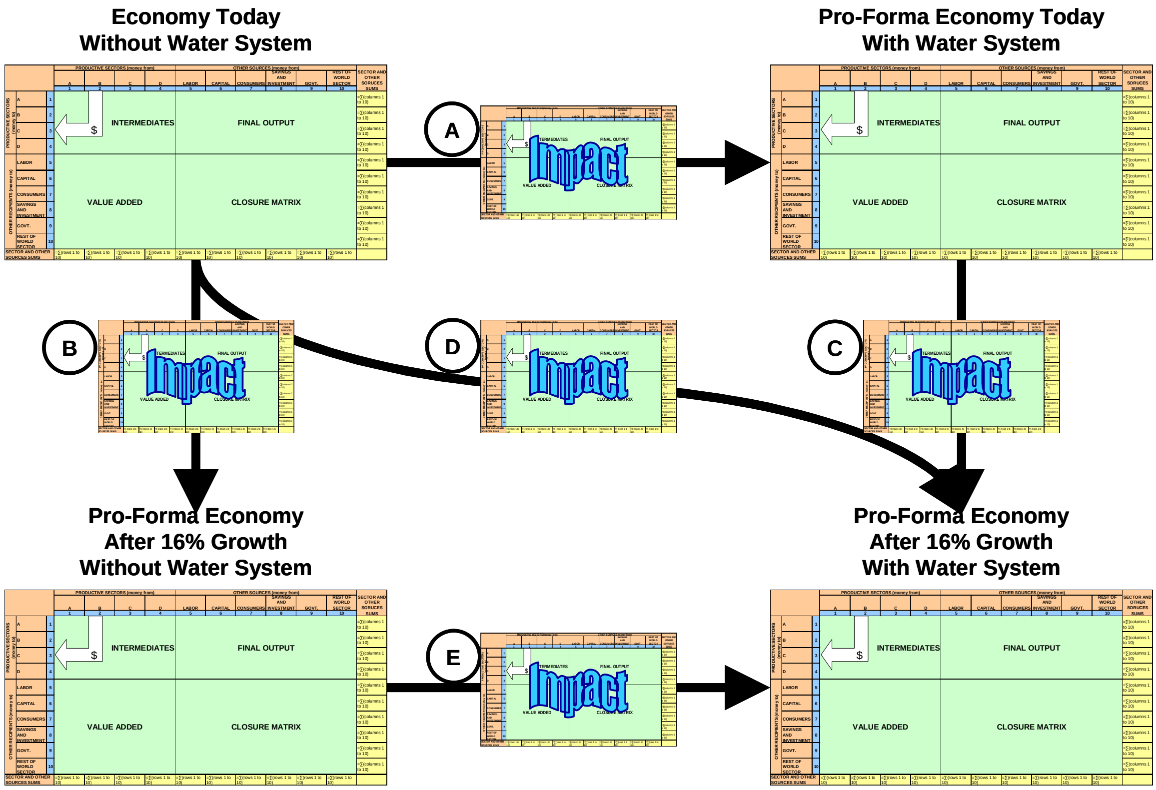


Source: RID IEP.

Typically, there is no reference to the time period it will take to reach the pro-forma state; it is assumed to occur immediately.

Apply An Exogenous Change. The RID IEP will then apply an exogenous change to both the economy today without and with the water system. For example, GDP is assumed to be 16 percent greater, stemming from an annual growth rate of 3 percent for five years. The GDP cells in the SAMs (and some related ones) are changed accordingly. The SAMs no longer balances (*i.e.*, the sum of each column does not equal the sum of the matching row). This is an unbalanced SAM. The Cross-Entropy method is used again to rebalance the SAMs. As shown in the following chart, there are three new comparisons of SAMs (that is three new measures of impact), that bear on the forecast.

96. Schematic Of Forecasting Impact From RID Project



Source: RID IEP Analysis.

B – Growth Without A New Water System. The impact of growth in the absence of a new water system is shown as B in the chart. This will show changes in sectoral output, wages, employment and so forth without a new water system but with a 16 percent growth of GDP (driven by the entire Georgian economy). In a sense this is a counterfactual (*i.e.*, what would happen without the new water system).

C – Growth With A New Water System. The impact of growth in the presence of a new water system is shown as C in the chart. This also shows changes in sectoral output, wages and so forth.

D – Combined Impact Of Water System And Growth. The overall impact of both the new water system and overall GDP growth is shown as D in the chart. As before, this shows overall changes in output by sector, wages and so forth.

E – Impact With Counterfactual. Comparing the pro-forma economy after 16 percent growth *with* the new water system to the pro-forma economy after 16 percent growth *without* the new water system is, in a sense, a difference of differences.

9.2.10 Scenario And Sensitivity Analyses

To the end, comparing the results A through E gives a very good understanding of how the new water system influences the effect of an exogenous change on the Studied Economy. Even better understanding is achieved by testing a range of scenarios and then performing sensitivity analyses on the results.

To understand the size of impact of the RID projects, several scenarios will be considered. Each scenario will be a set of assumptions about macro-economic variables that are exogenous to the CGE model. Under each scenario the values of business cycle indicators will be agreed upon and then the impact of the RID projects for that scenario determined. We will also examine the impact of the RID projects over several time scales and for specific sectors of the economy and locations.

The RID IEP will work with MCG to develop a range of scenarios. The impact of the RID projects under each of those scenarios will be determined as described above.

We will also run a few sensitivity analyses for each scenario focusing on key variables where assumptions are most uncertain. This will provide a range of estimates (or even a probability distribution) around the point estimates in each scenario. At this moment we believe assumptions about the following will warrant testing through sensitivity analysis:

- Water and sewer service tariffs, although the RID IEP is not a tariff study
- Water consumption levels
- Collection rates
- Switching behavior (*i.e.*, proportion of households and businesses that switch to the new municipal water and sewer systems).

9.2.11 Imports And Government Transfers

During the Design review concern was raised on how to handle imports to the RID cities (*i.e.*, primarily goods consumed in the RID city but produced elsewhere in Georgia). Import (from the rest of Georgia) are mostly relevant to businesses. For individual households nearly all purchases are not imports (from the rest of Georgia) since they buy from local suppliers (who themselves may import from the rest of Georgia). Nevertheless we will ask households about purchases made outside the city.

For businesses we will use two approaches to the import (from the rest of Georgia) issue. First, as businesses are asked about their purchases we will add a second question about purchases directly from the rest of Georgia; we do not expect this to be particularly problematic when asked on a percentage basis. In addition we will look into doing a general survey among wholesalers in individual RID cities. DS successfully asks wholesalers questions of this type (local vs. distant production) for 45 product categories.

During the Design review a question was raised about the treatment of Government transfers as a wage. We agree that treating transfer (either national or foreign) as a wage is hard to justify. There is no need for this assumption.

As can be seen on the following chart (SAM) there are separate rows devoted to the Government and the foreign sector. The intersection between government (vertical) and households (horizontal) represents transfers from Government to households. That is, we can identify what share of household income is received from Government transfers and we can identify these for each household type. We mentioned that for example third type of household are owners of capital and also possess professional labor skills. But, it might also be true that one or more members of household can be retired, therefore receiving both a pension and return on the capital that they own. In other words, we do not need to treat transfers as a wage because we can distinguish it anyway and transfers will not play a role for household disaggregation purposes.

By the same token, the intersection between foreign sector (vertical) and households (horizontal) represents foreign transfers. That is, Georgians employed abroad transfer their income to their families. As a result, income for some households will be comprised of foreign transfers and this can be easily seen in the SAM.

97. Flow Of Transfers In The SAM

	Sectors	Labor (Male)	Labor (Female)	Capital	HH (Low Expenditure)	HH (Medium Expenditure)	HH (High Expenditure)	Government	Taxes	Savings/Investments	Foreign sector
Sectors											
Labor (Male)		↓	↓	↓				↓			↓
Labor (Female)											
Capital											
HH (Low Expenditure)		←	←					←			←
HH (Medium Expenditure)		←	←					←			←
HH (High Expenditure)		←	←	←				←			←
Government											
Taxes											
Savings/Investments											
Foreign sector											

Source: RID IEP Analysis.

9.3 DISAGGREGATING IMPACT THROUGH MICRO-SIMULATION

As a macro-analysis tool, CGE analysis gives incomplete results. These shortcomings exist for the RID IEP CGE analysis as follows:

- We cannot measure distributional impacts on poverty and inequality of households (*i.e.*, changes in distribution of incomes or expenditures)

- The CGE analysis uses representative agents (*e.g.*, typical household) and fails to take into account the full heterogeneity of the population (*i.e.*, for the RID IEP CGE analysis there are only three types of households rather than many types)

- Macro-models have difficulties to capture the non-linearities of individual behavior.

9.3.1 Micro-Simulation Concept

For this reason micro-simulation analysis is often used to support CGE analysis. A micro-simulation is a model based on a dataset that contains information on individual micro-economic agents (*i.e.*, individuals, households, firms). In other words, basically, micro-simulations are econometric models at the level of the individual household or firm.

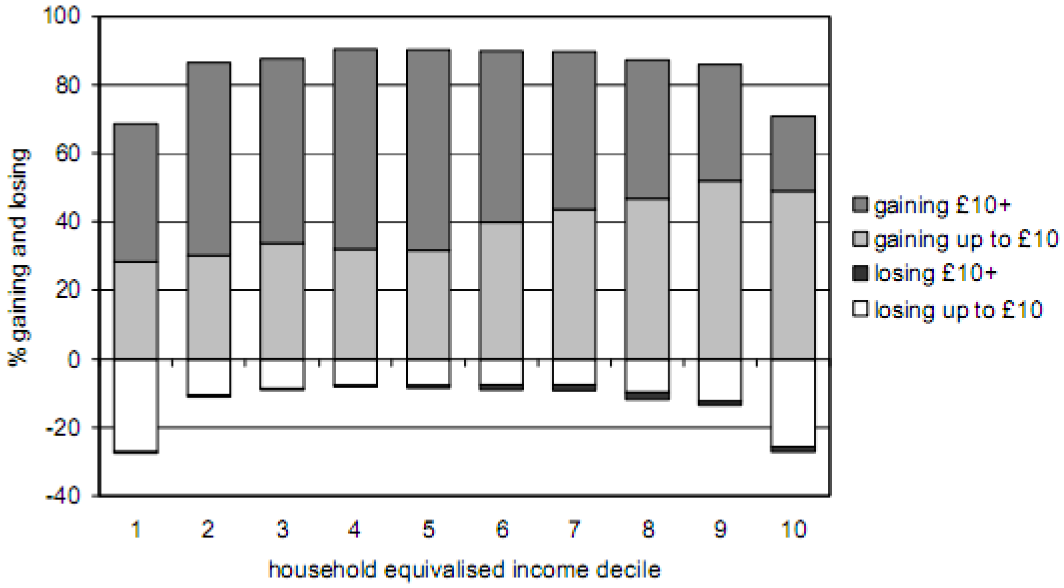
Micro-simulation is a type of partial equilibrium model in the sense that it analyzes a single subsection of the economy; the rest of the economy is considered to be exogenous. Micro-simulation is often used to assess changes in distributions of incomes or expenditures.[44] They are useful because they can detect exactly the fraction of the population that gains or loses from an economic change, and the magnitude of their gain or loss. This method will be used by the RID IEP to assess distributional effects of the RID projects.

For example, imagine a specific household with a certain income. There is a market price for all goods. The specific household consumes a certain quantity of each good, with total consumption and the consumption of each good being a function of the specific household's income, price level of each good and the consumption function for the specific household. Now introduce a change that causes income or prices to change (*e.g.*, a new water system). There is a new total consumption and consumption of each good. The change in income and consumption (overall and by good) is the effect of the change ***on the specific household***. One can perform this same analysis for every household under study (*i.e.*, all households in the survey dataset) to determine the differential effect of the change ***on all households***.

Micro-simulation models produce results such as those shown in the following chart. This shows the effect of tax policies in the UK. The chart shows the percentages of the population that benefited from a particular set of changes and those who did not, separated out by income decile. As can be seen, the impact was not equal across income levels. We anticipate reporting similar type results for impact of the RID projects.

[44] For example, *Who Pays Indirect Taxes In Russia?* Decoster and Verbina, World Institute for Development Economics Research, 2003. This paper describes in very simple terms how micro-simulation was applied to an existing dataset to answer the titled question.

98. Example Of A Micro-Simulation Showing Effects On Distribution Of Household Income

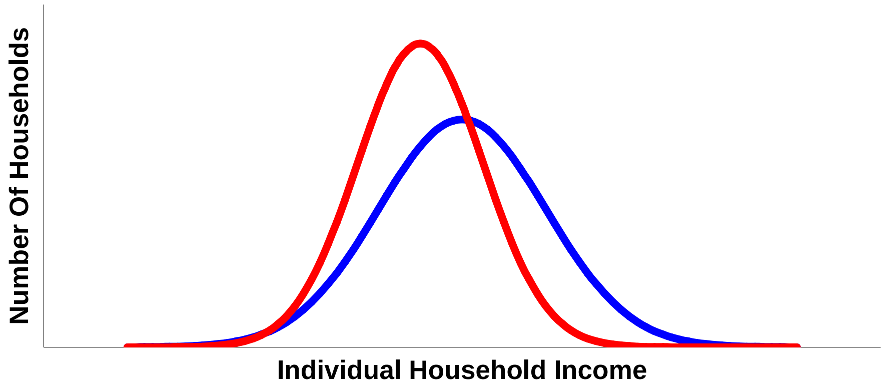


Source: Five Labour Budgets (1997 - 2001): Impacts On The Distribution Of Household Incomes And On Child Poverty; Holly Sutherland.

For the RID IEP the analysis will proceed as follows. The household expenditure survey will be done among individual households. The data will be used to create SAMs and CGE models for each RID city. The new water system will be introduced creating new prices and incomes. These price and income changes will be applied to the individual households with a micro-simulation to determine differential effects.

Results will be of the type shown in the following chart.

99. Schematic Output Of RID IEP Micro-Simulation On Distribution Of Household Income



Source: RID IEP Analysis.

Micro-simulation analysis is described more fully in Appendix K. A simple example of a micro-simulation is included in the appendix.

9.3.2 Cross-Elasticities In Micro-Simulation

During the Design review questions were asked about the cross-elasticities that are, or are not, implicit in the micro-simulation models. In order to answer this question we need to distinguish for a moment between CGE and micro simulations.

In CGE models description of household behavior is described by the utility function, optimization/maximization of which determines the consumption function of different goods by households. As new equilibrium produces new prices, the consumption function is updated and households behavior towards consumption of different goods changes. The consumption function involves modeling of preferences of households towards each good, which might be fixed or dependent upon price changes. If the consumption function is modeled as being sensitive to price change of all goods, cross-elasticities are explicitly considered in the CGE model. Either fixing consumption of goods, or making it dependent upon price change are correct and it dependents on the purposes of the study.

As for micro-simulations, cross-elasticities are considered as a behavioral part of the analysis. For the purpose of RID IEP we are planning to build poverty micro-simulation model, which only involves description of change in behavior of households towards labor choice depending on price change (an input from CGE). Consumption of goods in the micro-simulation model we are planning to build is not modeled at all. Therefore no cross-elasticities are involved. In other words, consumption is not considered for measuring poverty. Household income is taken as a proxy for poverty measurement and there is a well developed applied micro-simulation model for poverty measurement based on income (Bourguignon 2003).

For consistency of micro-simulation with CGE, it is required to have the match of modeling of behavior of household in both methods. For example, in case of labor discrete choice micro-simulation models (Bourguignon 2003), the household utility functions in the CGE model should include the utility levels for the same labor status choice as considered in the micro-simulation (*e.g.*, choice for being "unemployed" delivers a zero utility level).

9.4 APPLICABILITY OF THE RID IEP CGE MODEL TO OTHER PROJECTS IN GEORGIA

One of the great advantages of applied general equilibrium models is their capacity to explain the consequences of major changes in a particular sector in relation to the economy as a whole. The consequences of a change in an economic policy are frequently analyzed assuming that changes are generally small and using linear approaches based on relevant elasticity estimates. If the number of sectors is small, two-sector models as used in international trade theory are equally employed. However, if it is a disaggregated model and several changes take place, there is no option but to resort to the construction of general equilibrium numeric models for the economy to be studied.

9.4.1 General Features That Can Be Leveraged

Reviewing the pioneer applications of this type of modeling, we find the main areas on which applied general equilibrium models have had a greatest impact:

- Fiscal policy analysis
- Trade policy analysis
- Migratory policy analysis
- Interregional policy analysis

- Agrarian policy analysis
- Stabilization policy analysis
- Modeling under conditions of imperfect competition
- Inter-temporal exchange modeling
- Environmental policy analysis.

9.4.2 Examples Of Additional Analyses Enabled By The RID IEP CGE Analysis

At this moment four applications of the for the RID IEP CGE analysis come to mind. Each is described in the following paragraphs.

Food Safety. The Government of Georgia is struggling to develop an overall food safety strategy. There are competing interests. On one hand, consumers demand safe foods. On the other hand producers say that meeting food safety standards will be prohibitively expensive. The national SAM and CGE model could be used to assess the overall economic impact of different policy options for food safety.

Estimate War Impact. An open question for Government is the overall economic impact of the August war. This is complicated by the general economic conditions in the world. The national CGE, with adjustments for war effects, could estimate the differential impact of the war on different sectors.

Tax Policy. The Government of Georgia wishes to better understand the impact of indirect taxes, particularly VAT, on different sectors of the economy and on overall welfare levels. The national SAM and CGE can be used to understand these effects.

New Infrastructure Projects. CGE analysis is being used by the RID IEP to assess the impact of the RID projects. The same methodology could be used to assess new infrastructure projects at the feasibility study stage.

10 COMPLEMENTARY ACTIVITIES IMPACT GROUP

One of the Key research questions deals with understanding complementary effects of the RID projects with other MCG financed Projects. This is the sixth Impact Group: complementary activities. This refers to the intersection of effect between the RID projects and other MCG activities, or in one case another major initiative.

Upon reflection it became clear that the baseline and ex-post survey and economic modeling methods used for other Impact Groups would not sufficiently capture the subtle effects in the complementary activities Impact Group. Consequently, the RID IEP has chosen to use case studies for this Impact Group. The Impact Hierarchy for the complementary activities Impact Group is shown in the following chart.

100. Impact Hierarchy For The Complementary Activities Impact Group

IMPACT GROUP	IMPACT CATEGORY	IMPACT SUB-CATEGORY	REPRESENTATIVE METRIC FOR IMPACT SUB-CATEGORY ("Change in ...")
Complementary Activities	S-J Road Project	Tourism	Case Study Results (*e.g.* , number of tourists from Armenia in Borjomi and Kobuleti)
	ADA	Agricultural Output	Case Study Results (*e.g.* , increased output due to better water supply)
	GRDF	Economic Activity At Micro (company) Level	Case Study Results (*e.g.* , reduced production costs due to better water supply)
	Free Industrial Zone (FIZ)	General Economic Activity In The FIZ	Case Study Results (e.g., water as an enabler of investment)
		General Economic Activity In Poti	Case Study Results (*e.g.* , indirect and induced effects from investments at the FIZ)

Source: RID IEP Analysis.

There are four Impact Categories, one for each of the other MCG activities. The free industrial zone in Poti is an exception; it is not an MCG initiative. The Impact Sub-Categories reflect the particular intersection of RID project impacts and the impacts of the MCG initiative: tourism for the S-J Road Project, agricultural output for the ADA, economic activity for GRDC and economic activity in the free industrial zone and in Poti generally.

The individual firms who have received ADA or GRDF funding will be included in the pre-post surveys that will be done. To avoid sampling errors, their data (probably) will not be included in the overall strata used for analysis. However, their data will be used for analyses in this Impact Group.

The nature of the complementary impacts causes most effort in this Impact Group to be focused on case studies as described shown in the following chart and described in the following four Sections.

101. Analytical Methods Used For The Complementary Activities Impact Group

IMPACT GROUP	IMPACT CATEGORY	IMPACT SUB-CATEGORY	ANALYTICAL METHOD USED					
			BASLINE AND EX-POST SURVEY	TREATMENT AND CONTROL	MICRO-MODELS	SAMs AND CGE	MICRO-SIMU-LATION	CASE STUDIES
Complementary Activities	S-J Road Project	Tourism						√
	ADA	Agricultural Output						√
	GRDC	Economic Activity At Micro (company) Level						√
	Free Industrial Zone (FIZ)	General Economic Activity In The FIZ						√
		General Economic Activity In Poti						√

Source: RID IEP Analysis.

The Chapter has four Sections, corresponding to the four Impact Categories.

10.1 SJ ROAD REHABILITATION

Rehabilitation of Samtskhe-Javakheti road is expected to facilitate transportation of tourists from Armenia and Turkey to Georgia. The former is more important for Georgia, since few people from Turkey come to Georgia for holidays. Armenians however, come to Georgian seaside resorts intensively during summer. Since Kobuleti, one of the RID target cities is a popular place for Armenian tourists, effects of improved water supply combined with facilitated transportation has a potential of creating more incentives for Armenians to travel to Georgian resorts.

How to determine causality – whether the increase in the number of tourists is due to improved water supply or due to road? Or, how much is due to water and how much is due to road? This can be identified by interviewing foreign tourists or managers of hotels to understand how Armenian tourists decide whether to holiday in Georgia. These questions are not particularly relevant for the baseline (people do not know of the new road, so why would they have an opinion about it) but they are very relevant in the ex-post case. We will use case studies, particularly ex-post, to understand these issues.

10.2 ADA

ADA, a seven million USD MCG project, has financed 146 agriculture-oriented projects all over Georgia. From the total, four projects have been financed in Kutaisi, which include: a greenhouse, fruit dryer, hazelnut processing plant and meat processing plant. No other projects in other RID target cities have been financed by ADA.

The total amount of investment in Kutaisi enterprises amounted 260 000 USD, which is a small amount relative to the local economy. Consequently, CGE analysis will not be able to account for potential benefits at this level. Surveys on the other hand will enable us to understand the effect of RID on the enterprises financed by ADA.[45] However, we feel that more attention should be devoted to studying the complementary effects of the RID projects with other MCG projects.

Using the case study method we will look at different aspects of the RID projects as applied to ADA financed projects. First, all of the four ADA financed projects will be studied and intensity of water consumption will be evaluated. Based on in-depth interviews with company representatives and micro-model for each of the four companies will be created. This will enable us to understand possible firm-level affects of RID on target companies. Based on initial information gathering further interviews will be able to understand better potential impact areas of the RID projects on these four firms.

One important aspect of RID intervention is that once a water supply system is improved, it is easier for new businesses to enter the market (due to decrease in fixed costs) and for existing ones coping costs are (probably) reduced, creating more opportunities for expansion and development. If the ADA project beneficiaries have already invested money in alternative water systems, then this investment will be categorized as a sunk cost. However, benefits from reduced operating costs will still remain. In case the costs related to alternative water

[45] It is likely that the ADA recipients will not be included in the formal survey to avoid sampling errors. Nevertheless, they will be administered the survey instrument so that we can better understand the complementary impacts of the RID and ADA projects.

supply have not yet been incurred, the potential benefits for these companies from the RID projects increases.

Apart from analyzing information available internally in the companies, the case study approach will attempt to study similar enterprise(s) in cities other than RID target ones, where the water supply system is similar to a pre-rehabilitation (baseline) situation in RID target cities. The comparison will enable us to capture the effect of water system rehabilitation on similar enterprises across treated and non-treated cities. This analysis will not be based on usual treatment and control methods.

10.3 GRDF

The same approach as described above can be used for GRDF, which has financed several companies in the RID target cities. The projects financed by this program include a hotel, concrete factory and a fishing company in Poti and a hotel in Kutaisi.

Using the case study approach the RID IEP will gain a deep insight into the newly financed companies and the influence of water on their business and coping costs. From our initial observations we know that hotels, food processing companies and fishing companies are medium to high intensity water users. Consequently, the importance of water supply improvement should be significant for them.

10.4 FREE INDUSTRIAL ZONE

The Poti Free Industrial Zone (FIZ) is in the process of being leased to tenants. Reportedly, the FIZ was not considered during the feasibility study for the Poti water system. On the other hand, it is unlikely that the FIZ would be possible without the new water system.

The RID IEP will assess the impact of the new water system on the FIZ through detailed case studies in two areas. First we will look at impact within the FIZ itself. This is likely to focus on water as a business development enabler. Second, we will look at the impact of the FIZ on Poti generally and determine if the new water system creates any knock-on benefits. It is also possible that firms within the FIZ will be part of the business surveys, although this is dependent on the sampling design.

TREATMENT AND CONTROL AND PLANNED SURVEYS

11 TREATMENT AND CONTROL

The RID IEP created the Impact Evaluation Design with the purpose of meaningfully measuring the impact of the RID projects. Our work generally fell into two areas: *deciding what to measure* and *how to properly perform* the measurements. Chapters 5 through 10 described what to measure in the six Impact Groups (*e.g.*, total spending on water and sewer services for individual households). This Chapter describes how to properly perform the measurement so that the conclusions are reliable.

Reliability means that the methods used demonstrate causality for key elements being measured. The key elements which can show causality are:

- Concomitant variation (correlation)
- Appropriate time order of occurrence
- Elimination of other possible causal factors.

A basic Impact Evaluation Design (one-group pretest-posttest design, without treatment and control) addresses the first two elements. The third element, eliminating other possible causal factors, requires a treatment and control method. This is the subject of this Chapter.

The Chapter is divided into four Sections. The first Section describes the treatment and control method the RID IEP will apply. This includes discussions of alternatives that were not selected and ends with a list of problematic areas in the selected method along with general mitigation strategies.

The second Section discusses how the RID IEP has and will select the control group (*i.e.*, the individual households and firms that will be the controls). The next Section discusses which Impact Groups will receive the treatment and control methods. The final Section discusses a number of sample size issues vis-à-vis treatment and control requirements.

11.1 THE RID IEP TREATMENT AND CONTROL METHOD[46]

The terms of reference for the RID IEP are to perform quantitative impact evaluation including an explicit counterfactual analysis. This means that the RID IEP should estimate impact by comparing the actual observed outcomes among RID project beneficiaries with counterfactual outcomes (*i.e.*, the hypothetical outcomes that would have prevailed in the absence of the RID project). Individual households or firms are either beneficiaries of an RID project or not; they cannot be both. Consequently, the hypothetical counterfactual outcomes cannot be directly observed. The central objective of quantitative impact evaluation is to estimate these unobserved counterfactual outcomes.

11.1.1 Use Of Controls In The Impact Evaluation Design

The use of controls is not always required. This Sub-Section discusses this issue and describes why the RID IEP Design includes controls.

[46] The organization of this Section draws heavily on material from *Impact Evaluation: Operational And Methodological Issues* published by the Asian Development Bank; September 2006.

Before And After Without Controls Methods. A common technique to evaluate projects is to compare before and after outcomes for the same group of individual households or firms. This method observes the change in the state of the beneficiaries. This creates a biased estimate of impact because it fails to consider what would have happened to the households or firms if the project did not occur.

The absence of controls might also lead to underestimation or overestimation of impact from the RID projects. For example, assume that a particular RID project resulted in an improvement of the average water supply schedule from 5 hours a day to 18 hours a day. In the absence of controls, we might conclude that the impact of the RID project on the water supply schedule is a 13 hour increase.

However, we would not know what would have happened in the absence of the RID project. Suppose that in the absence of the RID projects the water supply infrastructure would have continued to deteriorate due to underinvestment and the water supply schedule would have deteriorated to 3 hours a day. This suggests that the impact of the RID projects on the water supply schedule is a 15 hour increase, more than we previously estimated.

Before and after comparisons only tells us what happened, not why. It is a description of the factual, rather than an analysis of a counterfactual. The situation before intervention, in some of the cases, is not an adequate counterfactual since other things may have changed between before and after, which also affect the outcome.

On the other hand, if the attribution is very obvious, there is not always a need for a comparison group and the before versus after approach is valid. In case of the RID IEP, there are many Metrics where the effect is directly attributable (*e.g.*, perception of water quality). There are other Metrics where the effect is not directly attributable. Treatment and control methods will be used in these cases.

Use Of Controls. A second technique is to compare outcomes between a group of households or firms that are beneficiaries of an RID project with a group of households or firms that are not beneficiaries of an RID project. The key to this method is to make the two groups (with and without the RID project) as similar as possible; that is, to minimize selection bias. This is not always easy; the balance of this Chapter discusses how the RID IEP proposes to avoid this selection bias.

There are generally two quantitative impact evaluation methods that can create the counterfactual: random experimental designs and quasi-experimental designs.

11.1.2 Random Experimental Design

A random experimental design would avoid selection bias by using a genuine random selection of households and firms to receive RID project benefits (or not to receive the benefits). Random experimental designs are sometimes possible, even for infrastructure projects.

For example, a random experimental design was applied to water and sanitation related interventions in Orissa, India (Pattanayak, 2005). Twenty villages were randomly selected to receive a Government-funded sanitation campaign. Treatment villages received an intensive information, education and communication (IEC) campaign geared at stimulating demand or individual household latrines, and subsequently, financial and technical support to construct household latrines. For evaluating an impact of IEC campaign on child health twenty control villages were also randomly selected. Control villages had similar observable characteristics as treatment villages, except they did not receive the intervention. In this case, the treatment and control villages were randomly selected from the same population.

A random design is not possible for the RID IEP. The RID cities were not chosen randomly by MCG and other donors. Selection criteria were used such as the availability of completed feasibility studies, time required to finish the rehabilitation projects, amount of investment required and others. Given these conditions, an experimental design for RID IEP is infeasible.

11.1.3 Quasi-Experimental Design

Quasi-experimental designs are a good alternative when a purely experimental design and randomizations is not possible or practical. Quasi-experimental design gives the opportunity to study and compare subjects or groups of subjects that are already naturally organized rather than to have to conduct random assignment of subjects. Additionally, utilizing quasi-experimental designs minimizes threats to external validity as natural environments do not suffer the same problems of artificiality as compared to a well-controlled laboratory setting.

Findings in a quasi-experimental design allows for some generalization to be made about population. It is also efficient in longitudinal research that involves longer time periods which can be followed up in different environments.

Undertaking a quasi-experimental design seems feasible for RID purposes. Based on predetermined criteria, controls can be constructed with similar observable characteristics as treatment cities or individual households and firms. Once optimal controls are constructed, certain impact areas can be identified for comparisons.

In this type of design a comparison group is constructed using matching or reflexive comparisons. Matching implies identification of potential controls comparable in essential characteristics to the treatment group. Both groups should be matched on the basis of either a few observed characteristics or a number of them that are believed to influence program outcomes. Matched comparison groups can be selected before project (called prospective studies) or afterwards (called retrospective studies). The RID IEP will use some of both.

Statistical techniques are used in quasi-experimental designs to construct the counterfactual. Two non-experimental methods are often combined to create the counterfactual: propensity score matching (PSM) and difference in differences (DID). The RID IEP will apply these two methods together in applicable areas.

Propensity Score Matching (PSM). In PSM beneficiaries of the RID projects are matched with non-beneficiaries using individual observable characteristics. Each beneficiary is matched with a small group of non-beneficiaries that are most similar to the beneficiaries in all areas except for being a beneficiary of an RID project. The probability that the two groups are similar – are from the same population – (the propensity score) is estimated using a statistical model such as the logit or probit model. Comparing the mean outcomes of these two groups (beneficiaries and matched non-beneficiaries) creates the counterfactual.

PSM methods are often applied to existing datasets. A single survey result can be used; depending on the subject being assessed, there is no particular requirement to have pre- and post- observations.

PSM methods will be used for the RID IEP.

Difference In Differences. DID, with or without PSM, compares the change in the situation of beneficiaries and non-beneficiaries before the RID project with their situation after the RID project.[47] This method requires both baseline and ex-post survey work.

The DID method assumes that outcomes for beneficiaries and non-beneficiaries would be the same in the absence of the RID project. This assumption may or may not be valid. Consequently, PSM is often combined with DID to improve the similarity of the treatment (beneficiary) and control (non-beneficiary) groups.

DID with PSM will be the treatment and control method used for the RID IEP.

11.1.4 Bias And Other Error Issues In Quasi-Experimental Designs

There are several problems with non-experimental methods that should be considered in the details of the RID IEP Design. These problems create a number of estimation biases and other errors. We have considered these and other sources of bias and structured the Design to minimize the likelihood or the impact of the bias.

Omitted Variable Bias. The first kind of estimation bias arises from failing to account for observable variables or when the assumed specification is incorrect, in that it omits an independent variable that should be in the model. For example, if education is a determinant of knowledge of proper sanitation practices then not including education when applying PSM will result in a biased estimate of the matching probability. This will give the wrong matched non-beneficiaries and consequently a wrong counterfactual constructed from these wrong matches. The estimated project impact is therefore incorrect.

Selection Bias. The second kind of estimation bias is called selection bias and comes from endogenous program placement. Assignment of poverty reduction programs often is determined by selection criteria, for example, income below a certain level. This endogenous program placement effectively makes program participants and nonparticipants different in some set of characteristics (*e.g.,* in income level). Even when participation is voluntary, that participants self-select into the program makes them different from non-participants. For instance, borrowers in a microenterprise finance program may be intrinsically more entrepreneurial or more willing to take risk than non-borrowers. Because of these endogenous program assignment and self-selection participation, those who are in the program are often not a good comparison for those in the program.

The observed difference in the outcome of interest is therefore attributable to both the program and the pre-existing differences between participants and non-participants.

Measurement Error. Measurement error is error or bias that occurs when surveys do not survey what they intended to measure. This type of error results from flaws in the instrument, question wording, question order, interviewer error, timing, question response options and so forth. This is perhaps the most common and most problematic collection of errors faced by the polling industry. The only solution of such types of is to ensure that the detailed evaluation and survey design are in rigorous accordance with Key Research Questions.

[47] Of course only the beneficiaries are in the RID project area. The situations of the non-beneficiaries are simply measured at the same moments as for the beneficiaries.

Non-Response Error. These errors result from not being able to interview people who would be eligible to take the survey. Non-response bias is the difference in responses of those people who complete the survey compared with those who refuse to participate for any reason. The most important matter in order to minimize non-response error is to train survey staff in the best manner.

Misspecification. Another source of estimation bias comes from a misspecification in modeling the behavior of beneficiaries and non-beneficiaries. Modeling misspecification may be theoretical or methodological depending from which source it comes. Theoretical misspecification arises when the researcher models the scenario which is incorrect from the standpoint of economic theory or from well known facts. Methodological misspecification results when the initial scenario is correct but one or more elements are inadequately communicated / correlated at the analytical stage.

For example, one may specify labor income as a linear function of individual attributes such as education, age, and work experience. By construction, this assumes that causation goes in one direction: from individual attributes such as education, age and work experience to labor income. In reality, it could well be a reverse interaction from labor income to individual attributes (*e.g.*, higher labor income permits higher levels of education). Specifying a model of a one-way direction therefore is erroneous and the estimated program impact is biased.

Contamination. This problem is not unique to quasi-experimental designs; it is common to all baseline and follow-up survey designs. The control cities (without an RID project) could receive a new water system between now and when the follow-up surveys are done. There are a number of agencies that could finance the water system (MDF, KFW, WB, ADB). If the control cities receive a water system then they can no longer be used as controls, or more properly, the individual households and firms within the cities can no longer be used as controls (*i.e.*, the controls have been contaminated).

Another source of contamination might come from the intervention itself (*i.e.*, intervention can create benefits for people located in places other than target locations). If these locations or people from those locations are selected as controls, the results of the comparison will be biased. In many cases, researchers try to select controls from places neighboring the intervention target to ensure similarity of treatment and control group. Although this might ensure similarity of the two groups, in fact the control group can be exposed to contamination risk.

There are other potential sources that might bias the outcomes. For example, the free industrial zone that is being constructed in Poti is expected to create significant economic growth in the city and also affect not only neighboring locations, but all of Georgia. Plans for another free industrial zone in Kutaisi have been announced. If these happen, it will be difficult to attribute economic growth, decrease in unemployment and other forecasted benefits to water and sewer system rehabilitation.

Mitigation Measures. Antidotes to these estimation biases and potential errors exist. They often are technically complex and data-intensive. Nevertheless, the most important matter is to ensure that the staff doing detailed survey design and sampling are aware of the problem areas and are continually thinking about how to mitigate the potential in the detailed Design.

In quasi-experimental designs, econometric techniques are used to model the participation and outcome processes and arrive at an unbiased estimate of program impact. Propensity score matching and multivariate regression methods control for selection on observables whereas instrumental variable methods control for selection on unobservable. The general idea is to compare RID target groups and controls holding selection processes constant. The validity of quasi-experimental evaluation results depends on how well the evaluation model is specified and the survey methodology, particularly sampling design, is created.

In order to prevent design bias, quasi-experimental approaches are frequently supported by statistical modeling techniques such as probit analysis, survival analysis and hierarchical regression analysis.

Probit analysis is designed for situations where linear regression is inappropriate or problematic. Like logistic regression, it can handle dichotomous variables and several different groups of subjects with abnormal population distribution characteristics.

Survival analysis allows statistical analysis of intervals between two events when the second event does not happen to everyone and when objects are observed over different periods of time.

Hierarchical linear models are useful because, unlike classical analysis of variance models, they do not require that the elements of the within-subjects model be orthogonal to each other. Perhaps more importantly, hierarchical linear modeling can deliver a powerful test of program effectiveness with very small samples, because it shifts the unit of analysis from samples of individuals (households or firms) to samples of 'occasions', where data are collected on a continuous basis over a significant length of time.

11.2 SELECTION OF CONTROL GROUP

As described in the previous Section, the RID IEP will apply a quasi-experimental design using PSM and DID. Key to using these methods is the proper selection of the population to use as the control group.

Two options were considered: citywide controls and some type of stratification at the city level and then controls selected from among individual households and firms within the stratified city groups. The two following Sub-Sections discuss each.

11.2.1 Citywide Controls

The new RID water and sewer systems are generally being installed on a city-wide basis. A logical control for a particular RID city, then, would be a comparable city that does not have an RID project, selected with some form of PSM.

There are several factors that are relevant in making a control-city decision:

- Structure of the economy must by similar in target and control city
- Target and control cities must have approximately the same potential in terms of economic development
- Condition of infrastructure in target and control areas must be more or less similar

- Rehabilitation of the water and sewer systems must not happen in control cities until the evaluation phase is conducted.

The following chart summarizes the relevant features of the RID cities.

The RID IEP spent considerable time understanding the nature of the economies and economic potential of the RID cities. This is described in Appendix B. For treatment and control purposes, we took a close look at other cities in Georgia to see if there were any that matched the RID cities on the basis of their economies and economic potential. The analysis was based on a number of indicators (*e.g.*, population, structure of economy). We concluded that, in fact, the RID cities are each unique in terms of economic structure and geography and that there are no suitable control cities, certainly not for all five RID cities.

This conclusion was reached in an *ad hoc* manner. For example, Bakuriani is a skiing resort and this sector is the major component of the economy of the city. The only other skiing resort and possible control city for Bakuriani in Georgia in terms of business development is Gudauri. However, Bakuriani and Gudauri are extremely different in terms of population and this causes difference in terms of the potential of the labor force and prospects for economic development.

Another RID city, Poti, is the largest port and one of the most important communication centers in the country. The only other port in the country is Batumi. The possibility of pairing these two cities was discussed but the RID IEP concluded that there is not a good match because:

- Despite of the fact that both of the cities have a port, tourism is the most important component of the economy of Batumi while Poti is more industrial oriented; there is very little tourism in Poti

- Poti contains the Free Industrial Zone and this fact makes the city absolutely unique from all areas of the country.

The RID IEP also took a close look at the current infrastructure situation and infrastructural rehabilitation plans for cities that might be controls for RID cities. There are a number of cities that have water and sewer systems in an equal state of disrepair compared with the RID cities. However, Georgia has attached high priority to improving water and sewer systems in all its cities. Consequently, the probability is quite high that between now and when ex-post surveys would be done that several or even all control cities would have their own water and sewer projects. If this happened, then the usefulness of those cities as controls would be zero.

To the end, matching of each RID city to a control (*i.e.*, city-to-city) on the basis of structure of the economy and economic potential is not possible. The next Sub-Section describes the recommended alternative.

102. Characteristics Of The RID Cities

CITY	POPULATION	NUMBER OF HOUSEHOLDS	LIVING ARRANGEMENTS	ECONOMIC ORIENTATION	WATER SUPPLY	WATER AND SEWER INFRASTRUCTURE CONDITION	COPING METHODS USED
Kutaisi	188 600	56 000	60 % of Households live in apartment blocks, 40% in private houses.	Former industrial city, currently relies mainly on trade and service sectors. Industry, mainly light, accounts only 25% of local economy.	75% of population receive water up to six hours a day. The rest have water supply from six to 18 hours a day.	Outdated water supply system, constructed in 1928, characterized with high leakages, non-operational sewage treatment facilities.	Wells and boreholes are mainly used as an alternative source of water. People use water tanks to store water.
Poti	47 400	13 450	50% of Households live in apartment blocks, 50% in private houses.	The city is developed mainly around the Largest Black Sea port in Georgia. Manufacturing is also important part of the city's economy. Free industrial zone is currently under construction.	3-4 Hours every other day. 24/7 water supply is expected after repair works on water distribution network are finished.	RID project in Poti, is already finished. New water source for the city was developed and distribution network was rehabilitated. 80% of households are metered.	Limited number of households use wells as an alternative source of water supply. People mainly have tanks to store water.
Kobuleti	18 500	6 100	More than 80% of households reside in private houses, the rest live in apartment blocks.	Tourism is the largest and most important sector. City can accommodate more than 20,000 tourists at a time. During summer more than 80,000 tourists visit the city.	Population is supplied with water six to ten hours a day. The difference is mainly due to geographic location.	Outdated water supply system, and insufficient capacity of sewer results in high level of breaks and leakages. Untreated wastewater flows into a nearby river which later flows into the Black Sea.	Wells and boreholes are mainly used as an alternative source of water. People use water tanks to store water.
Borjomi	20 000	6 300	40% of households live in apartment blocks, 60% lives in private houses.	One of the best known resorts in Georgia, accommodating 15000 tourists during summer. Mineral water company operating in the city is also important enterprise, employing 700 people.	60% of population residing in lower altitude areas receive water nine hours a day, while the rest gets water up to six hours a day.	Borjomi water and sewer system was constructed in 1932-1935 and due to underinvestment is in a very poor condition, characterized with high water losses.	Natural springs are popular alternative source of water, mainly used for drinking. Limited number of households have their own well. Water tanks are used to store water.
Bakuriani	3 000	645	Majority of households live in private houses.	Tourism is the largest and most important sector in the City, popular skiing resort. 70 hotels and many guesthouses accommodate tourists both during winter and summer season.	On average, water is supplied to households 5 hours a day. During spring length of water supply reached 24/7, however quality of water is very low.	Constructed in 1936, water supply network was upgraded in 1972. Water supply system is characterized with high water loss ratio.	Natural springs are used as an alternative water supply source. Supply of water is very seasonal, limited in winter and almost 24/7 in spring. However, quality of water is very poor and not used for drinking.

Source: RID IEP Analysis.

11.2.2 Stratified Controls

As discussed in the previous Sub-Section, a city-to-city control approach is not feasible for the RID projects. Consequently, the RID IEP developed an alternative approach based on stratification of the RID cities. This alternative approach is described in this Sub-Section.

Stratification Of RID Target Cities. There are many differentiating characteristics which make the RID cities unique in terms of economy and geography. Nevertheless, the five RID cities can be grouped into industrial cities and resort cities. This creates the opportunity to divide the RID cities into two strata – industrial and resort – as shown in the following chart.

103. Stratification Scheme For RID (treatment) Cities

STRATA 1 INDUSTRIAL CITY	STRATA 2 RESORT CITY
Kutaisi	Kobuleti
Poti	Borjomi
	Bakuriani

Source: RID IEP Analysis.

This strata structure will enable the RID IEP to compare differences in treatment and control industrial cities and treatment and control resort cities.

Selection Of Control Cities. With RID cities divided into two strata, it now becomes more feasible to identify *groups* of cities for each stratum.

Potential control groups / strata for each stratum were identified using following selection criteria:

- Main characteristic of city – Resort/Industrial
- Expected water rehabilitation project
- Water supply schedule
- Water quality
- Population
- Economy (distribution by size and directions)
- Availability of gas
- Availability of electricity
- Roads quality / accessibility.

Based on actual observations and mini-surveys conducted in potential control cities, several candidate cities were identified as members of the stratum control groups as shown in the following chart.

104. Stratification Scheme For Control Cities

STRATA 1 INDUSTRIAL CITY	STRATA 2 RESORT CITY
Rustavi	Tskaltubo
Zugdidi	Abastumani
Gori	Tsagveri
Batumi	Surami
	Akhaldaba

Source: RID IEP Analysis.

The following chart shows the features of the cities in the two strata.

105. <u>Features Of Strata One (industrial) Cities</u>

CITY	POPULATION	NUMBER OF HOUSEHOLDS	LIVING ARRANGEMENTS	ECONOMIC ORIENTATION	WATER SUPPLY	WATER AND SEWER INFRASTRUCTURE CONDITION	COPING METHODS USED
Batumi	121 806	33 586	Almost 50% of Population Reside in Private houses	The city is developed mainly around the Largest Black Sea port in Georgia. Tourism and manufacturing are both important parts of the city's economy	City water supply system is on 24/7 but because of the low pressure, households receive water with schedule	The system is characterized with high leakages and contamination. In some cases, households and enterprises are illegally connected to Central pipe. Water supply problems are mostly observed in block buildings. Batumi municipality with financial support of KFW plans to accomplish water supply system rehabilitation project for 2014	People mainly have tanks to store water. Only minority of the households use pumps
Rustavi	116 384	34 276	More than 90% of Households reside in apartment blocks	The city is developed near the capital of the city and hard industry is the most important components of the city's economy	City water supply system is on 24/7 but it is divided into three segments and each part of the city has individual schedule from 12 to 24 hours	City water supply system was fixed in 70s. Rehabilitation of the system is planned in three years period	Households use wells, tanks and pumps as alternative source of water
Zugdidi	68 894	17 181	Majority of households live in private houses	Trade and manufacturing are the core components of the city's economy	The city is divided into 12 segments and is supplied by water for 4 hours a day: 2-2 hours in the morning and in the evening. During spring water is contaminated	Rehabilitation of the system is planned in three years period	Households mainly use private wells as an alternative source of water
Gori	49 516	14 663	More than half of the population reside in apartment blocks, while the rest in private houses	Manufacturing and service are the core components of the city's economy	City water supply system is on 24/7 but because of the low pressure and the geography of the city blocks suffer with problems. About 5%-6% of households have 8 hours a day schedule	City water supply system was established in 1938 but some networks were added as the city was growing.	Households mainly use private wells as an alternative source of water

Source: RID IEP Analysis.

106. <u>Features Of Strata Two (resort) Cities</u>

CITY	POPULATION	NUMBER OF HOUSEHOLDS	LIVING ARRANGEMENTS	ECONOMIC ORIENTATION	WATER SUPPLY	WATER AND SEWER INFRASTRUCTURE CONDITION	COPING METHODS USED
Tskaltubo	16 841	5 143	Majority of households live in private houses	Medical tourism used to be the most important sector in the town	On average, water is supplied to households 3 hours a day. Minority of the households connected to the central pipe is supplied 24/7. Water supply schedule does not change seasonally	Constructed in 1950-1970 . Water supply system is characterized with high water loss ratio. 60% of water supply and sewing system needs rehabilitation	households living in blocks use pumps. There are some wells in the city but the water is contaminated with medical minerals
Abastumani	1 368	477	Majority of households live in private houses	Medical tourism is the most important sector in the town	The city is supplied 24/7 with water. The schedule does not change seasonally but during rains water is contaminated	The main water supply facility was constructed in 1924 and part of the system was added in 1964. The system needs rehabilitation because of leakages and contamination	During rainy seasons households mainly use spring water
Tsagveri	1 051	307	Majority of households live in private houses	Tourism is the most important sector in the town	The city is supplied 24/7 with water. The schedule does not change seasonally but during rains water is contaminated	The main water supply facility was constructed in 1950-1955 . Rehabilitation of the system is planned in 2009 by Borjomi municipality	Households does not apply any particular coping methods
Surami	9 773	2 547	Majority of households live in private houses	Tourism is the most important sector in the town	60% of population have 24/7 water supply and the rest of the households is supplied 12 hours a day. In summer the system suffers with low pressure	City water supply system was constructed about 70 years ago. Rehabilitation is not planned for the near future	Households use wells to overcome water supply problems, mainly during rainy seasons
Akhaldaba	2 377	695	Majority of households live in private houses	Agriculture is the most important source of income for households.	The city is supplied 24/7; during summer / autumn season 2 districts are supplied with 4 hour a day schedule (2 hours in the morning and 2 hours in the evening). But the water is of the very low quality and during spring is contaminated	The system was partially rehabilitated during 2007-2008 but it still suffers with problems	People use private wells and public tabs as an alternative source of water

Source: RID IEP Analysis.

11.3 APPLICATION OF TREATMENT AND CONTROL DESIGN TO IMPACT AREAS

As described in previous Chapters, the Impact Evaluation Design is of mixed character; a number of analytical methods will be used. Also as described previously, there are a number of impact areas to which one or more of the analytical methods will be applied.

The following chart shows the impact areas to which the treatment and control design will be applied. Treatment and control methods will be particularly important for the individual households and individual firms Impact Groups.

Generally, those impact areas that are based on baseline and ex-post survey analysis and micro-model analysis will have controls applied. Those impact areas based on SAM and CGE analysis, micro-simulation analysis (based on the CGE results) and case-study analysis will not have controls applied.

Applicability Of Treatment And Control Design To Impact Sub-Categories

IMPACT GROUP	IMPACT CATEGORY	IMPACT SUB-CATEGORY	ANALYTICAL METHOD USED: BASLINE AND EX-POST SURVEY	TREATMENT AND CONTROL	MICRO-MODELS	SAMs AND CGE	MICRO-SIMU-LATION	CASE STUDIES
Individual Households	Total Water And Sewer Cost	Monetary Costs		√	√			
		Economic And Perceptual Willingness	√	√	√			
		Coping Time		√	√			
		Water Consumption	√ (water audit)	√				
	Quality Of Life	Health Incidents	√	√				
		Perceptions Of Safety And Adequacy	√	√				
		Perceptions Of Organoleptic Properties	√	√				
		Public Sanitation Information	√	√				
		Individual Sanitation Practices	√	√				
		Time And Inconvenience Of Not 24/7 Water	√	√				
		Self-Reported Water Consumption	√	√	√			
		Gender Issues	√	√				
Individual Firms	Total Water And Sewer Costs	Monetary Costs		√	√			
		Willingness To Switch		√	√			
		Water Consumption		√	√			
	Business Enablers	Expand Existing Business			√			√
		Enter New Business			√			√
Water Utilities	Operations	Supply			√			√
		Demand			√			√
		Water Quality			√			√
	Finance	Cost Structure			√			√
		Financial Viability			√			√
		Efficiency			√			√
Governmental Institutions	Public Health System	Institutional Arrangements						√
		Water Borne Disease Incidence						√
	Other Budgetary Institutions	Prisons			√			
		Military Bases			√	√		
Overall Economy	Output	GDP				√		
		Productivity Of Labor				√		
		Productivity Of Capital				√		
	Prices	Real prices				√		
		Inflation				√		
	Poverty	Employment Level				√		
		Wages				√		
		Expenditures				√		
	Inequality	Household Expenditures				√	√	
		Gender				√	√	
		Wealth				√	√	
	National Accounts	Current Account				√		
		Capital Account				√		
		Public Finance			√	√		
Complementary Activities	S-J Road Project	Tourism						√
	ADA	Agricultural Output						√
	GRDF	Economic Activity At Micro (company) Level						√
	Free Industrial Zone (FIZ)	General Economic Activity In The FIZ						√
		General Economic Activity In Poti						√

Source: RID IEP Analysis.

11.4 SAMPLE SIZE ISSUES

The RID IEP is presently working on setting sample sizes as part of the next report (Deliverable F). A key input to this analysis is examining the expected incidence and effect of the RID projects on different Metrics. For this purpose we have selected indicative Metrics in the Impact Sub-Categories where treatment and control will be used and then estimated expected incidence and effect for each. The results of this analysis are shown on the following chart.

The chart is preliminary in the sense that we are presently dividing Metrics into two groups:

- Relatively few Primary Metrics that will drive sample-size decisions
- Remaining Metrics that will be used for analytical purposes.

Results for the few Primary Metrics will be fully supported with valid sample sizes as free as possible of selection biases and with good counterfactuals. These Metrics will determine overall sample sizes. Remaining Metrics will be suitable for analytical purposes (*e.g.*, understanding willingness to switch) but they will likely not be supported with suitable counterfactuals.

During the Design review questions were asked about whether setting sample sizes based on a 3 percent standard error will be able to capture the impacts of the RID projects. In order to decide what amount of standard error was acceptable we looked at all the Metrics we will be using. The majority of Metrics are such that a 3 percent change in them would be very small compared to what we are expecting to achieve from the RID projects.

For example, if we look at coping costs, a 3 percent decrease in these expenses can be categorized as no impact, since this is very small compared to what we expect to see as a result of RID projects. We might anticipate that there will be about 50 percent reduction in coping costs, although other costs may well rise (*e.g.*, municipal water costs).

There are other Metrics where even 0,1 percent change is important. For example output at the city level, or employment. These types of Metrics (at a more macro -level) will be estimated using CGE analysis and thus are not directly dependent on survey standard errors. When DS measures GDP or other macro-variables, they use surveys where acceptable standard errors range between 3 and 7 percent. However, this does not mean that a 5 percent change in GDP will not be captured.

These are examples of the judgment we have used to come up with an acceptable level of standard error for each impact area and analytical method.

107. Incidence And Likely Effect For Key Metrics In The Individual Households And Firms Impact Groups

IMPACT GROUP	IMPACT CATEGORY	IMPACT SUB-CATEGORY	LEAD METRICS (drives T&C and sample sizes)	VARIABLE TYPE	PROBABLE BASELINE VALUE	COMMENTS FOR TREATMENT AND CONTROL
Individual Households	Total Sewer And Water Costs	Monetary Costs	Monthly Household Total Water And Sewer Coping Cost	Continuous	20 GEL	Easily comparable across cities. Should be also adjusted/reported as per capita, since size of households can vary across cities. We need only coping costs, since water tariff is more or less the same across Georgia. Decrease in this amount in treated cities will be a positive impact.
		Time Costs	Monthly Households Time Spent On Water And Sewer Related Issues	Continuous	60 GEL	Easily comparable across cities. Should be also adjusted/reported as per capita, since size of households can vary across cities. Decrease in this metric (time) will be a positive impact.
	Quality Of Life	Health	Share Of Population Self-Reporting Water Related Disease (During Past Year)	Continuous	20%	Easily comparable across cities. One year horizon should be considered, since quality of water in some cities change during different seasons, hence all four seasons should be covered. Decrease in this metric can be attributed to RID and considered as a positive Impact.
		Perceptions Of Safety	Share Of Population Using Municipal Water For Drinking	Continuous	70%	Easily Comparable Across Cities. Using water for drinking is a good metric for evaluating perception of people. If this metric (share) increases in treated cities it will be a positive impact
		Perceptions Of Organoleptic Properties	Quality Of Municipal Water (Color, Smell, Tate, measured on Likert scale, from 1-5)	Discrete	3	Easily comparable across cities, well developed criteria for evaluation (color, smell, taste). Potentially unbiased results. Increase in this metric can be considered as a positive benefit of RID.
		Public Information	Frequency Of Obtaining Water and Sanitation Related Information (During Past Year)	Discrete	1	Easily comparable across cities. Increasing metric means more attention and care of WU towards customers and can be considered as a positive benefit of RID.
		Water Consumption	Per Capita Water Consumption From All Sources	Continuous	150	Difficult to measure, but easy to compare across cities (similar cities should be taken, since resorts might use more water per capita). Based on baseline result we can hypothesize possible upward or downward change of this metric.
			Share Of Alternative Water Consumption	Continuous	70	Decrease of this metric in treated cities is a sign of positive RID impact
		Sanitation	Share Of Population Reporting Inability To Wash Hands, Bathe, Wash Clothes Due To Water Problems	Continuous	80	Decrease in this metric is a sign of improved sanitation
		Time And Inconvenience	Length Of Water Supply Schedule (hrs per week)	Continuous	25	Easily comparable across cities. 24 hour water supply will not be possible immediately after RID completion. So, increase in water supply schedule is good metric to understand and compare impact of RID
Individual Firms	Total Water And Sewer Cost	Monetary Cost	Actual Water Cost Per Cubic Meter	Continuous	7 GEL	Comparable across cities and companies, since various companies have different consumption pattern
			Actual Sewer Cost Per Cubic Meter	Continuous	4 GEL	Comparable across cities and companies, since various companies have different consumption pattern
			Total Water And Sewer Cost Per Unit Of Output	Continuous	0,1 GEL	Similar companies should be compares, controlling for change in production technology between baseline and ex-post
		Time And Productivity	Number Of FTEs Dedicated To Water And Sewer	Discrete	2	This metric should be adjusted for size of firm and can be reported as average (e.g. 0,8 water FTEs per firm in a given city)
	Business Enablers	Willingness To Switch	Ratio Of Baseline To Ex-Post Water Cost	Continuous	1,5	Will capture how the incentive to switch to municipal water changed in treated and control cities
			Share Of Alternative Water Consumption In Total	Continuous	50%	Good metric for understanding the degree of dependence on alternative water supply. From baseline to ex-post we can observe partial as well as total switch
		Expand Existing Business	Cost Savings Due To Switching Per Cubic Meter	Continuous	1 GEL	Should be adjusted to consumption to derive total amount of savings
		Enter New Business	Ease Of Starting Business	Continuous	0,8	Will capture how the incentive to start new business changed in treated and control cities

Source: RID IEP Analysis.

12 PLANNED SURVEYS

This Chapter describes the nine surveys / case studies that comprise the RID IEP primary data collection:

- Household survey (comprehensive survey)
- School follow-up (visit local schools if needed based on household survey)
- Household water audit (survey oriented, but smaller than the household survey, to understand water consumption)
- Business survey (comprehensive survey)
- Wholesaler survey (close to a census of large wholesalers with in-depth interviews to understand imports to the RID city)
- Water utilities survey (census of all the utilities with in-depth interviews in several functional areas to understand utility performance)
- Water engineering company survey (relatively few in-depth interviews for specific engineering data collection)
- Investor case study (relatively few in-depth interviews to understand importance of water to the investment decision)
- Public health case study (relatively few in-depth interviews to understand impact on public health system)
- Complementary activities case study (relatively few in-depth interviews to understand complementary effects).

In the balance of this Chapter, each survey and case study is described with sufficient detail to understand its general objectives and approach. Each survey and case study will be elaborated in full detail during Detailed Survey Design, coming after the Impact Evaluation Design is approved.

The first Section, the household survey, also contains general information about the survey process that is applicable to all the surveys (*e.g.*, selection of interviewers, pilot testing).

12.1 HOUSEHOLD SURVEY

This Section briefly describes the household survey that is part of the RID IEP Design. Final details will be developed during detailed survey design.

12.1.1 Survey Purposes

A comprehensive and quantitative household survey is a key element of the RID IEP Design. The use of data from the household survey is described in Chapters 5 and 9 and Appendixes E, G and J. This survey will provide data to estimate impact of the RID projects on individual households and data on:

- Socio-demographic structure of households
- Coping and non-coping water and sewer costs for individual households
- Estimates on the willingness of households to switch to the new water and sewer systems
- Time spent coping with less than 24/7 water supply (*e.g.*, running private water wells)
- Prevalence of water-borne disease
- Perceptions about the safety of the water and sewer systems and overall satisfaction with each
- Perceptions about the physical features of water not related to safety (*e.g.*, taste, color)
- Availability of public sanitation information
- Individual sanitation practices in households
- Time and inconvenience of not having 24/7 water[48]
- Self-reported water consumption and conservation practices
- Gender impacts of less than 24/7 water
- Income and expenditure patterns among households (for CGE analysis).

12.1.2 Survey Technique And Sample Size

The household survey will use face-to-face interviews with one representative in each sampled household. The survey instrument will be shown in a later report.

Sample sizes are shown in the following chart; these are derived from an assumption that errors of the 50 percent prevalence parameter assessment shall not exceed 5 percent with 95 percent reliability for the groups of each RID city as well as in the control cities.

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[48] This is distinct from the third item that considers time spent obtaining or storing water. Rather and for example, this item deals with inconvenience from not being able to take a bath or shower at any time a person chooses.

108. Household Survey Sample Size

Group	Type	City	TOTAL NUMBER OF HH	MAXIMUM POSSIBLE ERROR	SIGNIFICANCE OF DESIGN EFFECT	SAMPLE SIZE	TOTAL
Target	Resort	Bakuriani	621	5%	1.5	355	**3 278**
		Borjomi	4 124	5%	2	702	
		Kobuleti	5 027	5%	2	713	
	Industrial	Photi	12 915	5%	2	746	
		Kutaisi	54 611	5%	2	762	
Control	Resort	Tskhaltubo	7 715	5%	1.2	440	**900**
		Abastumani					
		D.Tsagveri					
		D.Akhaldaba					
		D.Surami					
	Industrial	Batumi	95 943	5%	1.2	460	
		Gori					
		Rustavi					
		Zugdidi					
Total							**4 178**

Source: RID IEP Analysis.

The sample size will be further refined during detailed survey design.

The questions included in the household survey are largely shown in Chapters 5 and 9 plus Appendixes E, G and J.

12.1.3 Sampling Frame

For household surveys two sources will be used as the sampling frame: 1) DS population census and 2) water system maps which are available at local water utilities. The latter is important to understand which neighborhoods in the city have been rehabilitated and which have not been not. This is important to understand the distribution of benefits among city inhabitants.

Two step cluster random sampling will be applied to households using 2002 census data. The following formula was used to determine sample sizes in target and control cities:

109. Formula Used For Sample Size Determination

$$n_i = \frac{p(1-p)\times H_i \times Z^2_{(1-\alpha)/2}}{p(1-p)\times Z^2_{(1-\alpha)/2} + H_i \times \varepsilon^2} deff$$

Where:

H_i - number of households in i region

ε - maximum possible error

$Z_{(1-\alpha)/2}$ – $(1-\alpha)/2$ level quartile of standard normal distribution

p – expected significance of the evaluated parameter

doff - expected significance of design effect.

12.1.4 Methodological Matters Applicable To All Surveys

The following describes a number of methodological matters that apply to the household survey as well as other surveys described later. These matters are not repeated for the other surveys.

Pre-test – Pilot Study. A pre-test (pilot study) will be conducted in order to:

- Test survey techniques applied to the questionnaire
- To finalize the questionnaire
- Test and calibrate micro-models.

The sample size of the pilot study will be about 50 interviews. We expect to conduct the pilot testing in Poti but a final decision on pilot study target area will be made later.

In order to ensure the best feedback from the pilot study professional interviewers, who have undertaken specialized training on conducting pilot testing, will be used for the pilot testing. For example, after completing each interview, the interviewers will fill in special forms designed for the pilot study, where they will make notes concerning the questionnaire.

On the basis of interviewers' notes and after the data gained through pilot testing are processed, the final version of the questionnaire will be elaborated.

Interviewers Team. ACT has professional teams of interviewers in all regions of Georgia. The ACT interviewer team is specialized in a range of various respondent segments as well as in various techniques such as face-to-face interviews, phone interviews, in-depth interviews and so forth.

ACT recruits interviewers in accordance with the policy of the company and adopted procedures. Namely, interviewers are recruited based on testing of general skills after which candidates undergo a complete course of general techniques for interviewers and become closely familiar with Esomar Code of Ethics. After the completion of this course the field department holds follow-up testing; interviewers are finally hired only after successfully completing the final tests. After the tests interviewers are specialized in various study techniques.

For the RID IEP local interviewers from each target region will participate. Overall management of the interviewer team will be applied from ACT Tbilisi office but local regional offices will organize city teams.

Field Personal Training. Training of the RID IED interviewers will be held in two phases. At the beginning the ACT field department together with the survey manager will train regional supervisors on administrative issues and project specifications. Regional supervisors will visit the ACT Tbilisi office and MCG and all team members will be invited to attend the training sessions.

The second phase of the field personal trainings will be held in the RID cities. Interviewers will be selected for the RID IEP according to their specialization and experience. Trainings will be led by the field manager together with the survey manager. Regional supervisors will attend local training sessions as well.

On these training interviewers will learn in detail:

- Subject of the study and project specifications

- Study tools; the survey instruments (questionnaire, route cards, incomplete interview form, technical report form, show cards and so forth)

- Sampling procedures.

Together with the theoretical part, practical sessions will be held where interviewers will be divided into “interviewers” and “respondents” and the real interviews will be performed.

ACT will prepare all documentations for trainings and distribute it among field team including supervisor’s survey manual, interviewer’s survey manual, sampling guidelines and so forth.

Fieldwork Quality Control. Monitoring of field works will be conducted by the control group using a pre-designed special questionnaire. Specific questions will be agreed with the ACT project manager. Along with the field works the leader of the control group designs the action plan for monitoring. Monitoring of field works will be conducted in three phases: start, progress and completion.

Quality assurance will be enforced by:

- Attendance of field supervisors during the interviews

- Check of completed questionnaires through the phone (where possible)

- Checking interviewers’ daily reports

- Field trips of Project Quality Control Group to the survey areas.

The Project Quality Control Group will apply procedures of the quality monitoring and check about the 20 percent of the interviews on the following aspects:

- Authenticity of conducting interviews and asking all questions

- Relevancy criterion of respondents to the survey quota

- Consistency of selection criterion with sampling requirements and so forth.

In the end, in-office consistency checks of all the completed questionnaires will be carried out, with appropriate corrective action to resolve any inconsistencies. ACT staff will revise the validity of each questionnaire. Thus, 100 percent of the questionnaires will be controlled.

Data Processing. Data will be processed in the Statistical Package for Social Sciences (SPSS v. 15.0). Statistical analysis of the data obtained will consist of the following stages:

- Coding open-ended questions

- Creating data file

- Data entry

- File cleaning

- Data processing and statistical analysis.

Outcomes of the statistical analysis will include frequencies, cross tabulations, Chi-square test, t-test, rates and so forth on all survey indicators. Outcomes of the statistical processing will be used for traditional survey analysis as well as for SAM and CGE analysis, micro-simulation and micro-models.

12.2 SCHOOL FOLLOW-UP

There are several questions in the household survey concerning sanitation possibilities for children in their schools (*e.g.*, is flowing water available in the bathrooms). These questions will be asked of the household member completing the survey. If the respondent does not know the answers to these questions (very likely) then the RID IEP will visit local schools to visually confirm the proper answers for the questions.

12.3 HOUSEHOLD WATER AUDIT

This Section describes the household water audit that is part of the RID IEP Design. Final details will be developed during detailed survey design. Procedures described in the Section on the household survey will be applied to the household water audit as well.

12.3.1 Survey Purposes

The household survey will ask households general questions about their water consumption and water use. Our expectation that answers will reflect perceptions rather than being based on hard facts. Consequently, a household water audit will be used to more firmly establish the actual amount of water consumed by households. An engineering approach will be used to estimate consumption in several different areas. The Design is described in Sub-Section 5.2.9.

12.3.2 Survey Technique And Sample Size

Face-to-face interviews with direct observation and measurements will be use for the water audit. Interviewers will be equipped with measuring sticks, containers and stopwatches to estimate volumes and flows of water used for different purposes. These will be combined with questions asked of the household representative.

The final sample size has not yet been determined. To the end it is expected to be about 25 percent the size of the household survey.

12.3.3 Sampling Frame

The water audit will be applied to a sub-set of the households participating in the household survey. The method of selecting (the 25 percent or so) of the household survey participants to include in the water audit has not yet been determined.

12.4 BUSINESS SURVEY

This Section describes the business survey that is part of the RID IEP Design. Final details will be developed during detailed survey design. Procedures described in the Section on the household survey will be applied to the business survey as well.

12.4.1 Survey Purposes

A comprehensive and quantitative business survey is a key element of the RID IEP Design. The use of data from the business survey is described in Chapters 6 and 9 and Appendixes H and J. This survey will provide data to estimate impact of the RID projects on firms and data on:

- Firm profile
- Monetary costs of firms not having reliable water 24/7
- Estimates of willingness to switch to the new water and sewer systems among businesses
- Overall water consumption among firms
- Income and expenditure patterns among businesses (for CGE analysis).

12.4.2 Survey Technique And Sample Size

The business survey will use face-to-face interviews with probably several representatives in each sampled firm.[49] The survey instrument will be shown in a later report.

Currently estimated sample sizes are shown in the following chart; these are derived from an assumption that errors of the 50 percent prevalence parameter assessment shall not exceed 5 percent with 95 percent reliability for the groups of each RID city as well as industrial and resort towns.

110. Business Survey Sample Size

TARGET GROUP	FIRMS OPERATING IN TARGET CITIES (PRIVATE SECTOR)	
Survey Methodology	Quantitative survey	
Survey Technique	Face-to-face interview	
Sample Size	Bakuriani	25
	Borjomi	77
	Poti	126
	Kobuleti	91
	Kutaisi	183
	Total in target areas	502
	Control areas	400
	Total	902
	Volume of separate industries in each city will be identified based on the city's economic structure after the data from DS is available.	
Estimates Sampling Error	5 percent	

Source: RID IEP Analysis.

12.4.3 Sampling Frame

The volume of sampling within the settlements of the sub-group will be distributed proportionally to the square root from the number of enterprises in the settlement. We will use stratified sampling based on the full list of businesses operating in the target and control cities provided by DS and the Tax Department.

[49] Some questions will be best answered by the Director while others will require help of the chief accountant.

At the first stage of sampling formation, base of settlement points will be split into strata according to their turnover and volume of water consumption. All large enterprises, 25 percent of middle-size and 10 percent of small enterprises will be interviewed. Sampling of middle and small enterprises will be carried out by random sampling method. Additional list will also be formed together with the main list. If an interview cannot be conducted with any of the enterprises, it will be replaced from the additional list of enterprises in the same stratum.

12.5 WHOLESALER SURVEY

This Section briefly describes the wholesaler survey that is a part of the RID IEP Design. Final details will be developed during detailed survey design. Data from the wholesaler survey will be used in the CGE model; details are shown in Chapter 9 and Appendix J. Procedures described in the Section on the household survey will be applied to the wholesaler survey as well.

12.5.1 Survey Purposes

The CGE analysis requires estimates of imports to and exports from each RID city, imports being the more problematic of the two. Imports in this sense typically would be products produced in the rest of Georgia and consumed in the RID city. We will ask businesses during the business survey about their consumption patterns (*i.e.*, purchases from 37 productive sectors). We will also ask them to divide those purchases, on a percentage basis, between purchases from local companies and from foreign companies in the rest of Georgia. This will give us one measure of imports to each RID city.

The Wholesaler Survey will supplement those conclusions by directly asking the largest wholesalers in each city about domestic (within city) and foreign (in the rest of Georgia) supply to the RID city. This will give another measure of imports to the RID city.

These two measures of imports to each RID city in each of the 37 productive sectors will be used in the CGE analysis.

12.5.2 Survey Technique And Sample Size

Meetings with wholesalers will be a series of in-depth interviews with a complete interview guide. It is a misnomer to call this a survey; rather, this is in-depth qualitative research.

During the interviews we will cover the whole range of issues related to imports to the RID city. There will be a number of survey forms to complete as well.

We expect that a relatively small number of interviews in each RID city will capture a very large portion of imports to the city. The final sample sizes have not been determined.

ACT professional interviewers specialized in conducting qualitative studies and economists will be teamed together for the wholesaler survey. In some project areas we assume that local interviewers will not have relevant knowledge and experience for conducting the interviews. In these cases, trained interviewers from Tbilisi will be sent to the RID cities (and control cities) for the interviews.

All interviews will be recorded on digital recorders and later detailed transcripts will be prepared. Both the records and the transcripts will be archived and sent to the survey team.

12.5.3 Sampling Frame

The snowball technique will be used for the selection of participants. Results are not expected to be statistically based.

12.6 WATER UTILITIES SURVEY

This Section briefly describes the water utilities survey that is part of the RID IEP Design. Final details will be developed during detailed survey design. More information on this survey is shown in Chapter 7 and Appendix I.

12.6.1 Survey Purposes

One of the six Impact Groups is Water Utilities, with Impact Categories of Operations and Finance. During the Water Utility Survey we will collect data on:

- Condition of water and sewer infrastructure
- Supply of water, as viewed by the utility
- Demand for water, as viewed by the utility
- Water quality and testing results
- Cost structure
- Financial viability
- Staffing and other efficiency measures
- Problems with rehabilitated systems.

12.6.2 Survey Technique And Sample Size

Meetings with water utilities will essentially be a series of in-depth interviews. It is a misnomer to call this a survey; rather, this is in-depth qualitative research.

There is one water utility in each RID city and in the control cities. We will conduct several face-to-face interviews in each water utility, but with different people according to their spheres of competences.[50] In addition to interviews, we will prepare and submit official letters to the water utilities to provide us with more information related to their financial situation.

So far, we have visited water utility companies in the RID cities three times. Water utility representatives are very friendly and have provided us with all the information we have asked for. We anticipate few problems in obtaining the detailed data that is needed.

[50] Some questions will be best answered by the Director while others will require help of the chief accountant.

In some respects, it is a misnomer to describe the work with utilities as a survey. In fact, it is a census with in-depth interviews on a variety of subjects. A total of about 30 interviews will be done.

ACT professional interviewers specialized in conducting qualitative studies and economists will be teamed together for the water utility survey. In some project areas we assume that local interviewers would not have relevant knowledge and experience for conducting the interviews. In these cases, trained interviewers from Tbilisi will be sent to the RID cities (and control cities) for the interviews.

All interviews will be recorded on digital recorders and later detailed transcripts will be prepared. Both the records and the transcripts will be archived and sent to the survey team.

12.6.3 Sample Frame

The water utility survey will be a census; all water utilities in the RID and control cities will participate.

12.7 WATER ENGINEERING COMPANY SURVEY

This Section describes the water engineering sector survey that is part of the RID IEP Design. Final details will be developed during detailed survey design.

12.7.1 Survey Purposes

The micro-models used for households and firms (described in Chapters 5 and 6 and Appendixes E and H) are engineering based in the sense that they request costs for digging or renovating wells, installing pumps and so for. During the household and business interviews we will ask respondents about how much they spent on different types of water installations. We will specifically ask about historical costs for these items.

Separately, we will do face-to-face interviews with water engineering sector companies in each RID city to estimate current costs for the same types of water installations. The water engineering companies are involved in water installations as part of their normal business so they will have a very good understanding of current costs.

We will also use the water engineering companies to double check the semi-variable and variable costs that we are receiving from individual households and firms.

Costs from the water engineering companies will be combined with costs from individual households and firms to arrive at a consensus about water installations costs.

12.7.2 Survey Technique And Sample Size

Structured in-depth face-to-face interviews will be used for the water engineering company survey. We expect to complete about 30 such interviews as part of the RID IEP.

ACT professional interviewers specialized in conducting qualitative studies will be teamed with economists for the water engineering company interviews. In some RID cities we assume that local interviewers will not have relevant knowledge and experience for conducting the interviews. In these cases, trained interviewers from Tbilisi will be sent to the RID cities (and control cities) for the interviews.

All interviews will be recorded on digital recorders and later detailed transcripts will be prepared. Both the records and the transcripts will be archived and sent to the survey team.

12.8 INVESTOR CASE STUDY

This Section briefly describes the investor survey that is part of the RID IEP Design. More information on this survey is shown in Section 6.3.

12.8.1 Survey Purposes

Part of the Individual Firm Impact Group is business enablers, for either existing businesses or new businesses. We understand that the presence or absence of a suitable water and sewer system is an important consideration when making a decision on a large investment, particularly for a large hotel or resort. The Investor case study interviews will be used to understand these factors better.

The investor survey will focus on relatively few high value investors, 15 or fewer. We will interview the successful and failed investors to understand the influence new water and sewer systems would have on their investment decisions. Of particular importance will be:

- Importance of rehabilitated water and sewer systems in the investment decision
- Infrastructural problems
- Expectations regarding the RID projects.

Results will be documented as a case study.

12.8.2 Survey Technique And Sample Size

In-depth face-to-face interviews will be use for the investor case study. There are relatively few large investors in water-related areas in Georgia today; we hope to speak with most of them.

12.8.3 Sampling Frame

We will use our own contacts with investors and the snowball method to select respondents. In this case data are not expected to be of statistical character and representative sampling strategy will not be applied.

12.9 PUBLIC HEALTH CASE STUDY

This Section briefly describes the public health case study that is part of the RID IEP Design. Final details will be developed during detailed survey design. More information on this case study is shown in Chapter 8.

12.9.1 Survey Purposes

We will prepare case studies concerning the impact of the RID projects on the public health system. The basis of these case studies will be a series of in-depth interviews with doctors and other professionals in the public health arena.

The research questions for the doctors and public health sector survey are described in detail in previous Chapters. They generally fall into the following categories:

- Prevalence of water-borne disease
- Public health initiatives in the RID cities
- Expectations for improvements from the new water and sewer systems
- Likely responses by the public health system to the RID projects (*e.g.*, possibly reduced need to focus on water borne disease and more attention paid to other diseases).

12.9.2 Survey Technique And Sample Size

In-depth face-to-face interviews will be used for the public health case study. We expect to do approximately 30 interviews in preparation of writing the case studies.

12.9.3 Sampling Frame

The top-down method will be used to select respondents. That is, we will meet first with ministry officials and then work our way to less senior staff.

12.10 COMPLEMENTARY ACTIVITIES CASE STUDIES

This Section briefly describes the complementary activities case study that is p art of the RID IEP Design. Final details will be developed during detailed survey design. The case study is described in more detail in Chapter 10.

12.10.1 Survey Purposes

Other MCG initiatives are underway in the RID cities. It is possible that there will be some interaction between the RID projects and the other MCG initiatives (*e.g.*, a company supported by the ADA could also benefit from a new water or sewer system). The interaction between these projects will be the subject of the complementary activities case studies.

12.10.2 Survey Techniques And Sample Size

Face-to-face interviews with recipients of other MCG projects will be done for the complementary activities case study. A this time we expect there will be 20 or so interviews done for this purpose.

12.10.3 Sampling Frame

MCG will provide lists of beneficiaries from other MCG initiatives in each of the RID cities. It is likely that the RID IEP will interview every company on those lists.