Technical, Cost Effectiveness and Sustainability Audit, March 2016

Poverty Reduction Fund Project (PRF)

Final Report

Findings and Recommendations

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Technical, Cost Effectiveness and Sustainability Audit, PRF, January 2016

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Executive Summary

The Poverty Reduction Fund (PRF) was established in 2002 with support from the World Bank. Additional financial credits were received from the WB and the Swiss Cooperation for Development to extend the project to 2011. The second phase, PRF II, was again supported by these agencies along with investments from the Government of Lao PDR (GoL) and the Australian Agency for International Development. PRF II runs from 2012 to 2016.

This technical evaluation and audit were undertaken to independently assess the technical quality, cost effectiveness and sustainability of a random representative sample of infrastructures that have been completed. The random sampling was based on sub-projects from the Cycles 7, 8 and 9 (2009, 2010 and 2011 respectively), totaling 1174 number of sub-projects; from the north and the south of Lao PDR; from a mix of remote and not remote villages; and from a representative number of SP type. A total of 60 PRF sub-projects were evaluated during this exercise.

The cost effectiveness of PRF investments was determined by including visits and evaluations of comparable pieces of infrastructures financed by other entities.

The technical evaluation was conducted by Neil Neate, P.Eng. Neil was assisted by four staff members of Mixai Techno Engineering and Consulting Inc. who were trained before performing the fieldwork.

The selection of 60 PRF sub-projects was performed using a random sampling method, using the following criteria:

- Half of the SP were in the north of the country and half in the south;
- There was proportional representation (PR) of SP by type;
- Greater than 50% of the selected sites were considered remote; and
- Approximately one third of the SPs evaluated were constructed in each of Cycles 7, 8 and 9.

Five types of sub-projects were evaluated: Buildings for schools, health centers and village halls; Bridge; Water Supply; Road; Irrigation. Each SP type was evaluated using a set of Field Tools that were similar in scope and style but differed from one another in the type of information gathered. The Building Technical Rating Field Tool, for example, collected data in regards to concrete practices, wall and column information, etc., while the Water Supply Tool examined piping, reservoirs and public tapstands. There were five Field Tools for each SP type: Field Tool 1 – Technical Evaluation of Infrastructure; 2 – Cost Effectiveness; 3 – Environmental and Social Safeguards; 4 – Operations and Maintenance/Sustainability; and 5 – Economic Analysis.

Technical Design Quality

Considering the aggregated total of all sub-projects evaluated, it was found that 76% of the technical components of the structures have been constructed in accordance with the plans and specifications as set out in the sub-project proposals and considered to Meet Specification with a further **22% rated Slightly Below** in terms of meeting the intent of the sub-project proposal. Only 2% of technical ratings were Below Specification**.**

There were differences found in the technical quality of construction amongst sub-project type. Water supply and bridge sub-projects' components were found to Meet Spec 87% and 82% respectively. Building, irrigation and road sub-projects were below this, 74%, 71% and 45% respectively. Since ratings have been assigned specific components or aspects of these infrastructures, such as columns, concrete or roof fastenings, the identification of problem areas is possible and recommendations are provided to improve the technical quality of these items.

The entire sub-project 'packages' (preparation, design, implementation and follow-up) were evaluated using the WB six-point quality rating system (Highly Satisfactory, Moderately Satisfactory, Satisfactory, Moderately Unsatisfactory, Unsatisfactory, and Highly Unsatisfactory). It was found that **27% of the sub-projects are Highly Satisfactory. A further 63% are Satisfactory, while 7% are Moderately Satisfactory. There are only 2% were considered Highly Unsatisfactory.**

Cost Effectiveness

PRF's **buildings and irrigation works were found to be cost effective in comparison** to similar constructions by other agencies and the Government of Laos. PRF unit costs for these types of infrastructure are in line with those of other projects.

PRF's **road building program is not seen to be cost effective** when compared to road construction efforts of a similar project. The cost effectiveness of PRF's investment in roads is negatively affected by the lack of drainage ditches and structures to transmit road runoff and overland flows across roadways in an effective manner. Recommendations in this report will seek to help redirect PRF road building activities toward more fruitful results.

Although PRF's **gravity-fed water supply program incurs unit costs twice that of other agencies,** the design quality and user/tapstand ratio of PRF systems stands above those constructed by other projects. The data acquired by this study indicates that **other agencies typically provide far fewer tapstands per household than does PRF (PRF: 12 HH/tapstand; CSP: 21 HH/tapstand). The World Water Partnership recommends water systems be designed for a maximum of 6 HH/tapstand.**

PRF's **borehole program has incurred costs slightly below those of comparable agencies** for several well sub-projects, although budgets were observed to go up in geographic areas where groundwater is deeper and harder to access.

Community contributions, in almost all cases labour and locally sourced materials, **were found to enhance the cost effectiveness of all PRF sub-projects**, particularly buildings and irrigation schemes. There are few areas where the PRF can make distinct changes to its design/construction program to reduce the unit cost of PRF SPs without reducing quality or benefits of the infrastructure.

Compliance with Environmental and Social Safeguards

The data collected at the PRF SP villages indicates that the Environmental Codes of Practice, the Operation Manual standards for verification and monitoring, and the social screening checklists are being used and followed in a majority of SP village files – **85% of sub-project files contained appropriately completed ECOP documentation**, with **a lesser majority making use of the social screening checklist (75%).** Fully **100% of villages contained evidence that the Village Visioning Meeting had taken place.** Unfortunately, the PRF's use of **the safeguard compliance monitoring form was a disappointing 45% of SP files**.

Technical inspections of the sub-project sites during the evaluation showed that **95% of environmental considerations had been appropriately handled on the ground,** during and after construction.

Operation and Maintenance / Sustainability

O&M Committees have been formed and are functioning at 93% of the sub-projects evaluated (with road sub-projects being the extreme outlier at only 75%). The scale of activities undertaken by these committees, both routine maintenance items and major repairs, differs between the sub-project types. **All O&M Committees surveyed have conducted routine maintenance and some have done major repairs. Roads (again) and bridge sub-projects report greater numbers of deferred major repairs**, likely due to expense and capacity problems.

The prevalence of certain routine maintenance activities was measured for each sub-project type, as well as a summary of O&M fee structures and costs. **One third of the buildings evaluated, for example, had received repairs to their roofs; all of the bridges surveyed had handrails fixed and repairs made to their aprons and road approaches; 83% of water supply SPs had required minor repairs to piping.** On the negative side, however, **this study shows that routine mechanical repairs are often neglected, both in buildings' toilets and water system elements. Bridge deck repair and erosion maintenance were performed by lesser numbers of O&M Committees**. The results of this survey and analysis will inform future O&M training sessions, highlighting the routine tasks that are presently being neglected. It would appear as though **little ongoing capacity building has been received by village O&M Committees after completion of**

sub-projects. Village sub-project O&M Committees will benefit from an increased awareness of proper O&M techniques.

<u>Economic Analysis</u>

Economic analysis information was gathered during technical evaluation visits to school, water supply and road sub-project sites.

The general assumptions of this analysis are that the full benefit is realized in Year 1 of each sub-project and over the full lifetime of the infrastructure. Operations and Maintenance (O&M) costs are assumed constant over time and spent annually. The rationale is that for full expected benefit realization throughout the life of the project, the physical infrastructure must be repaired and maintained on a regularly scheduled basis. While O&M costs actually vary by project by year, with more costs towards the latter part of the investment life, a constant amount can be assumed as the average annual cost over the life of the subproject. A discount rate of 11.25% will be used in computing the Net Present Value (NPV) and evaluating the Expected Internal Rate of Return (EIRR).

The conservative analysis revealed an NPV of Kip 1,004,750,747 and EIRR of 43.5% and therefore the road project was deemed economically desirable.

A conservative analysis revealed an NPV of US$8,724 and EIRR of 20 percent for gravity supply and NPV of US$ 29,960 and EIRR of 126 percent for pump driven water supply, suggesting that returns from investment from water supply projects are very high.

The conservative analysis revealed an NPV of Kip 271.8M and EIRR of 26% and therefore the school sub- project was deemed economically desirable. The result is consistent with findings from other similar projects.

<u>Major Recommendations</u>

This report provides analysis and a summary of the major problems and challenges associated with the PRF construction program. Recommendations of corrective measures and proper construction methodologies are presented throughout the report for specific items. Following are the major recommendations from this study:

- PRF should convene a technical sharing session where provincial engineering representatives meet to exchange ideas on how SP designs and file documentation can be improved, presenting examples. Focus should be upon water supply and road design issues, as well as improvements to the survey, design, documentation and delivery of the other sub-project types.
- A DRM training course should be held to emphasize the responsibility of designers to more fully consider the forces of nature when planning rural infrastructures.

- PRF III should consider allocating additional resources to those districts with greater numbers of remote or very remote villages.
- All PRF environmental and social safeguard checklists and forms must be completed for each SP site. Environmental monitoring activities should be ongoing during the SP construction, with notes to file as appropriate. Refresher training courses should emphasize the importance of this documentation.
- The citation of improper materials being at least partially responsible for almost all of the major repairs should be studied further by the PRF Engineering Department. Substitutions for these poor materials may help reduce the incidence of major failures.
- O&M refresher courses should be provided to water supply O&M Committees on a periodic basis (first and third anniversary). These should be taught by the PRF designers themselves, so that they have first-hand knowledge of water system deterioration issues and how better design can extend the life of a system.
- The PRF should consider revising the O&M plan to stipulate activities that must be undertaken according to a routine schedule, with indicative costs and sources of funding.
- The PRF should consider revising the O&M plan to insert specific capital repair estimates. Estimates should be provided appropriate to SP type, for example, roof replacement for buildings, with options described to committees for the funding of such capital works.
- PRF SP menu should be altered to stipulate that road upgrades must normally be confined to spot improvements (drainage, culvert, small bridge, etc.) or steep road construction utilizing hard surfacing over short sections.

The findings and recommendations from this report will provide additional direction for the preparation of PRF III.

Technical, Cost Effectiveness and Sustainability Audit, PRF, January 2016
Final Report – Findings and Recommendations

1 Background

The Poverty Reduction Fund (PRF) was established in 2002 with support from the World Bank. Additional financial credits were received from the WB and the Swiss Cooperation for Development to extend the project to 2011. The second phase, PRF II, was again supported in 2011 by these agencies along with investments from the Government of Lao PDR (GoL) and the Australian Agency for International Development.

The PRF has implemented sub-projects in ten provinces, with 90 to 95% of sub-project (SP) budget expended on construction-related activities. PRF I and II have supported the development of schools, public buildings, bridges, health dispensaries, potable water systems, irrigation schemes and rural road upgrades. PRF II was designed around six core principles: Simplicity; Community Participation and Sustainability; Transparency and Accountability; Wise Investment; Social Inclusion and Gender Equality; and Siding with the Poor.

The objective of this technical evaluation and audit is to independently assess the technical quality, the cost effectiveness and the sustainability of the rural infrastructures financed by the PRF Project. Evaluation teams also took note of best practices observed and lessons learned at SP sites, in order to make recommendations for future project implementation improvements.

The cost effectiveness of PRF investments was determined by including visits and evaluations of comparable pieces of infrastructures financed by other entities.

2 Technical, Cost Effectiveness and Sustainability Audit Scope

The main objectives of the study are as follows:

2.1 Technical Design Quality of PRF SP

The evaluations required an inspection of the infrastructure, examination of SP village files, questioning of village implementation committee members, and comparison of the as-built structure with the approved-for-construction drawings.

The scope of questions to be answered are as follows:

- What is the technical quality of the design? Have the "for construction" design drawings being signed by a qualified and certified Lao engineer to confirm that "the design complies with the Lao National Building Code" and or " the relevant standards, codes and building regulations of Lao PDR". Assess the as-built condition, based on a fair engineering judgment, as good, fair or poor based on list of key criteria to be developed for each major type of sub-project to be checked as basis for the technical quality assessment.
- Is the design as constructed "fit for its intended purpose" in the view of the end-users? Were end-users consulted in the design of the facilities? Record the response of the end-users to these questions.
- What is the quality of materials/inputs and are these consistent with the BOQ and specification in the bidding documents?
- Did the sub-projects follow the technical specifications and scope as designed? Were any critical design elements, such as latrines, dropped?
- What construction documentation exists to show that the sub-project meets the design and specification requirements? Has each end-user been provided with a complete set of As-Built Drawings?
- Have all technical requirements been met and defects addressed before sub-projects are handed over to communities? Has a signed Hand-Over Certificate been prepared with a copy of the signed-off final inspection checklist attached?
- Did the sub-projects take into account DRM measures? If so, how?

2.2 Cost Effectiveness

The technical evaluation for cost effectiveness included similar rural infrastructures funded and constructed by other donors or the GoL. Bills of Quantity, designs, specifications and other SP documents were examined in order to record relevant data for these comparisons. SP dimensions were checked at the sites in order to confirm both as-built drawings and unit area costs of construction.

The scope of questions to be answered are as follows:

- How does the unit costs compare between the PRF sub-projects (SPs) and comparable infrastructure built by GoL or other projects? Care should be exercised and the report should demonstrate that only comparable cost items are assessed across different investments.
- Which specific designs, materials and processes may be altered to reduce the unit cost of PRF SPs without significantly reducing quality or benefit?
- Are investments implemented through community force account (CFA) more competitive than those implemented by contractors, when the cost of capacity development and supervision, tax liabilities, and the cost and quality of O&M, are taken into account?
- Are there community contributions, and if yes, how much were they, how were they calculated, what forms did these contributions take and what percent of total costs?
- Where community contributions are expected in the sub-project documents,
    - Did the contributions actually occur and were they accounted for properly?
    - Is the size of community contributions reasonable for the size of investments?
    - Were there additional community contributions not reported?
    - Assess whether contractors were ever paid for the part of works carried out with community contributions.
- Were community contributions an important factor in determining the cost effectiveness of PRF sub-projects relative to similar sub-projects supported by others?
- Are there significant different between PRF SPs and investments funded by other entities in terms of the costs for materials, transport, labor and other inputs?
- Based on sound engineering judgment and in comparison to comparable investments financed by other entities, were PRF SP designed to maximize community benefits through employment of local labor, procurement of local materials, or other means?
- Based on sound economic judgment and in comparison to comparable investments financed by other entities, were PRF SP designs and specifications selected to maximize value for money? Would other designs, technologies or methods have provided greater value?

2.3 Compliance with environmental and social safeguards

The SPs visited were also assessed in regards to their compliance with the Project's environmental and social safeguard standards and policies.
The scope of this assessment is as follows:

- Proper documentation and recording of Environmental Code of Practice (ECOP) and the Safeguard Checklist, and the verification and monitoring by the District PRF office of contractor / community compliance with ECOP.
- Loss of land or private assets, the scale of impact, whether or not they are addressed through voluntary donations and if so, whether all conditions of voluntary donations as provided in the CRPF are met.
- Verification of whether the collection of sub-project documents meet the requirement of Indigenous Peoples Plan as provided in the EGDP.
- Verification of whether any adverse environmental impacts occurred at the sub-project site, and how they were mitigated.

2.4 Operation and Maintenance (O&M)/Sustainability

The physical examination of the SP during the technical evaluation, for 2.1 above, also allowed for an accurate appraisal of the current state of O&M of the infrastructure. Additional information was gathered during the village implementation committee interviews.

The scope of questions to be answered are as follows:

- Are the current conditions of sample investments good, fair or poor?
- Have any major repair or restorative maintenance/ rehabilitation works conducted since the completion of civil works or does the current condition require such works? If so, what are the causes of defects? Break down the causes of defects into environmental/ natural factors; technical defects in design, implementation or materials; and lack of proper maintenance.
- If any O&M works have been done, who did what O&M works, when and how much did they cost?
- Was any routine maintenance (wear and tear and/or replacement of consumables) carried out on the sub-project, and what has been spent on maintenance each year since completion?
- Were the O&M plans developed? If so, is the quality adequate? Do the O&M plans adequately cover the O&M requirements over 3 – 5 years of operation, and clearly spell out specific O&M works, responsible agencies and expected cost, breaking down clearly typical scheduled maintenance works including capital repair?
- What are the implementation arrangements for the O&M? Are O&M committees in place and functioning? What are the roles and responsibilities (both financial and technical) of local governments/ line agencies and communities? Are roles and responsibilities, financial and technical, clearly spelled out for direct beneficiaries/ users and for the responsible government agencies? Are indirect beneficiaries also expected to contribute to the O&M?

- Was any training provided to local communities on O&M (including refresher training), and if so, what types of training were provided? Did communities request and/ or receive technical support from local governments/ line agencies on O&M?
- Is an O&M fund in operation? Who holds the funds, and who contribute how much? What is the current value of these funds? Are those expected to contribute able and happy to contribute?
- Is the O&M fund designed to cover all or most of the O&M works that should be conducted, including the cost of scheduled maintenance and capital repair?
- Assess whether applicable user fees are affordable to users and sustainable to finance longer term O&M. Did the line ministries contribute to O&M expenses ?
- Were necessary Government inputs (e.g., teachers and learning materials for schools, or health workers, drugs and equipment for dispensaries) provided adequately and in a timely manner?
- Did the community or contractor implementation modalities have any impact on O&M? What investment types are more suitable to community force account in terms of long-term cost effectiveness? What conditions have to be met to make the model of community force account cost effective in the long run?
- Did the capacity development of beneficiary communities carried out by the PRF contribute to SP sustainability cost-effectively? Compare the total cost including the cost of community engagement and capacity development of investments financed by different sources, taking into account (i) the current conditions of infrastructure; (ii) initial condition of infrastructure after completion and (iii) O&M works done. Any indication that the PRF's investments in the capacity development of communities contribute to long-term sustainability of sub-projects? If such an indication is observed, how cost effective is the PRF community capacity development in long term sustainability of infrastructure?

2.5 Economic Analysis

The technical field tool questionnaire for this section of the evaluation was developed in consultation with an expert consultant based in Singapore. The technical evaluation team questioned village and farmer representatives for the information requested. Economic analysis information was specifically requested for school, road and water supply SPs.

2.6 Best Practices/Recommendations/Lessons Learned

The technical evaluation team members were encouraged to make note of particular instances where good or bad practices were observed or related during interviews. The field instruments provided areas where this commentary could be noted.

The main ideas for capture in this section are as follows:

- What examples of good practice can be drawn to enhance technical design quality, operation and maintenance and sustainability for future PRF SPs?
- What are the key threats to sustainability and what good practices can effectively address these threats?
- What are the key lessons learned from the sub-projects undertaken? What practices should be replicated and/or avoided in future sub-projects?
- Provide a list of key recommendations based on these good practices and lessons learned for the future design, implementation and maintenance of future PRF SPs

All questions from above are repeated within the reporting sections.

Recommendations of the Technical Evaluation are presented throughout the text of this report, associated with each item under discussion/analysis, and gathered together in Annex 1 for convenience**.**

3 Technical Evaluation Team Members

The technical evaluation and audit was led by Neil Neate, P.Eng. Neil was assisted by members of Mixai Techno Engineering and Consulting Ltd. Mixai provided four personnel who were trained by Neil before performing the fieldwork.

The Mixai consultants were divided into two teams, each with one 'social' member and one engineer: Team 1 was Mssrs. Boun Nhaeng and Thavisith; Team 2 was Mssrs. Khampone and Lamphoukham. They traveled together to each province and divided the SP site inspections between the two teams.

4 Site Selection Procedure and Sampling Methodology

The selection of PRF sub-projects was performed using a random sampling method of available sites, with a number of general criteria to direct the selection. The criteria were as follows:

- Half of the SPs should be in the north of the country and half in the south;
- There should be proportional representation of SP by type;
- There should be proportional representation in regards to construction implementation modalities (i.e. community force account, contractor, or joint implementation);
- Degree of remoteness (with at least 50% of the selected sites being considered remote);
- Half of the sample should be from Cycle 7 and half from Cycle 8. (It was later decided that the study should be expanded to include infrastructures from Cycle 9 to ensure that there would be sufficient SPs of each type to meet the sampling criteria.)

During discussions with the PRF and World Bank, it was decided to complete the technical audit in all of the pre-identified provinces: Xiang Khouang (XKH), Houaphan (HPH), Luang Namtha (LNT), Savannakhet (SVK), Saravan (SRV) and Sekong (SKG).

The PRF MIS department provided information to determine the relative percentage of SP type that had been constructed in Cycles 7, 8 and 9 (2009, 2010 and 2011). Following is a summary of the approximate relative percentages of SP type for these construction cycles (derived from MIS Sector totals from which various non-construction activities were discounted):

Table 4.1 – Distribution of PRF Sub-project Types, Construction Cycles 7 – 9

	Building*	Bridge	Water Supply	Road	Irrigation
Cycles 7 -9	30%	10%	40%	10%	10%

- Note: The building sub-project type represents schools, school dormitories, health clinics and village halls. The final sampling was comprised of 30 schools, 2 dormitories, six health clinics and two village halls.

Also, for the fifth bullet above, the relative numbers of SP were provided to us:

Table 4.2 – Number of PRF SP per Construction Cycle

	Cycle 7 (2009)	Cycle 8 (2010)	Cycle 9 (2011)
Number of Sub-project	463	449	262
Relative % of Sub-project	38%	39%	22%

Mixai was provided with a complete listing of PRF SPs in the subject provinces for the three construction cycles. Mr. Boun Nhaeng used the criteria above to select a representative sampling of SPs. The sampling was viewed by the PRF and approved.

PRF Engineering Department personnel helped to coordinate the fieldwork by providing local contact names, cellphone numbers, addresses, etc.

It was recognized that the PRF SP sampling would likely require adjustments once the fieldwork had started. Mixai had chosen the SPs based on the detailed and restrictive criteria as above, but with only a cursory understanding of the actual ground conditions in different provinces. The state of road surfaces, serviceability of bridges and other factors might make visits to certain SPs difficult, time-consuming or impossible.

The list of selected SPs was transmitted to each subject province and it was resolved to confirm and make necessary changes to the field program upon arrival in each province/district. Where necessary, inaccessible SPs were replaced by other similar candidates using local knowledge. The final outcome of this combination of office and field SP sampling methodology and adherence to the selection criteria is presented below in Section 6 – Sub-Projects Evaluated.

5 Technical Evaluation Methodologies

5.1 PRF Sub-Project Types

The PRF MIS classifies SPs within a number of Groups and Sectors. The classifications currently used are as follows:

Table 5.1.1 – PRF MIS Sectors

Group ID	Sector ID	Sector Code	Sector Descriptor
01	ED01	ED	Education
02	HL01	HL	Health
02	HL01	WS	Water and Sanitation
03	PT01	PT	Public Works and Transportation
04	AF01	AF	Agriculture and Forestry
05	ITE01	TRS	Training
06	EM01	EM	Energy and Mines

The types of construction activities that can be supported within these Sectors are village infrastructures that will help reduce poverty by filling critical public service gaps at the Kum ban and village levels. The PRF generally uses an "Open Menu Approach" and an outline of the type and range of SPs typically funded under PRF auspices is contained in the PRF Manual of Operations, Table 3.

During preparations for the technical evaluation it was noted that some types of rural infrastructure are represented in more than one sector. For example, building construction is included as schools in Sector 01, health clinics in Sector 02, toilet buildings in Sector 02, markets in Sector 04, etc., creating reporting and coding difficulties for the technical evaluation data as it was collected, digitized, saved and analyzed.

SPs were therefore divided into SP 'types', allowing each SP evaluated to be assigned a sub-project type code. The sub-project types identified for the PRF menu are as follows:

Table 5.1.2 – PRF Technical Evaluation 2015 Sub-project types

Type	Sub-Project Type Descriptor	Sectors Represented Within This Sample
A	Building	ED, HL, WS, AF
B	Bridge	PT
C	Water Supply	WS
D	Road	PT
E	Irrigation	AF
F	Electricity	EM

Note: Type F Electricity was not included in the technical evaluation because no SPs of this type occurred in Cycles 7, 8 or 9.

Although the PRF MIS tracks individual SPs by Sector, this technical evaluation's SP sampling stratification methodology, based on SP type, is valid. The analysis within this report is based upon the above sub-project types, and the findings for each specific sub-project type apply across all sectors in which such infrastructure (or component/aspect of infrastructure) is found. For example, the technical evaluation's conclusions regarding reinforced concrete practices will apply equally to buildings found in most Sectors, to concrete bridges, road structures and retaining walls in Sector PT01, to concrete reservoirs in Sector HL01, and to concrete drainage channels in Sector AF01, etc. Thus this evaluation's findings for each sub-project type should be viewed and applied with equal interest across the PRF sectors featuring such infrastructure.

5.2 Technical Evaluation Field Instruments

The technical evaluation (TE) teams used unique field instruments for each SP type. These field instruments consisted of a set of five checklists that were to be completed at each village where the subject SP was located. The five topics of the Field Tools were: 1 Technical Evaluation of Infrastructure; 2 Cost Effectiveness; 3 Environmental and Social Safeguards; 4 Operations and Maintenance/Sustainability; and 5 Economic Analysis.

The Field Tools were developed, in consultation with the PRF and WB, prior to and during the first week of the assignment and submitted for comment. Valuable advice was received and the Field Tools were finalized.

Prototype sets of Field Tools were field tested in Thathom District, Xiang Khouang at two SP sites: a gravity-fed water supply system and a primary school. Subsequent feedback from the team spurred some minor changes to be made to the various checklists. A sample of one of the Field Tools is attached to this report in Annex 2 – Sample Technical Evaluation Field Instrument.

The technical instruments contain data fields that were filled in with a checkmark or notation at the SP site itself. Other parts of the field instrument would often be completed afterwards, during meetings at a village hall or Village Implementation Team member's home. Following is a general summary of the data fields in each of the individual Field Tools:

> Field Tool 1 – Technical Evaluation of Infrastructure – This three-page checklist is unique to each SP type. The five SP types were divided into a number of components, each to be rated separately (the rating system is defined below in Section 5.3). Components for the sub-project type Building, for example, started at the base: Foundation, Ground Beam, Wall, Column, etc., proceeding up to the Roof Structure. Where a particular component had several distinct aspects that should be evaluated separately, the component was subdivided, for example: Ring Beam - Reinforcement and Ring Beam -

Dimension. A complete list of the each of the SP types' components and aspects is provided in Annex 3.

This instrument also collected other SP quality ratings (Overall Quality, Design Completeness, SP Functionality, etc.) that are more fully discussed in Section 5.4 below. Space is provided on all the checklists for comments to be written.

Some parts of this field instrument were also completed for the Comparable Sub-Projects (CSP) visited, making possible a comparison of PRF's sub-project technical quality with those of other organizations.

Field Tool 2 – Cost Effectiveness – This checklist consists of two pages. The first page contains data fields unique to each SP type. TE team members were instructed to examine construction plans, as-builts and specifications to verify and record the dimensions and materials of the SP. Information from the first page was used to determine each SP's basic unit costs, allowing comparisons to be made. Where possible and when time allowed, teams would check some of the measurements at the SP site. The second page of this instrument was the same for all SP types, and required that SP accounting records be studied to determine if any special costs had been incurred, for specialized trades or for transport of materials, etc. Community contributions to the SP were also noted. This field instrument was also completed for all CSP visited, making possible a comparison of PRF SP unit costs with those of other organizations.

Field Tool 3 – Environmental and Social Safeguards – This single page checklist was common to all SP types. TE teams examined the village SP implementation files to verify the inclusion of all required policy and code of practice documents, as well as records of monitoring by PRF staff. A physical inspection of the SP was also performed to visually confirm the completion of requirements as set out in ECOP.

Field Tool 4 – Operations and Maintenance/Sustainability – This checklist consists of two pages. The first page contains data fields unique to each SP type. The second page collects standard information from O&M Committee members at each SP site and requires the team to examine and make notes from each SP O&M Plan.

Field Tool 5 – Economic Analysis – The information to be collected on this two-page checklist was suggested by an expert consultant based in Singapore. Village Implementation Team members or representatives of SP user groups were questioned by the technical evaluators.

5.3 Technical Rating System

Using Field Tool 1, each component or aspect of the SP infrastructure was rated as being one of five choices: Meets Spec. (Specification); Slightly Below Spec.; Below Spec.; Not Inspected; and Not Applicable. The component or aspect was examined in its current condition and reasonable allowances were made for normal wear-and-tear and degradation.

These ratings are defined for this technical evaluation as follows:

- **Meets Specification** (Meets Spec) – The sub-project component or aspect conforms to the plans, specifications, or criteria as set out in the Sub-Project Proposal.
- **Slightly Below Specification** (Slightly Below) – The sub-project displays certain characteristics that could be improved upon within its design/construction/operations/maintenance or environmental conditions to conform to the plans, specifications or criteria presented in the Sub-Project Proposal.
- **Below Specification** (Below Spec) – The sub-project was either (i) not constructed according to the approved plans or specifications in the Sub-Project Proposal, or (ii) presents a clear and present danger to the life or safety of users.
- **Not Inspected** – It may occasionally be impossible for the TE team to inspect a certain aspect of a sub-project. For example, many completed buildings feature ceilings with limited or no access to the attic. TE teams may not be able to inspect the interior of a building's roof structure in these instances. The TE team will question the village and District personnel in this instance to verify sub-project details as much as possible.
- **Not Applicable** – Some components or aspects will not be applicable to sub-projects. For example, the component Ceiling is included in the Building Checklist, but many building sub-projects do not include such installations.

Evaluators assessed the infrastructure in its current condition, taking into account normal deterioration of components over time and assuming that standard O&M tasks have been carried out. Infrastructure components are not penalized (rated Slightly Below or Below Spec) if it is evident that standard O&M practices have not been followed. O&M is rated separately for all SP type, and if it has not been carried out properly, the O&M SP component would be rated Slightly Below or Below Spec according to conditions. Degradation due to poor O&M is not the infrastructure's fault (where the SP works were well designed and installed).

5.4 Quality Ratings and Other Criteria

The second page of Field Tool 1 offers the evaluator an opportunity to rate the SP's construction quality as well as in several more general and less-technical areas. These "Overall Project Assessment" categories examine the entire SP, rather than each separate and specific component as above, and are as follows:

- Sub-project overall construction quality (rated in accordance with WB six-point rating system)
- Design completeness (Good, Fair, Poor), with opportunity to write a comment
- Functionality (High, Average, Low, None), with opportunity to write a comment
- Design consultations with user (Yes or No), with opportunity to write a comment
- SP Proposal documentation check. (Rated Yes if documentation found, No if not.)

These quality ratings are defined and further discussed below in Section 7, in separate sections for each. Analysis of the sub-project quality ratings gathered in this part of Field Tool 1 is presented along with commentary.

A listing of the 60 PRF SP evaluated and their WB quality ratings (first bullet above) is provided in Annex 4

The second page of Field Tool 1 also provides space for the evaluator to write a brief sub-project description and add comments regarding particular issues that were noted during the evaluation. The Mixai team included a Lessons Learned section with many SP field reports (all provided in Annex 5).

5.5 Field Checklist Data Input

The data from Field Tools 1 to 5 was input to digital spreadsheets in the office after the fieldwork was complete. The digital data input spreadsheets are patterned after each of the hard-copy Field Tools. These forms allow input of the field information in a format very similar to that in which it was gathered, thereby reducing input errors. The digital spreadsheets allow the data to be systematically filed, grouped and analyzed using computer sorting techniques. The data within the sub-project spreadsheets can, for example, be sorted by Cycle, by location, or by the rating evaluations under Overall Construction Quality or Functionality. Sorting procedures can be used to reveal trends or to highlight problem areas.

The Mixai team members input the field data for each sub-project evaluated and saved these spreadsheets to computer files using standard naming formats. The naming formats are based upon the national administrative numbers for each province, district, Kum ban and village along with an added code for Sub-project Type to enable this evaluation's sorting and correlation activities to take place.

The file naming system used for this technical evaluation is as follows, substituting numbers for each square-bracket item: [Province]-[District]-[Kum ban]-[Village]-[Sub-project Type], where GoL administrative numbers are used along with the SP type codes per Table 5.1.2 above. Thus, a water supply SP in Namuang village, Samphanxay Khum ban, Khoun District, Xiang Khouang is represented in the digital analysis as 02 08 03 09 C.

6 Sub-Projects Evaluated

6.1 Sub-Project Sample

There were ten PRF SP evaluated in each of six provinces. A complete list of the sub-projects that were evaluated is provided in Annex 4. Following is a table providing a summary of the SPs evaluated according to infrastructure type.

Table 6.1.1 – Number of Sub-Projects by Type in Each Province

	Building	Bridge	Water Supply	Road	Irrigation
Xiang Khouang	3		3	2	2
Houaphan	3		4	2	1
Luang Namtha	3	1	4	1	1
Savannakhet	3	1	4	1	1
Saravan	4		3	1	2
Sekong	3		6	1	
Total	**19**	**2**	**24**	**8**	**7**

6.2 Sub-Project Sampling Criteria vs. Audit Sample

- Half of the SP should be in the north of the country and half in the south.
  – 10 PRF SP were evaluated in each province, resulting in 30 in the north and 30 in the south.

- There should be proportional representation of SP by type.
  – The following table demonstrates that the study's SP selection proportionally represents the PRF's constructed SPs for the chosen construction cycles, with the exception of bridge infrastructure. It was attempted, during the SP sampling process, to include more bridges in the fieldwork program, but these proved hard to locate within reasonable distances of the District center and other SPs.

Table 6.2.1 – PRF Sub-Project Types during Construction Cycles 7 – 9

	Building	Bridge	Water Supply	Road	Irrigation
Cycles 7 - 9 (%)	30%	10%	40%	10%	10%
Study (number of SP)	19	2	24	8	7
Study (%)	32%	3%	40%	13%	12%

- There should be proportional representation in regards to construction implementation modalities (i.e. community force account, contractor, or joint implementation).
  – All PRF SP in the cycles examined were by contractors except for the gravity fed water supply SPs, which were implemented by communities.

- Degree of remoteness (with at least 50% of the selected sites being considered remote).
  – The degree of remoteness was rated as Not Remote, Remote, or Very Remote.
  – The SPs evaluated were judged as follows: 20% Not Remote, 48% Remote, and 32% Very Remote.
- There were 18 SP evaluated from Cycle 7, 23 SP from Cycle 8 and 19 SP from Cycle 9. The original fieldwork plan contained 20 SP from each cycle, but substitutions were necessitated by poor access conditions to several proposed SP. Substitutions were usually made in favour of locating another reasonably close SP of the same infrastructure type. Less regard was given to Cycle during substitutions.

7 Technical Design Quality – Findings

Following are the questions to be answered from the Terms of Reference and scope, with discussion and analysis presented for each item as appropriate.

7.1 What is the technical quality of the design? Have the "for construction" design drawings being signed by a qualified and certified Lao engineer to confirm that "the design complies with the Lao National Building Code" and or " the relevant standards, codes and building regulations of Lao PDR". Assess the as-built condition, based on a fair engineering judgment, as good, fair or poor based on list of key criteria to be developed for each major type of sub-project to be checked as basis for the technical quality assessment.

7.1.1 Technical Quality of Design

Village SP files were studied to verify that the appropriate documentation was present and properly completed. The village SP Implementation Committee was also questioned regarding the liaison that the PRF provided during the design and construction period.

Proper design drawings created by PRF staff, checked by qualified engineers and provided to the construction site are vital to properly executed SPs. **The technical quality of the designs was rated** by the TE team using Field Tool 1, under the item Design Completeness, which included a general appraisal of the construction documentation, design drawings and details for construction, and specification requirements. Following is a table showing how an aggregate of each province's files were rated, along with the total for all SP evaluated. The next table examines this data according to SP type.

Table 7.1.1.1 – Technical Quality of Design (aggregate of all SP evaluated) by Province

%	XKH	HPH	LNT	SVK	SRV	SKG	All SP
Good	60	80	60	70	70	70	68
Fair	30	20	40	30	30	30	30
Poor	10	0	0	0	0	0	2

Table 7.1.1.2 – Technical Quality of Design by SP Type

%	Building	Bridge	Water Supply	Road	Irrigation
Good	14	1	16	4	6
Fair	5	1	7	4	1
Poor	0	0	1	0	0

Discussion:

In the upper table above, **all provinces have a majority of SP designs rated Good**. Those with the lesser percentages (XKH and LNT) might choose to focus on improving this overall quality indicator with a concentrated effort to increase the quality of SP designs and documentation. Annex 6, Documentation, examines SP documentation in more detail and looks for regional trends.

Table 7.1.1.2 provides a good indication of which types of infrastructure require greater efforts in these regards. **Building and irrigation SP designs and documentation were generally considered Good**, while larger numbers of **water supply and half of the road SPs were deemed only Fair**. There is not enough bridge SP data to draw conclusions. A single water supply SP was rated as Poor (this is a diversion weir that has been destroyed).

One third and one half of water supply and road SPs, respectively, were considered only Fair in this part of the evaluation. A study of comments noted from the fieldwork shows that these low ratings are many times based on key missing information in the Sub-Project Proposal files. The items noted included incomplete or inaccurate survey (for both water and road SP); lack of construction details on drawing (building, water, bridge, road); incomplete drawings (missing important details of water and road SPs); no elevations on drawing (water); inadequate drainage design (road).

Recommendation 1: PRF should convene a technical sharing session where provincial engineering representatives meet to exchange ideas on how SP designs and file documentation can be improved, presenting examples. Focus should be upon water supply and road design issues, as well as improvements to the survey, design, documentation and delivery of the other sub-project types.

7.1.2 Design Drawing and Engineering Verification

A number of other design and construction process indicators were checked by the TE team at each SP site visited, including a check that all design drawings had been signed by an appropriate engineer.

Table 7.1.2.1 – Construction Drawing Signature (Aggregate of all SP evaluated)

	Yes	No
Construction drawings signed by appropriate PRF Engineer	86%	14%

Discussion:

The table above shows that most SP design drawings have been signed by the relevant PRF engineer, but not all (86%/14%). The PRF should strive to improve this and ensure that all designs have been carefully checked and signed-off by engineers knowledgeable in the specific SP type.

Recommendation 2 – PRF engineers must check and sign all design drawings for code compliance and verify that they have met the requirements of the recipient village.

Recommendation 3 – PRF engineers with specific experience and skill in water supply, irrigation and road building should be identified and used as National Experts where local talent may be lacking. SP plans, site photographs, calculations and BoQ should be checked by these individuals. Construction inspections by these National Experts should be planned for early in the construction period in order to ensure the plans relate and are appropriate to the site conditions.

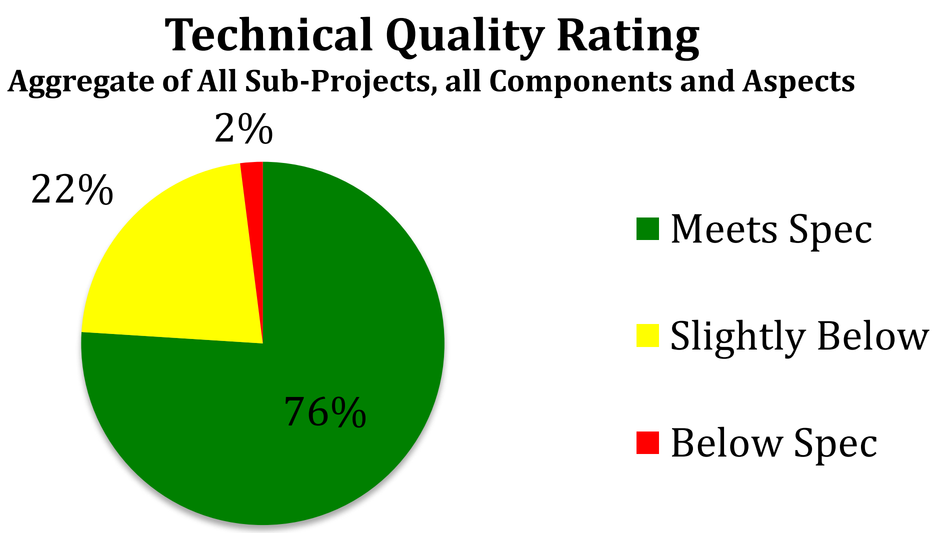
Recommendation 4 – Senior PRF staff should make it a practice to spot-check random villages for SP construction implementation filing. Field personnel will likely make improvements if they are aware of such verifications.

7.1.3 As-Built Condition Assessment

Field Tool 1 allowed each component or aspect of the individual sub-project types to be rated as being one of five choices: Meets Spec. (Specification); Slightly Below Spec.; Below Spec.; Not Inspected; and Not Applicable. The rating is a reflection of how the component/aspect has followed the SP specifications, the quality of its material composition/inputs, and its consistency with the bill of quantities (BoQ). Critical design elements such as toilet facilities, if dropped from a SP, would merit a Below Spec rating and, likely, a specific written comment on the field tool.

To understand how the entire PRF construction program is doing, on average, the technical quality ratings for all SP components and aspects can be aggregated. This procedure shows that **for ratings of technical construction quality, 76 % of the sub-projects have been constructed in accordance with the plans and specifications contained in the Sub-project Proposals and considered to Meet Specification,** with a further 22% rated Slightly Below in terms of meeting the intent of the sub-project proposal. Only 2% of technical ratings were Below Specification. The chart below represents this finding, using an aggregate of the ratings from all of the sub-projects evaluated.

Chart 7.1.2.1: Technical Quality Rating of Sub-Project Construction



The following table presents separate totals for each of the sub-project types evaluated. It should be noted that there were only two bridge sub-projects inspected during this technical evaluation so that extrapolation of these technical findings over PRF entire portfolio of this sub-project type may be tenuous.

Table 7.1.3.1: Summary of Technical Construction Quality Ratings by PRF Sub-project Type

	Meets Spec.	Slightly Below Spec.	Below Spec.
Building (19 sub-projects)	74%	25%	1%
Bridge (2)	82%	18%	0%
Water Supply (24)	87%	11%	2%
Road (8)	45%	47%	8%
Irrigation (7)	71%	25%	4%
Average (60 PRF sub-projects)	76%	22%	2%

Discussion:
Water supply and bridge sub-projects' components were found to Meet Spec 87% and 82% respectively. Building and irrigation SPs were below this, at 74% and 71%. Road sub-projects are the outlier, with an aggregate of all components meeting specification only 45% of the time.

A similar examination of the data can be done for all SP evaluated in each province, as shown in Table 7.1.3.2 on the following page.

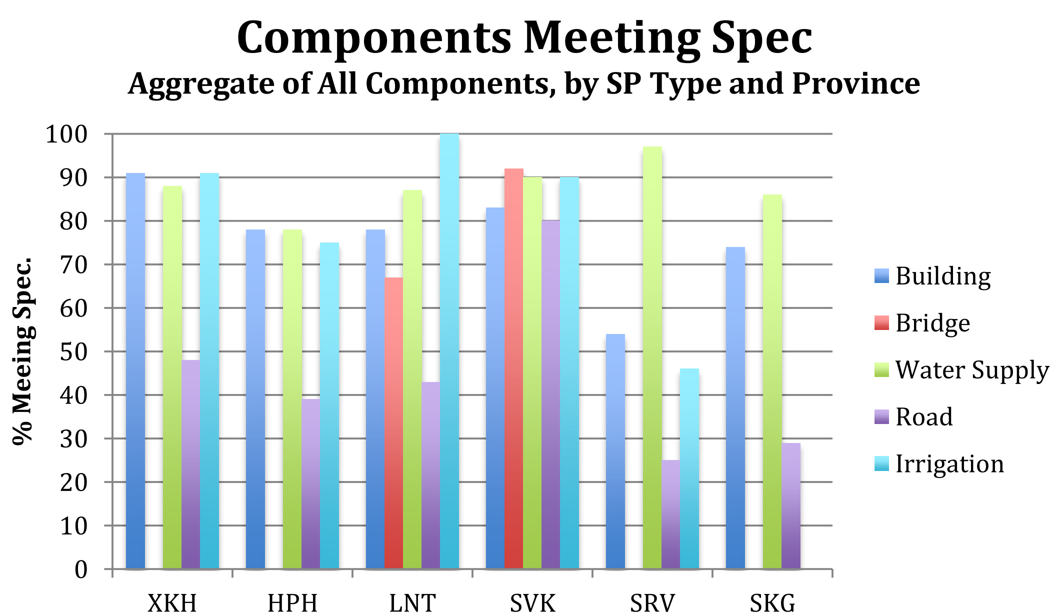
Table 7.1.2.2: Summary of Component Technical Ratings by Province

	Meets Spec.	Slightly Below Spec.	Below Spec.
Xiang Khouang (10 sub-projects)	80%	13%	7%
Houaphan (10)	74%	25%	1%
Luang Namtha (10)	80%	18%	2%
Savannakhet (10)	87%	13%	0%
Saravan (10)	61%	36%	3%
Sekong (10)	78%	21%	1%
Average (60 PRF sub-projects)	76%	22%	2%

Discussion:
The provinces where the Meets Spec percentage of SPs falls below 80% contain roads, and poor or failed irrigation works.

A further breakdown that can be depicted is the percentage of components/aspects that meet specifications shown for each SP type within each province. The data can be shown in a chart, although the information becomes quite dense (and undecipherable when printed in black/white).

Chart 7.1.3.2: Components/Aspects that Meet Specification, by Province



The chart above depicts the provinces in the order of evaluation. The technical evaluation team started in Xiang Khouang, completed the northern provinces, carried on to the south, and ended in Sekong. Several additional CSP were evaluated in Khamouane to complete the array of comparable infrastructure.

The data to produce charts of this kind is contained within spreadsheets that can be organized and sorted by Province, by SP type, by Cycle, etc. (an example of which is attached in Annex 7). It can be seen in Chart 7.1.3.2 that Saravan and Sekong have a visibly lower number of SPs with components that meet specification as compared to the other four provinces, even discounting the low aggregated totals for road SP across the country.

In Saravan, for SP types building, road and irrigation, the aggregate ratings for Meets Spec are low, at 54, 25 and 46% respectively. In Sekong, building and road are at 74% and 29% respectively. The reasons for these lower-than-average levels (averages for each SP type are in Table 7.1.3.1 above) are explored in Section 7.3, below. The Building average for PRF is calculated as 74% (which is heavily influenced by the 54% Saravan outlier). The reasons for these lower aggregated ratings can be discerned after carefully examining the specific components in each of these SP types that have received the low ratings. Low technical ratings can be influenced by design or construction/supervision issues.

The technical quality ratings can also be viewed in detail for each component of each SP, to understand how well each particular piece of the infrastructure has been constructed. If one is examining the data collected for a bridge SP, for example, the individual technical quality ratings for 14 different components can be reviewed, from Layout and Foundation to Connections and Apron/Ramp. Hypothetically, a detailed examination of the data from one bridge might reveal that the concrete foundation and reinforced column works were done poorly, while the upper wood assembly was done in a very good and proper fashion. This could show that local unskilled workers are familiar with woodwork but not with concrete, thus exposing a lack of proper construction direction and facilitation by a contractor or implementation committee. Notations to each individual SP data input sheet might be informative in regards to the particular circumstances at individual SP sites.

It is possible to aggregate the component ratings, so that one can identify general trends in the data gathered. For water supply SPs, for example, the ratings recorded for each of 14 components/aspects can be gathered and examined as a representation of the average quality rating of each component/aspect of PRF water supply SPs as a whole. It can be argued that an aggregate of the ratings from representative samples will provide insights into the whole group of SP types, and will point towards those parts of PRF's construction methodologies that most require improvements. The following table presents the aggregate of ratings from 24 PRF water supply SPs. Water supply SPs were rated using a list of 14 separate components and aspects. Table 7.1.3.3, below, presents an abbreviated list of water supply components/aspects. A full list of the components/aspects rated for each SP type is provided in Annex 3.

Table 7.1.3.3 – Technical Quality Ratings by Water Supply Components (all SP ratings aggregated)

	Meets Spec.	Slightly Below Spec.	Below Spec.
Water Source – Watershed Protection	86%	14%	0%
Water System Design	95%	0%	5%
Transmission/Distribution Pipe	65%	25%	10%
Reservoir – Easy to Clean	95%	0%	5%
Public Tapstands – Drainage	82%	18%	0%
Water Pressure and Quantity	50%	50%	0%

Another useful way of analyzing the ratings is to collect similar components from each SP type and aggregate their ratings for comparison. For example, one can examine the reinforced concrete aspects of SPs that use this construction methodology. A typical PRF new school building will feature the following reinforced concrete components: Foundation, Beam, and Column, while a new bridge will likely contain Foundation, Abutment, Pier/Support, Wingwall. Water supply and irrigation SP components also offer a number of uses of concrete. Gathering only these aggregated ratings for comparison will highlight those areas where improvements may be necessary. It can be seen in the following table that the PRF's use of reinforced concrete in construction is robust and not in need of great changes to the program.

Table 7.1.3.4 – Technical Quality Ratings by Reinforced Concrete Component (all SP ratings aggregated)

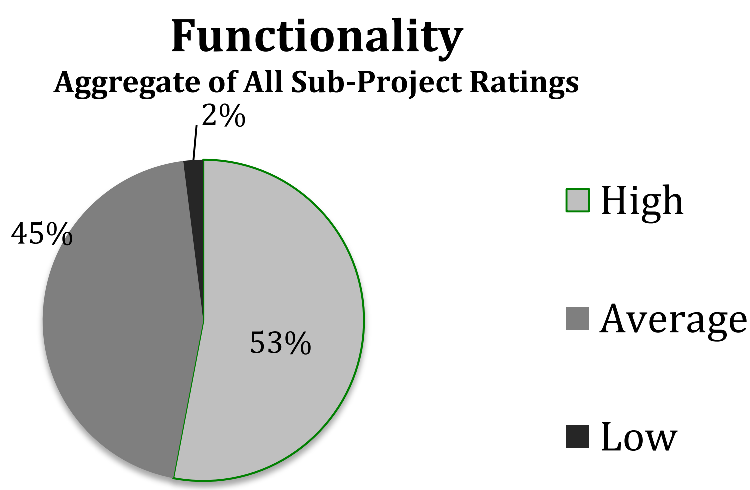
	Meets Spec.	Slightly Below Spec.	Below Spec.
Building – Foundation/Column/Beam (19 SPs)	96%	4%	0%
Bridge – Foundation/Abutments/Pier/Wingwalls (2)	91%	9%	0%
Water Supply – Concrete Reservoir (20 SP)	100%	0%	0%
Water Supply – Tapstand Platform (21 SP)	86%	14%	0%
Irrigation – Concrete Weir (3 SP)	100%	0%	0%
Irrigation – Channel Control Structures (4 SP)	75%	25%	0%

A full summary and analysis of the technical construction quality ratings for each component of each SP type is below, Section 7.3.

7.2 Is the design as constructed "fit for its intended purpose" in the view of the end-users? Were end-users consulted in the design of the facilities? Record the response of the end-users to these questions.

Functionality (fitness for intended purpose) is defined as whether or not the infrastructure is still operating as originally planned or intended, and is neither over nor under-designed. If the infrastructure has fulfilled the requirements of the recipients and is neither over nor under-designed, then a rating of 'Average' would be considered. A Good rating for this aspect of the evaluation is an empirical judgment, and might be represented by a SP where the recipient community or user group have independently added to, improved or used a SP in ways to increase its usefulness. Actions of this nature would be a very large vote of confidence in the original PRF works as the instigator of further self-directed community development activities.

Chart 7.2.1: Functionality, aggregate of all sub-project ratings



Examples of sub-projects that were rated High are as follows:

- A village hall in Chaleunxay Village, Chaleunxay Kum ban, Long District, Luang Namtha is used by all villages in the Kumban. The interior of the hall is well appointed with furniture for Kumban use. The villages perform maintenance duties on a rotating basis and there is a caretaker that safeguards the building.
- A three-room school in Khangkhao Village, Khangkhao Kumban, Houameuang District, Houaphan is being used by four villages, with a total of 301 students attending it on a regular basis. Classes are being taught in shifts to accommodate the great interest the surrounding villages have in securing education for their children.
- A water system in the village of Kape, Doup Kumban, Ta Oy District, Saravan has saved over one hour per trip for fetching water, allowing the villagers much valuable time to grow vegetables (using excess water) for their household consumption. It should be noted that this system has not been

over-designed (the collection basin and transmission pipe are normally sized) to provide these extra benefits to the community.

- An irrigation weir in the agricultural area of Phonexay Village, Youn Kum ban, Khoun District, Xiang Khouang replaced an old wood, stone and earth village structure. The concrete weir continues to function in an excellent and well-cared-for manner. The local farmers report that the weir has saved them hundreds of hours of yearly labour, allowing them to dig new and maintain existing irrigation ditching that serves paddy fields owned by many in the village. Yields have gone up, from 3.5 tonnes of rice per hectare to 4.5 or 5. O&M fees are collected and saved in a bank account for repair materials (labour is usually donated). Economic analysis of these benefits versus the cost of this infrastructure is necessary to fully confirm this SP's fitness for purpose.

A curious case is an irrigation SP in Pachoucheun village, Saravan. The irrigation weir has failed almost totally and in a somewhat spectacular fashion. This concrete weir replaced a traditional wood/earth dam that had been positioned at this location in the past, part of a Lao *Meuang Fai* traditional irrigation system. The concrete weir was constructed in Cycle 8, 2010, and failed within a few years.

The villagers have grown to depend upon irrigation infrastructure at this location. It has historically allowed them to raise the local stream's elevation to send water to their fields at critical times of the rice season. Villagers have returned to their old practices, blocking portions of the broken weir to raise water levels as needed during the rice season. The Low Functionality of this SP has not prevented the villagers from continuing their ancient irrigation practices.

The PRF should be studying this failure carefully to learn about the dynamics of strongly flowing streams and water's power to destroy poorly designed concrete structures. Monies should be found to build a properly designed weir here.

Discussion:

From the chart **it is evident that the majority of PRF infrastructures are fit for their intended purpose.** No cases were recorded where the evaluators considered the SP to be either under or over-designed in terms of the design standard that PRF used to provide benefits to villagers. A suitable number of SPs had been independently expanded or used in new ways that deserved, in the evaluator's opinion, a High Functionality rating. **There were no cases of over-built/under-used structures or infrastructure, which points to the PRF using appropriate and cost effective methods for meeting village needs and requirements**.

7.2.1 Design Consultation with End-Users

Villagers were questioned in regards to the PRF's consultation with them during the SP design period. **Fully 100% of village implementation committee members indicated that the PRF had spent time in their village to understand their needs** and requirements with respect to the SP under design. TE team members were encouraged to record the responses of the end-users to this question. Written commentary from the field tools was transferred to digital files and submitted for compilation. Annex 8 contains SP descriptions along with all submitted commentary.

Several comments were made by villagers, during the technical audit field training period in Xiang Khouang and Houaphan, regarding their appreciation of the PRF technical staff's efforts during the design of the SP. Many villagers confirmed that lengthy surveys and meetings had taken place to determine their village's precise requirements (this is particularly remembered during interviews for several water supply and irrigation SP villages). This indicates that consultation of this kind is basic PRF methodology throughout the country, something that deserves commendation.

7.3 What is the quality of materials/inputs and are these consistent with the BOQ and specification in the bidding documents?

The overall quality of inputs to the PRF construction program and their consistency with BoQ and specifications was assessed using aggregates of the technical quality ratings, in Section 7.1 above.

An analysis of the field evaluation technical quality findings, broken down by SP type and by component can also be done. Following is a detailed analysis of the technical quality ratings by SP type and selected component.

7.3.1 Buildings

Most of the buildings examined during this technical evaluation met the specifications set out for them (74%) or were considered Slightly Below (25%). For rating purposes the buildings were divided into 21 components/aspects that were individually assessed and rated. An examination of this data (see Annex 7 for sample spreadsheet of Building data) shows that those components/aspects most often considered Slightly Below Spec are as follows:

Table 7.3.1 Building Components/Aspects Considered Slightly Below Spec

Building Component/Aspect (19 SP)	Percentage of SP evaluated Rated Slightly Below Spec
Wall	28%
Floor	33%
Roof	16%
Plastering	39%
Doors and windows	56%
Toilet/Septic Tank	27%
Ramp for disabled	53%
Water	45%
Electrical	23%
Drainage	58%

Note: there are no significant building components/aspects that were rated Below Spec.

Discussion:

Walls and floors are considered slightly below specification if they are cracked. Cracks in these building elements are generally a result of slight settlements in the foundation or fill materials beneath the building. These types of failure generally reveal themselves within one year of construction, unless large changes are made to the landscape surrounding the building, altering drainage conditions, etc. Proper maintenance activities would see cracks cleaned out, patched and repainted.

Roofs can start to leak within a few years if they have been poorly installed or if other elements of the roof structure allow vibration in the roof sheeting during strong winds. Proper fasteners and attention to correct roof construction methodologies will prolong the life of galvanized sheet steel roofs.

Plastering was noted as being Slightly Below Spec when it was visibly rough, pitted or performed in a sloppy manner. It is common that PRF SPs are supplied with sand through Community Contributions. Local sand sourced by villagers is many times coarse stream or river sand. The use of this coarse sand in plaster creates a rough surface. Walls will attract dirt and will be harder to keep clean.

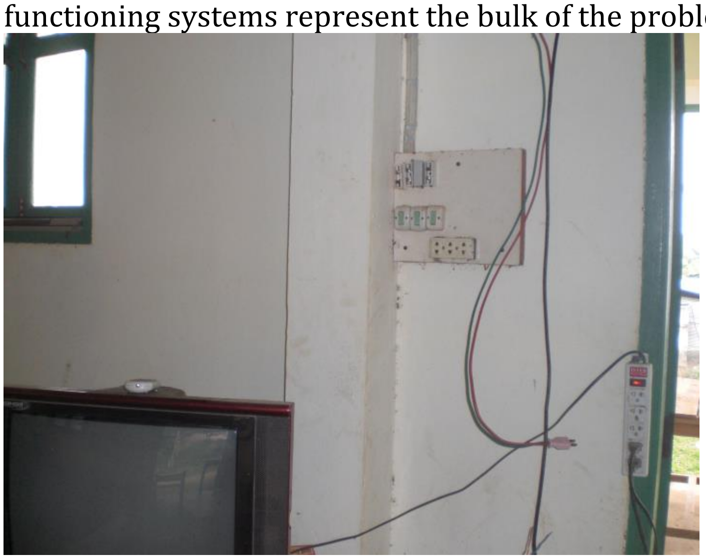
Doors and windows were frequently noted as being Slightly Below Spec (56% of SP). These ratings are directed at sagging and fractured panels that are only a few years old, or broken and malfunctioning doorknobs, locks and hinges. Properly constructed doors and window panels, using high-grade wood, should last a decade before needing major repair or refurbishment. The use of lower-grade woods, inadequate millwright techniques and inexpensive hardware serve to cheapen a building for its users.

> **Recommendation 5:** PRF should review the specifications for mechanical fixtures and compile a list of brands or manufacturers whose products consistently fail within short periods of time, putting them on a Non-Approved List.

Sanitation facilities had 27% of their components considered Slightly Below. Notes regarding this topic cited leaking pipes, broken faucets, poorly graded floors that have pools of stagnant water, exposed plastic pipe and poor access to septic tank for inspections and cleaning. Some plans featured inadequate septic tank designs. Septic tank should include two-chamber tanks draining toward a separate open-bottomed soak away pit.

Ramps and accessibility features for the disabled has been discussed in Section 7.7 – Universal Accessibility. Fully half of the buildings visited did not feature adequate UA measures.

Water supply connections to the buildings evaluated were deemed to be problematic in 45% of the SP visited. Comments on the field reports indicate that leaking or non-functioning systems represent the bulk of the problems with water supply.



Electrical services were at times found to be Slightly Below (23%). Some of these ratings were directed at the lack of electricity flowing (which may have been a lack of supply to the building and out of PRF's control), but some electrical installations have created hazardous conditions in school settings. An example is depicted in the photo to the left. This installation was likely done after PRF had completed its final inspection and so is also out of PRF's control.

And finally, **drainage** around the Building SPs was considered to be lacking in 58% of the sites visited. This finding is most often directed at ponded water in the vicinity of walking paths or stagnant pools around the school. The nuisance factor of stepping around puddles and the opportunity for breeding of disease vectors contribute to this low rating. Designers must take note to situate buildings high on sites and provide adequate drainage courses to guide storm runoff away.

It is noted that **reinforced concrete practices** at the PRF SP evaluated were uniformly well done. Access to some of the building attics was arranged when ladders were available. Unplastered concrete beams and columns were visible within these areas. Photographs show that all surfaces are well formed, with flat smooth sides and sharp corners. The concrete appears to have been well-mixed and placed, with no reinforcing bar visible at the surface. No honeycombing is visible.

The PRF building program has produced many fine schools, health clinics and other public structures. **No further specific recommendations for buildings are necessary**. Building program engineers and technicians should carefully review the findings of this evaluation, as described in the building components above, and make improvements to future infrastructures in areas noted.

7.3.2 Bridges

Foundation, abutment and wingwall design are fundamental to the integrity of a bridge structure and must be based on the actual condition of each individual site. National PRF expert engineers review all bridge designs that feature these components. Standard design manuals contain generic drawings and specifications, but these must be carefully chosen and fitted to each individual site. Additional features such as wingwalls, ramp, slope protection, etc. are added during the design stage based on the field survey. Foundation considerations are amongst the most crucial of decisions in bridge planning and design, carefully considering the nature of the underlying soils. Senior personnel should be consulted throughout the design process. Erosion protection measures must be carefully selected, designed, installed, and maintained. Ministry sectors should continue to be consulted and involved with these sub-projects, particularly since use of public equipment might be requested in the future for maintenance and repair activities.

Table 7.3.2 Bridge Components/Aspects Considered Slightly Below Spec

Bridge Component/Aspect (2 SP)	Percentage of PRF SP evaluated Rated Slightly Below Spec
Deck	50%
Handrail	50%
Connections (nails, bolts)	50%
Apron/Ramp	50%

Discussion:
There were only two PRF bridges evaluated during this assignment. Two of the Slightly Below ratings in Table 7.3.2 were for components of one of these SPs, two the other. The small sampling size should encourage the PRF to see these findings as helpful advice rather than failings of the PRF program. (The aggregate of all PRF bridge

ratings were 82% Meets Spec, 18% Slightly Below.) The technical sampling did not reveal any systemic problems with the PRF bridge program.

One of the wooden bridge decks evaluated during this assignment was in Nongkham Village, Luang Namtha. The original deck has deteriorated greatly along the middle of the walkway of this suspension bridge (see inset box, Section 10.6). Regular maintenance of the deck and cabling of a wooden suspension bridge should have been undertaken consistently through the years, using low yearly user fees. A refit of the scale that is presently contemplated should rarely be necessary if proper preventative maintenance is done.

It is noted that the Slightly Below rating for **connections** in Table 7.3.2.1 was recorded for this LNT bridge. Nails had been used in its construction, contributing to the deterioration and making the deck and railings harder to maintain.

Recommendation 6: The PRF engineers who are identified as experts in bridge design should continue their checks and verification of SP designs of this type. Site inspection visits before, during and after construction should continue.

7.3.3 Water Supply Systems

Similar to bridge SPs above, water supply sub-projects frequently involve specialized knowledge and experience. The relatively high quality of water supply SPs shows that senior PRF design/construction engineers have provided expert guidance, assistance and advice to PRF field personnel.

Table 7.3.3 Water Supply Component/Aspect Ratings

Water Supply Component/ Aspect (24 SP)	Percentage of PRF SP rated Slightly Below Spec	Percentage of PRF SP Rated Below Spec
System Design		5%
Source – Watershed protection	14%	
Reservoir – Ease of cleaning	14%	
Transmission pipe	28%	
Public tap – fixture/platform	14%	
Public tap – drainage	18%	
Water pressure/quantity	50%	

Discussion:
The total failure of the water supply weir in Phonhome, Xiang Khouang likely indicates that senior personnel did not spend enough time reviewing the **water system design**, both in the office and the field. The destruction of this weir and undermining of its transmission pipe happened during a normal rainfall event (i.e. not associated with a typhoon), so designers should have anticipated such an event. The selection of an

appropriate site for an in-stream weir is as important as a proper design in that location.

Watershed protection and plumbing provisions for **reservoir cleaning** are being included in most PRF water supply SP (86% included these items).

Water transmission pipes (that transports water from the catchment reservoir/tank to the village) have been constructed Slightly Below Spec in 28% of the SPs evaluated. Substandard work in this case normally consists of inadequately supported pipe (improper pipe stands), lack of cover over pipe (especially PVC), or poor assembly of the piping.

Public tapstands and platforms have generally been constructed in an appropriate fashion. Slightly Below ratings were assigned to 14% and 18% of these water supply installations, respectively. Imperfections were generally associated with faulty faucets, leaking pipes or poorly graded concrete platforms that allowed water to pool (a nuisance for users and potential breeding area of disease vectors).

Water pressure and quantity was identified as problematic at half the SPs evaluated. There is sometimes little that can be done about this, due to constraints presented by elevations of sources and spring-fed volumes fluctuating during the year. Engineers should be aware of this village concern and should work to ensure the installed systems are as leak-free as possible.

Recommendation 7: The PRF engineers who are identified as experts in water supply design should continue their checks and verification of SP designs of this type. Site inspection visits before, during and after construction should continue.

7.3.4 Roads

Road building is a very specialized and difficult trade. The PRF Operations Manual menu provides for rural road construction, extension and rehabilitation. PRF should approach any sub-project proposal for a new road opening or lengthy existing track widening with a large degree of caution. Proper road design requires detailed survey, a good knowledge of the local soils, and plenty of design experience.

The ratings of Slightly Below and Below Spec for road components and aspects are as follows:

Table 7.3.4 Road Component/Aspect Ratings

Road Component/Aspect	Number of PRF Sub-projects	Percentage of SP rated Slightly Below Spec	Percentage of SP Rated Below Spec
Foundation	8	50%	
Road surface – crown	8	50%	38%
Road surface – width	8	25%	13%
Road surface – compaction	7	57%	
Ditches	8	88%	12%
Culvert	6	67%	17%
Embankments – cut	7	71%	
Retaining wall – structural	3	33%	

Discussion:
Road Foundation conditions were found to be lacking in 50% of the SPs evaluated. The strength of a roadbed foundation is often linked to problems with drainage. Poor drainage will cause foundation soils to be weaker. As can be seen on line 5, roadside ditching was considered to be below specification in all road SPs evaluated.

Road surface issues – the shape and crown of the road; the width; and the placement and compaction of gravels – were rated slightly or below specification for between 38% and 88% of SP roads evaluated. Road sub-base soils must be excavated and shaped to form an adequate camber (providing a crown to the road surface), before placement of road gravels. Failure to do this will promote water pooling on and within the road gravels, softening the underlying sub-base soils.

The study of comparable SP for cost effectiveness (Section 8) highlighted some of these ideas. It was found that the KDP road SPs evaluated were roughly 3 times the cost of PRF roads on a unit basis. The KDP roads, however, were of a much higher quality than those of the PRF SP. Their surfaces are in very good shape as compared to PRF roads of a similar age. Care had evidently been taken during construction to properly shape the KDP roads, allowing positive drainage away from the road crown to ditches or grassed slopes on both sides. It is these investments that play a large part in the long-term viability of the road works.

PRF SP roads, however, display few areas where a proper crown still exists. Much of the road alignments improved during PRF SP works are returning to their former soft and muddy condition. Steep road sections are being ravaged by storm runoff. Low areas lack proper drainage facilities and are becoming boggy and soft.

Ditches – 88% of PRF SP are rated Slightly Below, with the remaining 12% Below Spec. Properly shaped and adequate roadside drainage is vital to the long-term stability of road surfaces. As described above for road surfaces, care and attention must be directed at ensuring roads are adequately drained. This component, almost more than any other, determines the viability of PRF road sub-projects.

Culverts also suffer from a lack of proper placement and design. 67% of the installed culverts are rated Slightly Below, with a further 17% considered Below Spec. Poorly located culverts become nightmares for maintenance crews, as they rapidly fill with silt and debris. Conversely, well-designed and properly constructed infrastructure simplifies maintenance activities and strengthens a road.

Cut slope embankments were found to be Slightly Below Spec in 5 of the 7 road SP evaluated (71%). These ratings identify those slopes that are greater than 1 vertical: 2 horizontal and normally already show signs of erosion. The construction of **retaining walls** is one solution to the problem of steep slopes, although one SP (of 3) was noted to have structural issues concerning such an installation.

In light of the apparent systemic nature of problems with the PRF road-building program, it is recommended that future road improvement sub-projects should concentrate on spot repairs and steep grade improvements. The spot repairs will normally be small drainage or bridging installations, with appropriate road approaches on both sides. Many rural road and track users will greatly benefit from sensible and well-designed spot repairs. Local low muddy areas where weather can hamper one's journey can be improved through sensible small structures that gather and transmit storm flows from one side of a road/track to the other. Such structures should be constructed wide enough that they will be able to accommodate future road widening improvements.

Steep grade improvements will frequently involve some form of hard surfacing. Sub-base preparation is important, but cambers can be reduced since stormwater runoff will be rapidly drained from such inclined roads. Drainage, however, must be properly handled, with armoured ditches alongside the road to catch, contain and control rapid flows. The installation of concrete wheel tracks on steep sections is a smart labour-based solution to slippery road conditions.

It was noted that retaining walls are not often specified for the retention of high cut slopes alongside PRF roads. Many road widening SPs feature such unprotected slopes. Drainage and runoff from the upper lands, many times forest, promotes erosion on these slopes. Vegetation and soil at the top of such steep slopes becomes saturated and frequently collapses – blocking the road and bringing a request from the community for heavy equipment to move the fallen earth. PRF plans should specify these cut slopes be protected with stone masonry walls (a spot improvement).

Recommendation 8: The PRF engineers who are identified as experts in road, drainage and retaining wall design should continue their checks and verification of SP designs of this type. Site inspection visits before, during and after construction should continue.

Recommendation 9: PRF SP menu should be altered to stipulate that road upgrades must normally be confined to spot improvements (drainage, culvert, small bridge, etc.) or steep road construction utilizing hard surfacing over short sections.

Recommendation 10: The PRF and Village SP Committees should ensure that the road construction foreman has prior road-building experience.

Ministry sectors should continue to be consulted and involved with these sub-projects, particularly since use of public equipment might be requested in the future for maintenance and repair activities.

7.3.5 Irrigation

There were 7 PRF irrigation SP evaluated during this assignment. Three of the schemes featured in-stream weir works, four were confined to improvements of existing canals.

Table 7.3.5 Irrigation Components/Aspects Ratings

Irrigation Component/Aspect	Number of PRF Sub-projects	Percentage of SP rated Slightly Below Spec	Percentage of SP Rated Below Spec
Design	3		33%
Water level controls	4	50%	
Culverts and pipes	1	100%	
Channel controls	4	25%	
Embankment – cut slope	4	25%	
Embankment – fill slope	3	33%	
Retaining wall – structural	4	25%	
Erosion protection	4	50%	

Discussion:
Irrigation design is a specialized field. As can be seen from the weir in Saravan (inset box, 7.2 above), the forces of nature can rapidly destroy installations that have not been designed correctly. PRF engineers should carefully study such situations to understand the reasons for the failure and to design more robust structures in the future.

Recommendation 11: PRF field personnel should ensure that local GoL irrigation departments are aware of new infrastructure and provide support to village O&M Committees.

Water level and channel controls, culverts and pipes associated with irrigation facilities are also strongly linked to design. The operation of water level controls is a very important aspect of irrigation SP, particularly with in-stream weir schemes. Again, PRF should involve GoL irrigation personnel with all SP of this nature in order to guarantee ongoing support to farmer user groups.

Embankments were identified as problematic on two sub-projects. The slope of irrigation embankments is critical to their long-term stability.

A single **retaining wall** was rated Slightly Below, associated with the failed weir in Saravan. This rating should likely have been Below Spec.

Erosion protection measures were rated Slightly Below in half of the irrigation SP evaluated. The design and installation of effective erosion control on slopes surrounding irrigation schemes is vital to the long-term viability of the facilities.

> **Recommendation 12:** The PRF engineers who are identified as experts in irrigation design should continue their checks and verification of SP designs of this type. Site inspection visits before, during and after construction should continue.

7.4 Did the sub-projects follow the technical specifications and scope as designed? Were any critical design elements, such as latrines, dropped?

Similar to 7.3, above, SPs were rated based on the technical specifications presented within the SP documentation. Should a SP have not followed the scope as outlined in the village documentation, a rating of Slightly Below or Below Spec would have been assigned as appropriate. The omission of critical design elements would normally spur a rating of Below Spec (and hopefully accompanied by a written comment).

Table 7.1.6, Summary of Technical Ratings by SP Type, shows that an average of only 2% of the components making up all SP types were considered to be Below Spec. (with a heavy weighting of these associated with road SPs). Considering that building SPs display an average of only 1% Below Spec, **it would appear likely that very few (if any) critical design elements have been omitted from site works**. **All schools and health clinics evaluated during this audit contain appropriate sanitary facilities where water supply connections exist (three schools and a clinic lack clean water).** It might be argued, however, that the high incidence of Below Spec components in road SPs is, indeed, due to the absence of critically important drainage works. This is not, however, a case of this infrastructure being 'dropped' from a design – PRF road designs typically feature very little drainage infrastructure.

7.5 What construction documentation exists to show that the sub-project meets the design and specification requirements? Has each end-user been provided with a complete set of As-Built Drawings?

Following is a table containing the aggregated results of the TE team's viewing of SP files and documentation.

Table 7.5.1 – Design Certification and As-Built Drawings

		Yes	No
1	Construction drawings signed by PRF Engineer	86%	14%
2	Final Inspection form (duly completed) and Hand-Over Certificate	90%	10%
3	As-built records in possession of Village Implementation Committee	93%	7%

Discussion:

Lines 1 and 2 above show that **a large majority of PRF SPs have been inspected and certified by the PRF Engineer or authorized personnel**, both at the design stage (**86% of design drawings are signed** by PRF Engineer) and at completion (**90% of SPs have a Final Inspection form** completed). Both of these steps confirm that appropriate actions have been taken to insure that SPs meet the design and specification requirements.

Line 3 indicates that **as-built drawings were found in 93% of the files inspected**. This is, again, a good indicator that engineering inspections have taken place and that confirmations of dimensions, material specifications and SP inspections have taken place.

7.6 Have all technical requirements been met and defects addressed before sub-projects are handed over to communities? Has a signed Hand-Over Certificate been prepared with a copy of the signed-off final inspection checklist attached?

Line 2 in Table 7.5.1 includes the confirmation that the TE team found duly completed Final Inspection forms in SP files. These forms are designed to highlight deficiencies in the construction that must be corrected before final sign-off. The successful completion of all items on the Final Inspection form prompts the creation of a Hand-Over Certificate. **90% of SP files evaluated contained these two documents, appropriately completed with dated signatures, indicating that the PRF inspectors were satisfied that construction deficiencies had been addressed and all SP requirements met.**

7.7 Did the sub-projects take into account DRM measures? If so, how?

The evaluation of SP documents included verification that DRM measures had been addressed during SP preparation. It was found that **only 17% of SP files contained DRM checklists** and measures. The largest number were found in Sekong, with 4 SP files containing these checklists and descriptions of risk management measures. Saravan (2 SP), Luang Namtha (2) and a single SP in each of Houaphan, Savannakhet and Xiang Khouang completed the forms. The PRF possesses DRM checklists for all SP types evaluated during this study.

The importance of these should be stressed to PRF field staff, along with a viewing of photographs of failed infrastructure due to major disasters. This evaluation has witnessed two weirs that failed during normal rainfall events. Designers must be made aware of the risks that are ever-present when planning infrastructure on or near watercourses.

Recommendation 13 – A DRM training course should be held to emphasize the responsibility of designers to more fully consider the forces of nature when planning rural infrastructures.

7.8 Sub-Project Overall Quality Ratings

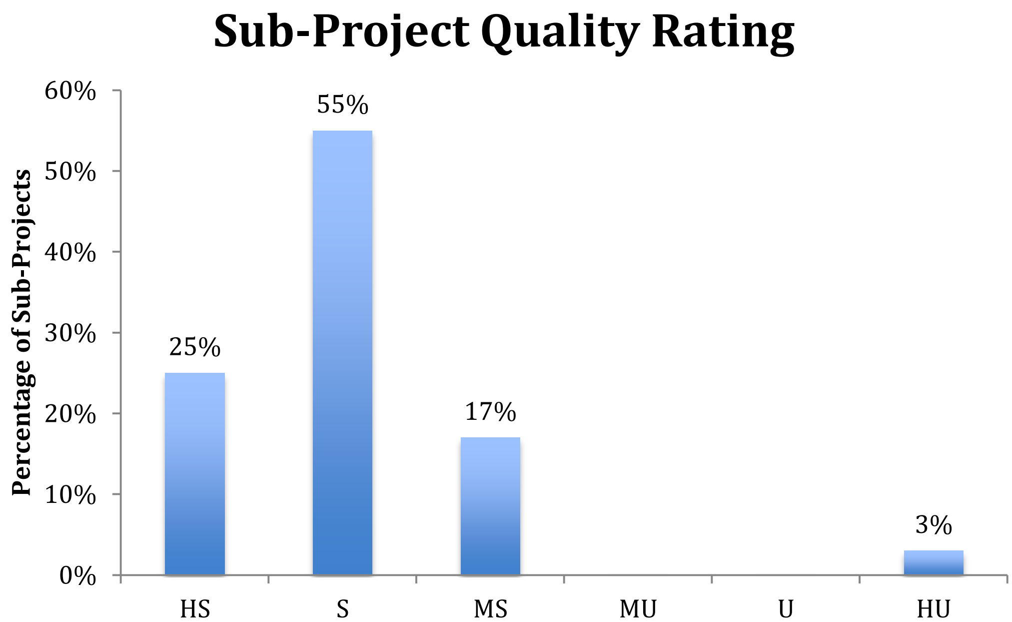
The second page of Field Tool 1 provides a section where the evaluator, having evaluated each of the components of the infrastructure itself (Section 7.1 above) and the SP Proposal (Section 7.4 above), can review the sub-project as a whole entity, taking into account the severity of imperfections or deficiencies in some aspects of the construction. The ratings are as described in the World Bank's six-point, as below, and are empirical in nature.

Table 7.8.1 – World Bank Rating system

1. Highly Satisfactory (HS)	Project fully complies with or exceeds policy requirements.
2. Satisfactory (S)	Minor shortcomings exist that do not have a material impact on compliance with policy requirements or achievement of development objectives and implementation progress.
3. Moderately Satisfactory (MS)	Moderate shortcomings exist that do not have a material impact on compliance with policy requirements or achievement of development objectives and implementation progress.
4. Moderately Unsatisfactory (MU)	Moderate shortcomings exist in compliance with policy requirements or achievement of development objectives and implementation progress but resolution is likely.
5. Unsatisfactory (U)	Significant shortcomings exist in compliance with policy requirements or achievement of development objectives and implementation progress and resolution is uncertain.
6. Highly Unsatisfactory (HU)	Major shortcomings exist in compliance with policy requirements or achievement of development objectives

Note : A complete listing of the SP evaluated and their individual WB ratings is provided in Annex 4.

Chart 7.8: Sub-Project Quality Rating



Most of the infrastructure examined during this evaluation was considered to be Satisfactory in its construction and documentation quality. A suitable number of sub-projects were rated as Highly Satisfactory.

The quality ratings under this section can be broken down by SP type and by province, as in the following tables.

Table 7.8.2 – WB Quality Rating by Sub-Project Type (Number of SP)

	HS	S	MS	MU	U	HU
Building	3	14	2			
Bridge		2				
Water Supply	10	13				1
Road		2	6			
Irrigation	2	2	2			1

Table 7.8.3 – WB Quality Rating by Province

	HS	S	MS	MU	U	HU
Xiang Khouang	4	4	1			1
Houaphan	6	4				
Luang Namtha	2	6	2			
Savannakhet	2	8				
Saravan		8	1			1
Sekong	3	7				

Discussion:

Building, bridge and water supply SP types were largely rated as Satisfactory or Highly Satisfactory. Only two buildings were rated Moderately Satisfactory and a single water system in Xiang Khouang where a poorly designed weir had failed was rated as Highly Unsatisfactory.

Road overall SP quality ratings (2 are Satisfactory and 6 Moderately Satisfactory) reflect the evaluation's concerns regarding under-designed drainage facilities. The absence of appropriate stormwater runoff infrastructure (ditches, swales, culverts, etc.) is worrisome and does not bode well for the long-term sustainability of these PRF investments.

Finally, the ratings for the irrigation SPs seem plausible. One of the HS irrigation SP was visited during the training period in Xiang Khouang and it deserves this accolade – a well-designed and totally appropriate small-scale irrigation infrastructure that replicates in reinforced concrete and earthworks the ancient Lao *Meuang Fai* system of rural water management. The spread of ratings, 2 HS, 2 Satisfactory and 2 MS is realistic (along with one HU as discussed in the box in 7.2, above).

7.9 Remoteness

The technical evaluation Field Tool 1 provided data fields where the evaluator could rate the degree of remoteness for a SP village. The degrees, their definitions, and number of SP for each are as follows:

Table 7.9.1 – Degrees of Remoteness and Sample Number of SP

	Definition	No. of SP
Not Remote	Close to a main road and within 30 minutes drive from District	12
Remote	Off main road; within 2 hours of District	29
Very Remote	Greater than 2 hours from District	19

The data were sorted to determine if a village's degree of remoteness played a significant part in the technical quality rating of a sub-project and its components. A hypothesis might be that the technical quality of a sub-project will go down as the degree of remoteness goes up, due to a number of possible factors: increased difficulty for technical facilitators to visit the site; reduced number of skilled labourers being available; increased difficulty in securing proper construction materials; etc.

In the table below, the aggregate percentage of "Meets Spec." component ratings for each individual sub-project type are shown for each degree of remoteness, along with the aggregate sum of all sub-projects evaluated. The aggregate percentages can be thought as representing the portion of SPs that were rated as meeting the specifications as set out in the SP proposals. The percentages do not add up to

100% across the table, since each column represents only those SPs in that degree of remoteness.

Table 7.9.2: Aggregate of "Meets Spec." components for SP Types vs. Remoteness (PRF SP only)

	Not Remote	Remote	Very Remote
Building	84%	71%	73%
Bridge (2)	67%	92%	-
Water Supply (24)	83%	88%	88%
Road (8)	-	47%	36%
Irrigation (7)	75%	76%	67%
All Sub-Projects	80%	75%	76%

So, for example, 84% of the Building components in Not Remote villages were evaluated as "Meets Spec" (in effect, 84% of the average building SP in Not Remote villages was constructed in accordance with the SP proposal). In Remote and Very Remote villages, this percentage falls to 71 and 73% respectively. The SP types Road and Irrigation also show this trend of decreasing quality with increasing remoteness. Water supply SP are similar in quality regardless of remoteness, and there were too few bridges evaluated to make a judgment.

Recommendation 14: PRF III should consider allocating additional resources to those districts with greater numbers of remote or very remote villages.

7.10 Project Cycles 7, 8 and 9 (2009, 2010 and 2011)

Spreadsheets were sorted to determine if there are any apparent trends in technical quality based upon when the SP was constructed. The main difference that might influence technical aspects of SPs according to cycle is the frequency and quality of technical facilitation and supervision (assuming that quality of material supply and local skilled labour remain the same). The influence of technical facilitation was not studied closely during this technical evaluation because of the number of years that had passed since construction. Memories fade and written records of technical facilitator visits to SP sites have often been misplaced.

There were 18 SP evaluated from Cycle 7 (2009), 23 SP from Cycle 8 (2010) and 19 SP from Cycle 9 (2011). In the first table below, all PRF SPs evaluated are analyzed by construction cycle. The following tables present each SP type shown separately.

Table 7.10.1: Aggregate of ratings for all SPs, all components

	Meets Spec	Slightly Below	Below Spec
Cycle 7 (18 Sub-Projects)	72%	27%	1%
Cycle 8 (23)	82%	17%	1%
Cycle 9 (19)	74%	23%	3%

Table 7.10.2: Aggregate of ratings for all Building SPs, all components

Building SPs	Meets Spec	Slightly Below	Below Spec
Cycle 7 (6 Sub-Projects)	77%	22%	1%
Cycle 8 (6)	80%	19%	1%
Cycle 9 (7)	67%	33%	0%

Table 7.10.3: Aggregate of ratings for all Bridge SPs, all components

Bridge SPs	Meets Spec	Slightly Below	Below Spec
Cycle 7 (0 Sub-Projects)			
Cycle 8 (2)	82%	18%	0%
Cycle 9 (0)			

Table 7.10.4: Aggregate of ratings for all Water Supply SPs, all components

Water Supply SPs	Meets Spec	Slightly Below	Below Spec
Cycle 7 (6 Sub-Projects)	85%	15%	0%
Cycle 8 (7)	86%	14%	0%
Cycle 9 (9)	87%	9%	4%

Table 7.10.5: Aggregate of ratings for all Road SPs, all components

Road SPs	Meets Spec	Slightly Below	Below Spec
Cycle 7 (4 Sub-Projects)	56%	39%	5%
Cycle 8 (1)	42%	29%	29%
Cycle 9 (2)	28%	61%	11%

Table 7.10.6: Aggregate of ratings for all Irrigation SPs, all components

Irrigation SPs	Meets Spec	Slightly Below	Below Spec
Cycle 7 (2 Sub-Projects)	60%	40%	0%
Cycle 8 (4)	92%	8%	0%
Cycle 9 (0)			

Discussion:

The first table shows that for an aggregate of all SPs evaluated, the technical quality of construction has not fluctuated in any distinct trend with the cycle in which the SP was constructed.

This lack of apparent trend is not, perhaps, surprising. The PRF's Engineering Department is a mature organization with embedded methods and individuals who have performed project tasks for a number of years. The technical quality of water supply SPs, in Table 7.10.4 for example, has remained remarkably stable – 85%, 86% and 87% Meets Spec – over the three construction cycles evaluated. Irrigation SPs show some marked improvement, but the sample size was small and one utter failed SP moved Cycle 7 numbers downward.

Worthy of highlight, however, are the road SPs evaluated. These show a distinct downward trend that should be carefully examined by the PRF. Recommendations have been made within this report that will realize improvements to these ratings for road SPs.

7.11 Universal Accessibility

Universal accessibility (UA) is the concept that public infrastructures and services should be designed and constructed to be inherently accessible to older people, people without disabilities, and people with disabilities.

The addition of UA facilities to public buildings can often be done for approximately 1% of the infrastructure's total budget. The PRF Engineering Department has confirmed that the addition of a concrete ramp (and a railing should the ramp be steeper than 5%) will add this small amount to one of their typical budgets.

Recommendation 15: PRF III engineering design guidelines should consider including explicit provisions for UA to buildings and public infrastructure.

Recommendation 16: Ramps for the disabled are an important feature to guarantee Universal Accessibility to public infrastructure. Ramps should not be constructed steeper than 16% (wheelchair accessible with helper) and should feature a rough/non-slip surface. Ramps steeper than 5% should be equipped with a proper handrail.

8 Cost Effectiveness

The technical evaluation of PRF SPs and comparable sub-projects (CSP) used Field Tool 3 for gathering information that would aid in determining the cost effectiveness of the investments. The instrument provided numerous data fields for key infrastructure financial information, dimensions, materials and construction management costs. Technical evaluators examined SP/CSP file resources at the site, village and district/province levels to complete these checklists, as well as physically measuring the rural infrastructures. The creation of spreadsheets containing all of this information has allowed comparisons to be made and conclusions drawn in regards to the cost effectiveness of investments in PRF SP versus those made in comparable infrastructures by others.

The Cost Effectiveness field tool was unique for each type of SP (Building, Bridge, Water Supply, Road and Irrigation). The Building data sheet, for example, required length and width of the building, number of rooms, type of materials used, etc., while Water Supply required length and size of pipe, size of reservoirs, number of tapstands, etc. A portion of the field tool, pertaining to standard SP costs, was common to all SP types.

Following is a table showing the number of PRF SP versus the CSP evaluated by the technical evaluation teams.

Table 8.0.1: PRF and Comparable Sub-projects by SP Type

	Building	Bridge	Water Supply	Road	Irrigation
PRF SP	19	2	24	8	7
CSP	21	2	10	2	3

It can be seen that the field data gathered during this evaluation for Building and Water Supply SP types will be more reliable than that collected for the other SP types, due to the smaller sampling size accorded Bridge, Road and Irrigation. Comments below will reflect limitations that should be placed upon any analyses of these types.

Following are the questions to be answered from the Terms of Reference, scope and subsequent instructions, with discussion and analysis presented for each item as appropriate.

8.1 How does the unit costs compare between the PRF sub-projects and comparable infrastructure built by GoL or other projects? Care should be exercised and the report should demonstrate that only comparable cost items are assessed across different investments; and for the assessment of cost effectiveness, please assess the impact of distance to market/district centers [Additional criteria from email comments, Feb. 23, 2016].

All SPs were evaluated for cost effectiveness using Field Tool 2. This instrument is unique to each SP type and contains an array of data fields that are completed as per the conditions at each infrastructure. The data fields offer choices for construction materials (is the building structure constructed of wood, concrete, steel? Is the water pipe PVC or steel?); infrastructure size (outer dimensions of building, size of reservoir, width of irrigation weir); number of rooms, tapstands or culverts; length of irrigation canal; etc.

Costs and budget breakdowns were also noted, where the information was available, in order to allow comparisons to be made.

8.1.1 Building Sub-Projects

Building data was gathered at 19 PRF SP and 21 CSP sites. Spreadsheets of this aggregated cost effectiveness data were developed and detailed analysis performed. Almost all buildings evaluated were constructed using reinforced concrete columns and beams, wooden trusses and steel roofs. Several CSP buildings utilized steel trusses and tile roofs (the higher costs for these CSP were discounted from the aggregates used to develop unit costs below).

Building square footage costs were calculated based on data usually drawn from village SP Proposal files. Some information was gathered at other project offices, mainly PRF district or provincial headquarters. All buildings examined during this technical evaluation were new constructions, there were no building rehabilitations evaluated. Budgets include taxes and community contributions, as well as all costs for materials, transport, labour and other inputs.

PRF building construction costs lie mostly between 1,300,000 and 3,100,000 Kip/sq.m. (of 19 PRF SP visited). There are two outliers at 1,100,000 and 4,.2M Kip/ sq.m.. The outliers were discounted which produced an average of **2.4M Kip/sq.m.**

CSP building construction costs lie between 1,000,000 and 4,700,000 Kip/sq.m. with one outlier discounted at 6,600,000 Kip/sq.m. The average of CSP buildings (21 evaluated) is **2,600,000 Kip/sq.m**.

The foregoing calculations are based on the entire sample of buildings evaluated from PRF's portfolio and those CSPs viewed. It is known, however, that the distance from a district town is a strong determinant of the unit cost of buildings. The following table demonstrates the trend for higher costs in more remote villages.

Table 8.1.1.1 – Unit Cost for All PRF Buildings by Remoteness (Kip/sq.m.)

	Not Remote	Remote	Very Remote
PRF	1,750,000 (2 SP)	2,000,000 (8 SP)	2,457,143 (7 SP)
Comparable	2,900,000 (7 CSP)	2,300,000 (6 CSP)	2,200,000 (6 CSP)

Discussion:
The higher PRF unit costs borne by more remote villages is readily apparent in Table 8.1.1.1. The variance for the Remote and Very Remote villages is large (High/Low of 2,900,000/1,100,000 and 4,200,000/1,300,000 respectively). One PRF outlier of Not Remote, 2,300,000 kip/sq.m. for a somewhat ornate village hall, was discounted.

The averages for the CSP buildings by degree of remoteness do not make sense and limited data gathered from these sites makes it difficult to explain the paradox of more remote building costing less on a unit basis than those that are not remote. A study of the technical data and photographs of the infrastructures, both PRF and CSPs, does not reveal telling variances in materials or methodologies (except for the two CSPs that used steel trusses and tile roofs). It does seem likely, from studying the CSP information in Table 8.1.1.1, that the CSP buildings visited in Not Remote villages are not comparable to PRF's works in some way that was not captured in the field instruments.

Purpose-built buildings for health and community hall uses are more expensive than the utilitarian buildings created for school or dormitory use. The health/hall buildings were discounted from the unit cost data with the following results for schools only in Table 8.1.1.2.

Table 8.1.1.2 – Unit Cost for Schools by Remoteness (Kip/sq.m.)

	Not Remote	Remote	Very Remote
PRF Schools	1,750,000 (2 SP)	1,660,000 (5 SP)	1,925,000 (4 SP)
Comparable Schools	2,900,000 (6 SP)	1,800,000 (5 SP)	2,300,000 (5 SP)

Discussion:
The same trend as observed in Table 8.1.1.1, with greater unit costs for SPs in more remote locations, does not hold for schools in Not Remote and Remote locations (although the sample size is small for Not Remote). Very Remote schools are more expensive. The CSP evaluated during this study are shown to be more expensive on a unit basis than PRF school-building SPs. A study of the SP and CSP photographs tends to indicate that many comparable schools have been developed to a higher standard than some PRF schools, which may explain the much higher unit costs calculated for the CSPs in the table above.

It would appear from this analysis that PRF costs for building construction are in line with those by other agencies. It is noted that several of the comparable building SP utilized steel trusses and tile roofs, moving these CSP up in unit cost. Discounting the five buildings that used such materials, the **CSP average drops to 2,200,000 Kip/sq.m**. (slightly lower than PRF costs).

The PRF SP have been subject to taxes due to the use of contractor implementation modality. If PRF were to shift to community force accounts for construction this taxation would be avoided. Examinations of the CSP building costing paperwork was not consistent and it was difficult to confirm if they were subject to taxation, although it is considered likely that they were.

8.1.2 Bridge

There were only four bridges evaluated by the teams, two PRF SP and two CSP. There are key differences in each of the bridges evaluated in terms of size and materials used in construction. There was one PRF suspension bridge; one PRF reinforced concrete substructure/wood deck vehicle bridge; one entirely wooden, wider bridge by KDP; and an entirely concrete vehicle bridge by CIDA.

The suspension bridge has been constructed 1.2 m wide and is intended for pedestrians and motorcycles. The PRF concrete/wood bridge is 3.1 m wide and intended for small four-wheel vehicles, whereas the two CSP bridges are 4.0 m wide and are able to accommodate larger trucks. There is little to be learned by calculating unit area costs for bridges that are so different.

8.1.3 Water Supply

Water supply SPs by both PRF and other agencies were divided into two types of systems: gravity-fed piped systems and drilled boreholes. The materials used for the construction of these systems was very similar between PRF SPs and the CSPs viewed.

PRF water supply construction costs for gravity-fed systems lie mostly between 1,600,000 and 5,200,000 Kip/HH (of 13 PRF SP visited). There are two outliers at 6,300,000 and 9,800,000 Kip/HH. The average for **PRF water supply SP** is **2,600,000 Kip/HH**.

CSP gravity-fed water supply construction costs lie mostly between 700,000 and 2,400,000 Kip/HH (9 evaluated); one outlier was discounted at 11,000,000 Kip/HH. The average of water supply CSP is **1,250,000 Kip/HH**.

It can be seen from this calculation that there is a greater than two-fold cost difference between PRF rural water supply constructions and those of comparable organizations.

A study of the data and photographs of the PRF SP and CSP indicates that PRF infrastructure is of a generally higher caliber than the CSP evaluated. A key statistic in this regard is that PRF water supply systems provide one tapstand per 12 families (households) on average, while the CSP figure is 21 HH/tapstand. This indicates that other agencies typically lay approximately half as much pipe within villages as does PRF. It should be noted that the Water Partnership Program of the WB recommends that public faucets serve 4 to 6 HH (WPP, Rural Water Supply, Design Manual, 2012).

Another large determinant of cost/household for gravity-fed water supply systems is the length and diameter of pipe used to bring the water down from the mountain source. Information in regards to these important costs were easily accessed from PRF village SP files. The comparable water supply SP visited were not able to provide this information. Evaluators entered some estimates of length and sizes of pipe but did not complete the data input sheet as thoroughly as for PRF SP. Analysis of this facet of water supply SP in order to make comparisons is difficult and error-prone.

The PRF water supply SPs evaluated were predominantly gravity-fed systems (21 gravity systems vs. 3 groundwater hand pump systems). The CSP were 6 gravity-fed and 4 hand pump systems. The CSP organizations for gravity-fed were Danish Red Cross, Austrian Red Cross, two by Helvetas, and two by Government of Laos (GoL); and boreholes were installed by UNICEF, Helvetas and two by GoL.

Costs for village groundwater hand pump systems are sometimes difficult to compare, as borehole costs can vary greatly from location to location. The four **CSP drilled well/hand pump averaged 29,425,000 Kip/hand pump** (lowest was 18M, highest was 39M). Two boreholes in Kum ban Vongsikeo, Savannakhet were completed by **PRF for 25,000,000 Kip/hand pump.** Two other PRF SP of this type, however, spent 53M and 151M Kip/hand pump, so it is apparent that the difficulty of finding groundwater at reasonable depth is a large determinant of the cost effectiveness of this type of SP.

A study of the remoteness effect on unit costs of PRF water supply SP is shown in the following table.

Table 8.1.3.1 – Unit Cost for PRF Water Supply Systems by Remoteness (Kip/HH)

	Not Remote	Remote	Very Remote
PRF Water Systems	1,950,000 (2 SP)	3,110,000 (10 SP)	3,828,000 (7 SP)

Discussion:
The awareness that SPs in more remote locations cost more is reflected in the data gathered during this evaluation. The two water systems in Not Remote locations are, perhaps, not totally representative of PRF's larger portfolio and may show an average cost less than a larger sampling. A similar study of the data from CSPs has

not been done since it has already been shown that these other agencies supply villages with less than half the water infrastructure as does the PRF.

8.1.4 Road

There were 8 PRF and 2 CSP roads evaluated. The CSP roads were both by implemented by the Khammounane Development Projects (KDP).

PRF road construction costs lie mostly between 2,200 and 14,200 Kip/sq.m. (for 7 PRF SP visited). There is one outlier at 25,000 Kip/sq.m. The average of the **PRF road SP** is **7,700 Kip/sq.m**.

The two CSP road construction costs on a square meter basis were very similar, 20,004 and 22,024 Kip/sq.m, averaging to **21,015 Kip/sq.m.**

Photographs were taken of all SP evaluated. It is apparent from viewing these photos that KDP has achieved a higher quality of final product. The KDP road photographs, such as that below, display well-graded gravels placed on a properly shaped road base. Examining this picture, one can discern the substantial amount of

KDP Road Sub-Project in Thadeua, Kumban Sikhod, Thakhet District, Khammouane road base and surface materials that have been imported to create this raised alignment. The elevation to which this road has been constructed promotes quick and effective drainage to both sides and away from the travelled surface. Stormwater runoff rapidly drains from the road with no pools left to become mud.

Many PRF SP roads are punctuated by muddy or deeply rutted sections where the construction of drainage infrastructure as part of the SP works would greatly improve the passage of pedestrians, bicycles and motorcycles (surely a large percentage of user groups for most PRF roads; no traffic counts are available). The cost effectiveness of PRF's investment in roads is negatively affected by the lack of drainage structures to transmit ditch and overland flows across the roadway in an effective manner.

To the left is a drainage culvert crossing the same KDP road as in the previous photograph.

One can see that the road maintenance committee have spent much time removing grass and cleaning this accessible and well-designed culvert/ head wall/apron installation.

A study of the culvert data returned from the evaluations was done to understand PRF road SPs' use of this vital aspect of road infrastructure. The following table shows the distance between PRF and CSP road crossing drainage culverts, derived from the data gathered in the Field Tools 1 and 2. In order to calculate the average distance between PRF vs. KDP culverts, the total road length was divided by the number of culverts plus one. For example, in the first line of Table 8.1.4.1, overleaf, the road in Tasoum village has three culverts along its length. Therefore, dividing the 4,000 m length by four (3+1) produces an average distance between culverts of 1,000 m. The single KDP road where culvert data was reported is the second-shortest distance between drainage structures, as compared to the great majority of PRF road SPs.

The average distance between road drainage culverts is an indicator of the amount of attention given to this basic requirement of road works. As derived in last column of Table 8.1.4.1, the greater the distance between culverts, the lesser the number of drainage infrastructures per metre of road. The cost effectiveness of road SPs goes down as drainage infrastructure is reduced (see Table 7.1.6, where PRF road SP type has the lowest aggregate totals of components/aspects meeting specification).

Table 8.1.4.1 – Distance Between Drainage Culverts, all PRF road SPs

Village	Kumban	District	Prov.	Length of Road	Number of Culvert	Average Distance between Culverts (m)
Tasoum	Pakkhan	Vieng Phoukha	LNT	4000	3	1,000
Nameuang	Xiengluang	Viengxay	HPH	775	No Data	
Houeihou	Muang	Houameuang	HPH	3000	4	600
Houay Na	Keo Bone	Nong Haed	XKH	6800	1	3400
Phalin	Keopatou	Nong Haed	XKH	12000	3	3000
Palienglao	Khoum 7 Asing	Nong	SVK	8400	0	8400
Talor Tai	Talor	Samuay	SRV	12850	1	6425
Dakdom	Daktaok	Dakchueng	SKG	4000	0	4000
Comparable – KDP						
Thadeua	Sikhod	Thakhek	KMN	1436	1	718
Namdone	Namdone	Thakhek	KMN	2500	No Data	

Discussion:
It can be seen that PRF road SPs in four of the six provinces exhibit very much less infrastructure directed toward road drainage and culvert installations. A viewing of the photographs confirms that the road SPs evaluated in Xiang Khouang, Savannakhet, Saravan and Sekong Provinces have numerous low and wet, or steep and gully-scarred sections of road that are difficult to pass. The proper installation of road drainage works is necessary to avoid the problems frequently observed on PRF roads. **Poor drainage contributes to rapid deterioration of roads and results in lower cost effectiveness.**

The argument for the PRF to concentrate on spot repair and steep road works to increase the cost effectiveness of the PRF road investments may deserve a more in-depth empirical study. PRF road works currently feature about half as spot improvements (although none were represented in this evaluation's sampling), so further study of this issue should compare the cost effectiveness of lengthy road improvements with local spot repair/steep road works.

Notwithstanding the voiced satisfaction by the user groups, this report's recommendation to redirect PRF road building efforts toward spot repairs and steep road works is done with the awareness that it is these two areas where the majority of PRF road SPs meet with difficulties. Other sections of PRF road works are generally simple small earth cuts or fill placement for track widening purposes. These sections of proposed track improvement SPs can be fully implemented by the villagers as their community contributions, while the PRF can concentrate its engineering resources on the proper design and installation of appropriate culvert structures at low points and hard surfacing/drainage works on steep roads.

8.1.5 Irrigation

There were 7 PRF irrigation SP and 3 CSP evaluated. The CSP were all sponsored by KDP.

The **PRF irrigation** construction costs were between US$413 and US$2,493/hec., with an average of **US$1,145/hectare**.

Comparable SP averaged **US$1,125/hectare**.

Irrigation SP are, by their nature, each quite unique. The various components of irrigation facilities are necessarily designed to fit the conditions of each site. They may feature embankments, weirs, erosion protection measures, water level control structures, and canals on one or both sides. Each is designed to suit its site.

Advice from a long-time consultant to the Lao office of ADB (JR Rinfret, P.Eng.) indicates that normal costs for irrigation schemes in Lao PDR can be from US$1,200 to $5,000/hectare, depending upon their size. The lower unit figure would apply to the average size of PRF irrigation command area (an average of 16 hec.). The average size of the KDP irrigation command area is 21 hectare.

A study of the remoteness effect on unit costs of PRF irrigation SPs is shown in the following table. It can be seen that the sampling was perhaps too small to draw firm conclusions about this hypothesis.

Table 8.1.5.1 – Unit Cost for PRF Irrigation Systems by Remoteness (US$/Hectare)

	Not Remote	Remote	Very Remote
PRF Irrigation	735 (3 SP)	1,929 (3 SP)	809 (1 SP)

In summary, however, and although the number of irrigation CSP evaluated was small, it can be seen that the **PRF investments in irrigation rural income-generating SP are cost effective**.

8.1.6 Summary of Unit Cost Analysis

In summary, the unit costs for PRF buildings, drilled borehole water supply systems and irrigation schemes are competitive with comparable agencies' works and therefore are cost effective. Factoring in the local labour and material contributions increases the cost effectiveness of PRF sub-projects – the total cash investment required from the government for the infrastructure is less as a result of the local contributions.

Gravity-fed water supply systems are approximately twice as expensive as CSPs on a per-household basis. The cost effectiveness of the PRF systems, however, is revealed when examining the number of households sharing tapstands within recipient villages. The PRF systems generally supply about half the number of households per tapstand as the comparable systems (where lesser numbers of households per tapstand is a good thing). PRF systems are not over-designed, however, as WPP standards call for a lower number of households per tapstand on an ideal design basis.

Road SP unit costs are less than half of another rural development project, KDP. The cost effectiveness of these PRF investments is debatable, however, as the quality of the roads and their long-term durability is a concern.

8.2 Which specific designs, materials and processes may be altered to reduce the unit cost of PRF SPs without significantly reducing quality or benefit?

The unit cost data as developed in 8.1, above, indicates that there are few areas where the PRF can make specific changes to its design/construction program to reduce the unit cost of PRF SPs without reducing quality or benefits of the infrastructure.

It has been shown that the unit cost of PRF buildings is close to that of numerous comparable agencies. No large changes to PRF's building program are warranted based on the sample evaluated.

The data for the bridge program of PRF as compared to structures by others was limited. The bridges that were sampled for this evaluation were not actually comparable. A broader study with careful selection should be undertaken if conclusions are to be drawn in regards to this type of infrastructure.

Water systems are always unique in their layout and construction. PRF systems have a unit cost approximately twice that of comparable systems, but it is noted that PRF's density of tapstand/household is more than twice that of the other agencies. It can be argued that little is to be gained by reducing the size or lengths of PRF system components. The technical evaluation team did not note any extraneous pieces of infrastructure that could feasibly be reduced or eliminated.

The PRF road program should undergo changes to redirect investments toward more sustainable infrastructure works which will increase cost effectiveness. More discussion on this is offered in later sections of this report.

The PRF irrigation unit costs are in line with other Lao government and private projects. No changes to reduce unit costs are warranted.

In conclusion, there are **no materials or methodologies that were noted during this technical evaluation of the building, water supply or irrigation SP types that could be changed or altered to increase the cost effectiveness of the PRF investments**. This conclusion should not be surprising, since PRF engineers, technical personnel and advisors have wide experience in many different capacities, learning of the best and most cost effective materials and methods available. PRF's construction program has matured over the years, and it is evident from this study's comparison of unit costs that little further change is urgently required.

It is recommended, however, that the works associated with **future road SPs be focused on spot improvements and steep road works** to increase the longevity of this type of infrastructure and thus the cost effectiveness of PRF's road program.

8.3 Are investments implemented through community force account (CFA) more competitive than those implemented by contractors, when the cost of capacity development and supervision, tax liabilities, and the cost and quality of O&M, are taken into account?

There were no CFA construction modality SPs evaluated.

8.4 Are there community contributions, and if yes, how much were they, how were they calculated, what forms did these contributions take and what percent of total costs?

Local community contributions to PRF SPs are recorded in the village sub-project implementation files. Almost all local contributions were made through the provision of labour and materials. There was a single cash contribution noted in the files of a village in Xiang Khouang. **The average community contribution to a PRF SP is 14% of the infrastructure's total budget.**

Details of the labour and material contributions can be found in PRF forms and in attachments that provide the name of the labourer, the nature of the labour or the type and quantity of materials supplied, and the date of such work. **Labour contributions are often for excavation; supply of sand, gravel or stone; general construction activities**; etc. Numbers of manpower hours on specific days are recorded, along with calculations of daily contribution amounts based on hourly wages and typical market values for materials.

8.5 Where community contributions are expected in the sub-project documents,

8.5.1 Did the contributions actually occur and were they accounted for properly?

TE team members studied the SP files at the village level to see if there was evidence of PRF personnel checking and signing-off on information in forms and labour summaries. The following table provides information in regards to community contributions. Each line represents data from the 10 SP evaluated in each province. The final line sums up the full SP sampling for the country.

Table 8.5.1 – Community Contributions and Verification of Accounting

	Average SP Budget (Kip)	Average Worth of Community Contribution (Kip)	Community Contrib. (CC)/Budget	Verification of CC Accounting (Evidence in file of PRF checks)
Xiang Khouang	243,600,000	33,700,000	15%	80%
Houaphan	135,500,000	9,500,000	13%	100%
Luang Namtha	195,200,000	25,900,000	17%	70%
Savannakhet	227,600,000	19,200,000	9%	60%
Saravan	275,600,000	18,400,000	8%	60%
Sekong	247,800,000	43,100,000	21%	90%
All Provinces	222,000,000	25,100,000	14%	80%

The evaluation found that 80% of the village SP accounting records of community contributions have been properly checked and verified by PRF staff.

Two provinces, Savannakhet and Saravan, are below the average for community contributions. The minimum size of community contributions is stipulated in the PRF Operations Manual as 10% of the SP budget. There may have been missing or incorrect information copied by the evaluators in these provinces on one or more SPs, producing these lower than normal percentages. These two provinces also display low percentages of files that had been signed-off by PRF staff. There is likely no connection between these coincidences, but it may prompt accounting staff in these provinces to be extra vigilant in the future.

Recommendation 17: PRF field staff training should emphasize the importance of village SP implementation file review on a regular basis. Community contributions should be checked and signed-off on a regular basis.

8.5.2 Is the size of community contributions reasonable for the size of investments?

In this study's sampling, 31 communities of the 60 SP evaluated made contributions more than the minimum requirement of 10%, some as much as 25% of the budget and one at 60% (a road in Dakdom, Sekong). In order to determine if these contributions are reasonable it could be argued that a study of each recipient village's or Kumban's resources should be conducted. The study might count the number of motorcycles, trucks or other indicators of financial worth, and thus predict the availability of villagers to make inputs of labour or local materials. Those village populations more able to make community contributions might be readily apparent through such a survey. Repeating the survey a year or two after construction of road, irrigation or other economic generation SPs would also be useful in these regards.

Without this background social data the only parameter that can be assessed is the size of the community contributions as compared to the requirements of the PRF Operations Manual. **Based on the evaluation sample's community contribution rate of 14% of total SP budget, we conclude that the size of the contributions is reasonable for the size of the PRF investments.**

It is evident that certain types of investments are most benefited by community contributions in the form of labour and materials. Those forms of infrastructure that rely on labour-based methodologies, such as large excavations for road alignment cuts or lengthy irrigation canal construction, can realize greater benefits with smaller monetary investments. Other types of infrastructure, such as buildings or water systems, cannot make as much use of labour-based implementation as these works tend to require more skilled labour and purchased materials.

8.5.3 Were there additional community contributions not reported; and
8.5.4 Assess whether contractors were ever paid for the part of works carried out with community contributions.

Village committee members were questioned during interviews in regards to any other village contributions to the SP construction that may not have been reported. Committee members deferred to the official records, indicating that there were no other contributions of which they were aware. Committee members also confirmed at all SPs evaluated that contractors were not paid for any of the work covered by the voluntary community contributions. The technical evaluators were not able to view contractor invoices to confirm the scope of billed services.

8.6 Were community contributions an important factor in determining the cost effectiveness of PRF sub-projects relative to similar sub-projects supported by others?

The PRF requires that recipient villages make Community Contributions (CC) to the infrastructures being constructed. The value of these contributions, usually labour costs (based on skilled/unskilled national labour rates) or supply of local construction materials (value based on quantity or unit length/size of material supplied) is counted as part of the PRF SP budget.

The first line in Table 8.6.1, below, provides the PRF unit costs as calculated in Section 8.1, above. The second line calculates the actual PRF investment by subtracting the average local contributions and then calculating a new unit cost based on floor area, number of households, etc. The effect of this subtraction is to lower the average unit cost of PRF infrastructure. The table compares the result with those unit costs of other agencies (line 3). Building, water supply and irrigation SP are the only useful infrastructure types for this comparison.

Table 8.6.1 – Community Contributions' Effect on Cost Effectiveness (Approximate)

		All PRF Buildings	Gravity-Fed Water	Irrigation
1	PRF unit cost	2,400,000 Kip/sq.m	2,600,000 Kip/HH	1,145 US$/hectare
2	PRF unit cost less CC	2,100,000 Kip/sq.m	2,250,000 Kip/HH	985 US$/hectare
3	Comparable	2,200,000 Kip/sq.m.	1,250,000 Kip/HH	1,125 US$/hectare

Discussion:
It can be seen that these community contributions enhance the cost effectiveness of PRF buildings and irrigation schemes, providing a locally sourced and cost effective method of lowering rural infrastructure costs. In the case of building and irrigation infrastructure, the community contributions have moved the PRF works from a slightly-more expensive position to a slightly-less vantage point. A large disparity for water supply SP remains.

8.7 Are there significant difference between PRF SPs and investments funded by other entities in terms of the costs for materials, transport, labor and other inputs?

The costs gathered from PRF village sources were often broken down to show separate amounts for materials, transport, labour and other inputs. Field Tool 2 provided data fields for this information. These details were rarely available at the CSP sites visited because of the differing construction management methodologies used by other agencies. The analysis provided in Section 8.1 above, the unit cost calculations, is therefore based upon total SP cost for both PRF and comparable infrastructures. No separate conclusions can be drawn for the various inputs.

Overall, **there is a slightly positive difference in building construction (9% cheaper) and a slightly negative difference in irrigation schemes (2% more expensive) between PRF SPs and comparable infrastructures by other agencies in the costs for materials, transport, labour and other inputs**.

Borehole SPs were roughly in line with other agencies, bearing in mind the sometimes-significant challenges that drill rigs encounter to find suitable sources of potable water. The significant negative difference in gravity-fed water supply costs (approximately 100% more expensive) between PRF and other agencies is understandable when the tapstand/HH ratio is considered. No conclusions could be reached for bridge SPs due to lack of comparability. Roads are also a special case, in that PRF efforts in this sector tend toward rural track improvements while the CSP examined were more extensive constructions.

8.8 Based on sound engineering judgment and in comparison to comparable investments financed by other entities, were PRF SP designed to maximize community benefits through employment of local labor, procurement of local materials, or other means?

The designs for PRF SPs always use standard Lao PDR construction practices which frequently are labour-based methodologies. For example, most excavations are performed by labourers rather than using machinery; most of the concrete is mixed by hand and placed in formwork using buckets. These techniques enable and promote the use of local unskilled labour. Construction materials are also sourced locally whenever possible, including sand, rock and wood, providing additional benefits to the community. Some of this work by villagers is provided as a community contribution to the SP financing, but much of it is paid as skilled or unskilled labour working for a contractor. The social benefits through employment of local labor and procurement of local materials contribute to the cost effectiveness of PRF SPs.

It is apparent that PRF SP are designed to utilize as much local labour and locally sourced construction materials as possible. This construction modality increases the local sense of ownership of the infrastructure which, in turn, benefits the ongoing operations and maintenance of the facilities. Some of the CSP evaluated used similar methodologies of local supply of labour and materials. Complete financial information for these CSPs was generally not available so that detailed analysis of this aspect of CSPs is not possible.

8.9 Based on sound economic judgment and in comparison to comparable investments financed by other entities, were PRF SP designs and specifications selected to maximize value for money? Would other designs, technologies or methods have provided greater value?

The findings of this cost effectiveness study show that the PRF model of community SP implementation produces rural infrastructure of a generally suitable technical quality for costs that are reasonable when compared to those of other entities. Buildings, borehole wells and irrigation systems demonstrate this most readily, as do gravity-fed water systems when the tapstand/household ratio is considered. Changing the PRF's road construction methodologies to concentrate on spot repairs (particularly relating to drainage) and steep road works is recommended to increase the cost effectiveness of the PRF's road construction program.

With the exception of the PRF's road construction program, **it is evident from cost comparisons with CSPs that PRF SPs have been designed, specified and constructed to maximize value for money. The majority of the designs, technologies and construction methods are suitable for the PRF's clientele,** with few changes possible that might offer greater value. **The changes recommended to the PRF road program will provide more sustainable infrastructure to villages and thus provide greater long-term value and cost effectiveness.**

9 Compliance with Environmental and Social Safeguards

Following are the questions to be answered from the Terms of Reference and scope, with discussion and analysis presented for each item as appropriate.

9.1 *Proper documentation and recording of Environmental Code of Practice (ECOP) and the Safeguard Checklist, and the verification and monitoring by the District PRF office of contractor / community compliance with ECOP*.

Field Tool 3 provides a questionnaire where the quality of the infrastructure, its site selection, and the process under which the construction took place can be assessed in regards to environmental and social considerations. The TE team referenced the Environmental and Social Management Framework (ESMF), Compensation and Resettlement Policy Framework (CRSF) and Ethnic Group Policy Framework (EGPF).

Project files were examined for proper documentation, and evidence of monitoring and verification by District PRF officials of community and contractor compliance with the ECOP, CRSF and EGPF. Table 9.1.1, below, presents a summary of these findings for an aggregate of all PRF SP evaluated in each province.

Table 9.1.1 – Summary of Environmental and Social Safeguards Findings by Province (Number of Sub-Projects)

		XKH	HPH	LNT	SVK	SRV	SKG
1	Environmental Codes of Practice (ECOP) included in the contract and completed by the contractor (of 10 SPs)	6	7	8	10	10	10
2	Environmental Screening checklists from Eng'g and Technical Guidelines completed (Cycles 7 and 8) and filed (number of SP)	2 (6)	6 (8)	2 (7)	6 (9)	5 (5)	5 (5)
3	Evidence of verification and monitoring by District PRF office (of 10 SPs)	8	9	8	10	9	9
4	Social Screening Checklist Form on file (CRPF, Annex 1a) (of 10 SPs)	7	3	6	8	9	6
5	Form on Safeguard Compliance Monitoring (CRPF, Annex 5) (of 10 SPs)	4	4	5	6	3	5

Discussion:
A general overview of the data in lines 1 to 4 in Table 9.1.1 indicates that the **environmental codes of practice, the Operation Manual standards for**

verification and monitoring, and the social screening checklists are being used and followed in a majority of SP sites, although there are several provinces where this documentation is missing. The data in line 1 shows that provinces Xiang Khouang and Houaphan are lower than their peers in adherence to ECOP, with no discernable reason for this occurrence in written commentary in the field data reports. A close inspection of the individual data sheets submitted from those two provinces shows that clusters of lower-rated SP in this respect can be found in Nonghaed, XKH and Xiang Khor, HPH. Facilitators in those areas may benefit from refresher training courses in regards to the importance of the various environmental and social frameworks that govern the work of the PRF.

Line 5 shows that **less than half of SP files contain the safeguard monitoring form**, with some provinces doing better than others in this documentation.

Recommendation 18: All PRF environmental and social safeguard checklists and forms must be completed for each SP site. Environmental monitoring activities should be ongoing during the SP construction, with notes to file as appropriate. Refresher training courses should emphasize the importance of this documentation.

The POM also stipulates that monitoring/quality control visits by technical experts will take place on a regular (and, in some cases, random) basis, with written records left behind of comments and instructions regarding construction matters. The data on Line 3 provides a good indication of the diligence of the provincial/district PRF personnel in attending SP construction sites and making appropriate notes for village files. There is room for improvement in most provinces (perhaps Savannakhet can offer advice to other provinces).

Recommendation 19: PRF personnel should strive to improve their monitoring and verification methodologies, including the writing of comments and instructions to Village Implementation Teams.

9.2 Loss of land or private assets, the scale of impact, whether or not they are addressed through voluntary donations and if so, whether all conditions of voluntary donations as provided in the CRPF are met.

The ownership of the land upon which PRF SPs are constructed was researched by the TE team, along with examination of SP files for the required documentation for voluntary transfers of land. No instances of involuntary land transfer have taken place during the PRF cycles studied.

Table 9.2.1 Summary of Land Donation Documentation by Province (Number of Sub-Projects)

		XKH	HPH	LNT	SVK	SRV	SKG
6	SP works take place on existing public land	9	6	10	10	8	10
7	SP require donation of land from private landowner	1	4	0	0	2	0
8	Land Acquisition Report (LAR) on file	1	4	0	0	1	0
9	Voluntary land donation conditions met	1	4	0	0	2	0

Discussion:

The results of this evaluation, as shown in Table 9.2.1 above, clearly show that **the majority of PRF SPs are constructed on existing pieces of public lands for which no LAR is required**. Examples of this include new schools built upon an existing school property, road works along an existing track, irrigation improvement works in a streambed and along existing *Meuang Fai* alignments between farmers' fields.

In those instances **where new lands are required, Land Acquisition Reports were found to be on file in almost all cases of voluntary land donation.** It is noted that only a single SP in Saravan was missing a LAR, although the file did have a voluntary donation letter on record from the landowner to the village implementation committee.

Mixai performed cursory inspections of the completed LAR in the SP files, looking for missing information or obvious notations of problems. Nothing untoward was noted on any of the documents inspected (the evaluators looked for indications that the donor does not benefit from the SP, the parcel size is too small, the donated land is greater than 5% of the total productive assets of the donor, and that no one has to be relocated) so that it can be concluded that **all conditions of voluntary donations as provided in the CRPF have been met at the SPs evaluated.**

9.3 Verification of whether the collection of sub-project documents meet the requirement of Indigenous Peoples Plan as provided in the EGDP.

Field Tool 3 contains several questions that pertain to SP file documentation in regards to the Ethnic Group Policy Framework (EGPF) and Ethnic Group Development Plan (EGDP).

Table 9.3.1 – Summary of Documentation re Ethnic Groups by Province (% of Sub-Projects)

		XKH	HPH	LNT	SVK	SRV	SKG	Ave.
9	Evidence within sub-project files that Village Consultation and Visioning meetings have taken place	100%	100%	100%	100%	100%	100%	100%
10	Percentage of villages with 100% same ethnicity	90%	70%	70%	80%	100%	100%	85%
11	Evidence of documentation of feedback from ethnic groups (% of SP)	10%	40%	50%	40%	40%	50%	38%

Discussion:

The participation of ethnic groups in the Village Consultation and Visioning Meeting was verified through questioning the village implementation committee members present during the SP inspection and by an examination of SP files. Line 9, above, confirms that the important Village Visioning meeting has taken place in all communities. The evaluators examined the Village Visioning documentation, which consisted mainly of sign-in forms containing lengthy lists of participants. Most files contained itemized lists of suggested development infrastructure and evidence of discussion and meeting votes, etc. The evaluators did not attempt to confirm participants' ethnicity from these forms nor understand the particulars in each case. There were few examples found in SP files of handouts containing visual representations of monitoring activities (this EGPF requirement was not yet in force during these early cycles). Similarly, sub-grant agreement documentation was not located in the files.

The ethnic mix of each evaluated SP village had already been determined using Field Tool 1, shown above on Line 10. It is noted that the great majority of SP villages are of a single ethnicity (**average 85% of evaluated villages are of single ethnicity), so it can be logically assumed that a similar majority of Village Visioning meeting participants belong to these ethnicities,** as required by the Indigenous Peoples Plan. It was not possible to verify this from cursory inspections of attendee lists.

Ensuring that feedback from community members, particularly ethnic minorities, is received and registered is an important part of the EGPF. The TE team members looked for evidence of such communications in the SP files. They tried to find, for example, minutes of village meetings where feedback by community members was addressed, Feedback and Resolution Report Form documentation, letters referring to individual disputes or notes of commendation, etc. Line 11 provides the results from these investigations, showing that less than half the SPs evaluated (38%) contained documents or correspondence relating to feedback of some nature, although very few Feedback and Resolution Mechanism forms were noted in the files. Again, the evaluators did not inquire as to the ethnicity of the feedback signators, but from a review of the line 10, where 85% of villages are of a single (minority) ethnicity, it can be logically inferred that **a majority of this feedback is from ethnic minorities.** There were several Mixai commentary notes made on the data input forms explaining that local villagers had no problems with the SP implementation process and therefore sent in no feedback. It could be argued that **a fairly low 38% feedback rate is a demonstration of PRF's experience and skill in socializing village implementation teams ensuring relatively smooth implementation periods.**

The evaluators were not able to accurately assess the quality of handouts and other training materials pertaining to participatory monitoring activities conducted by the Village Implementation Team. Materials from these sessions were not organized or filed in similar ways as other financial and auditing aspects of the SPs. Sub-grant agreements describing the cost and description of SPs were also difficult to verify during this evaluation.

9.4 Verification of whether any adverse environmental impacts occurred at the sub-project site, and how they were mitigated.

A thorough examination of the SP and surrounding site was performed as part of the Field Tool 1 investigation. Environmental impacts of the SP were often observed at this time, along with mitigation measures that would be part of the constructed works. TE team members also reviewed the terms and conditions as set out in ECOP (line 1, Table 9.1.1 above), where it was available, to verify the SP's environmental requirements and mandated mitigation measures.

Table 9.4.1 – Environmental Impacts and Mitigation by Province (% of Sub-Projects)

		XKH	HPH	LNT	SVK	SRV	SKG
12	Examination of SP site and visual confirmation that environmental considerations have been completed.	90%	90%	90%	100%	100%	100%
13	Evidence of verification by PRF/Kumban that ECOP/EMP mitigation measures implemented	80%	60%	70%	50%	70%	80%

Discussion:

Line 12 represents the TE team's assessment that appropriate measures have been taken to mitigate the environmental impact of a SP on its site and surroundings. Line 13 provides a percentage of SP files that contained evidence that the local authority had confirmed the mitigation measures for specific environmental concerns.

The high number of sites that have satisfied these criteria (line 12: 95% of all SPs evaluated) lessens the concern that local authorities are not documenting SP mitigation measures (line 13: 68% of SP files contain verifications of environment mitigation measures). It is likely that many SP sites did not suffer from any environmental problem or adverse impact, and thus did not require any mitigation measures. The Field Tool question may have been flawed, resulting in evaluator confusion.

10 Operations and Maintenance/Sustainability

Following are the questions to be answered from the Terms of Reference, scope and subsequent instructions, with discussion and analysis presented for each item as appropriate.

10.1 Are the current conditions of sample investments good, fair or poor?

As reported in Section 7.4.2, Overall Quality Rating (using the WB six-point system), the current condition of the majority of PRF SPs is good. The overall assessment took into account SP preparations, construction, environmental issues and O&M..

Considering Highly Satisfactory and Satisfactory to be good, **90% of PRF SPs are good**. Moderately Satisfactory can be equated to **Fair, which comprised 7%** of the SPs evaluated**.** Those SPs found to be **Highly Unsatisfactory are considered Poor, just 3%** of those SPs sampled.

10.2 Have any major repair or restorative maintenance/rehabilitation works been conducted since the completion of civil works or does the current condition require such works? If so, what are the causes of defects? Break down the causes of defects into environmental/natural factors; technical defects in design, implementation or materials; and lack of proper maintenance.

Village O&M Committee members were questioned by the TE team in regards to major repair work that had been performed or that was considered necessary. Major repairs are those items requiring attention beyond routine maintenance. Major repairs normally involve expenditures of cash (whereas routine maintenance tasks are usually labour-based), for example: replacement of bridge decking; acquisition of gravel to restore deeply eroded road surfaces; purchase of pipe and fixtures to replace broken components of water system, etc. Following is a table presenting summaries of this information.

Table 10.2.1 Major Repairs, by Sub-project Type (% and Number of SP evaluated)

	% of SPs evaluated	Building	Bridge	Water Supply	Road	Irrigation	All SP
1	Major repairs or rehabilitation performed	37%	50%	21%	13%	11%	25%
		7 of 19	1 of 2	5 of 24	1 of 8	1 of 7	15 of 60

Table continued overleaf

2	% of major repairs performed by villagers	100%	100%	100%	100%	100%	100%
		7 of 7	1 of 1	5 of 5	1 of 1	1 of 1	15 of 15
3	Major repairs or rehabilitation required	32%	50%	25%	50%	11%	32%
		6 of 19	1 of 2	6 of 24	4 of 8	1 of 7	18 of 60
4	O&M Committee in place and functioning	95%	100%	96%	75%	100%	93%
		18 of 19	2 of 2	23 of 24	6 of 8	7 of 7	56 of 60

Discussion:

Information supplied to the TE team members indicates that almost all SPs have persons who identify themselves as O&M Committee members (Table 10.2.1, line 4, 93% of SPs evaluated). Some of these committees have undertaken major repairs or rehabilitations of their infrastructure (line 1, 25% of all SPs have had active committees in this regard), but a large number of committees (line 3, 32%) have not acted to perform major repairs that are required. It was noted that **all major repairs have utilized village labour and village procurement of equipment and materials**, with government forces participating in only a single instance (heavy equipment for road repair in Dakdom, Sekong).

A closer look at line 3 above shows that many of these "inactive" O&M Committees are responsible for failing bridges and roads – two SP types for which ongoing maintenance is more technically complex, and it is possibly more difficult for village members to organize materials and equipment. A study of the photographs associated with some of these SPs requiring major repairs does show that failures of bridge decking (an expensive fix) and pervasive drainage problems along road alignments (perhaps too extensive to be solved through normal labour-based O&M practices) are likely largely to blame for these delayed O&M responses. Thus it can be seen that technical complexity of maintenance tasks directly affects an O&M Committee's response or lack of a response to a problem.

The photographs taken indicate that many of the PRF road SPs are rapidly falling into disrepair with major drainage works necessary before any further work can be done on the road surface. The new works necessary to restore these roads go beyond reasonable maintenance activities and should not be considered as failures of the O&M Committees to act. Table 10.2.1 shows a revealing situation where village users perhaps do not feel as much a sense of ownership with road SPs as they do for other SP types (line 4, Functioning O&M Committee: Road SP, 75%; Average, all other SP, 97%)

Technical Quality of a SP vs. Ongoing Maintenance Activities

The analytical results in Table 10.2.1 can be compared to the earlier summary of technical ratings by SP type, Table 7.1.6. A hypothesis might be that those SP types that exhibit lower overall technical quality will also suffer from ongoing Operation and Maintenance issues that perhaps stem from the low quality of earlier work. This is borne out if one considers the SP type Road: 45% Meets Spec, 47% Slightly Below, 8% Below Spec; and 50% of road SPs require major repairs, along with the findings that only 75% of SP have active O&M Committees.

The other SP types do not, however, offer similar correlations: Bridges have a generally high technical rating (82% Meets Spec) but are suffering from a high percentage of delayed response to major repairs (67% of SP evaluated require such attention). Irrigation SPs are the opposite: only 71% Meets Spec but just 11% of SPs require major repairs – this perhaps should not be surprising, as farmers will instinctually seek to make repairs to infrastructure that directly affects their harvests and livelihood. The variety of results from this analysis suggests that there is no distinct correlation between a SP's overall technical quality (upon completion) and the activities of the O&M Committee on an ongoing basis.

When major repairs had been completed or were necessary, the causes for these circumstances were explored by the evaluators, breaking down the defects into environmental or natural factors; improper design; faulty construction techniques; poor materials; or lack of adequate and timely maintenance. Following is a table that shows the percentage of SPs requiring major repair work as a result of defects in these areas.

Table 10.2.2 Major Repair Cause (both Completed and Required Major Repairs)

	Environmental	Design	Construction	Materials	O&M
Building (13 SP)				100%	100%
Bridge (2)			100%	100%	100%
Water Supply (11)	14%	29%	29%	100%	86%
Road (5)	25%	50%	75%	50%	50%
Irrigation (2)				100%	100%
All SP evaluated	11%	21%	32%	100%	95%

Discussion:
Building major repairs is almost solely directed at roof sheeting becoming leak-prone as it ages. The use of low-grade materials is a culprit in this, but incorrect roof sheet fastening techniques also play a part. Insufficient O&M has correctly been

cited as a factor by the evaluators, where slowness in responding to leaks contributes to ceiling degradation, etc. PRF field staff must ensure that roof sheet fastening is done correctly.

Bridge major repairs are directed at deck and railing replacement/refurbishment. Photographs of the SPs show that original materials must have been low quality and inadequately fastened. Maintenance efforts on the deck have been haphazard, with loose and uneven boards fitted in an untidy and dangerous fashion for young and aged users.

The need for **water supply** major repairs has been caused by a wider range of problem areas. Environmental and natural causes were cited in 14% of SP; these include such things as streams undermining pipe supports and mountain springs drying up or moving. Design flaws (29% of SP) are often responsible for poor water pressure in portions of village systems. Improper construction of water systems has been blamed for 29% of the required repair work. All of the major repair works were reported to be related to faulty materials (this may be less plausible than the other findings). Finally, a lack of proper O&M is also cited in 86% of the major repairs required on water systems (for unrecorded reasons).

Road repair works also references the full range of causes. Discussion in regards to road repair follows in Section 11.4.

Irrigation major repair work, using data from 2 SP, is centred on improper materials being used to construct the infrastructure and a lack of O&M. Upon viewing the photographs, however, one can also see that poor design is the major cause of one failure (see 7.3 inset box). It is difficult to understand how improper materials have contributed to a major failure requiring repair. No comments were recorded to explain this finding.

> **Recommendation 20:** The citation of improper materials being at least partially responsible for almost all of the major repairs should be studied further by the PRF Engineering Department. Substitutions for these poor materials may help reduce the incidence of major failures.

Further recommendations in regards to design and construction techniques for all SP types are offered in Section 11.

10.3 If any O&M works have been done, who did what O&M works, when and how much did they cost?

Both routine maintenance and major O&M/repair work is primarily done by the villagers themselves: 58 SP and 51 SP of the 60 SP evaluated, respectively, were found to be wholly serviced by villagers. Occasional supports of repair materials or equipment are provided by line Ministries or government agencies.

There were 16 major repairs of the PRF SP evaluated, the average costing approximately 1,100,000 Kip (discounting one outlier at 23M Kip). The following table provides the number of major repairs by SP type and average cost.

Table 10.3.1 Major Repairs Completed

	Building	Bridge	Water Supply	Road	Irrigation
Number of Repairs	7	1	5	1	1
Average Cost (Kip)	536,000	210,000	1,900,000	250,000	450,000

Discussion:

It is evident that village committees are largely responsible for all maintenance and restorative works on local infrastructures, with some construction materials or equipment occasionally available from the government (but, anecdotally, only after frequent requests and lengthy petitions). The costs of the repairs, paid by the O&M committee using funds gathered by user fees or special collections (averages shown above) can sometimes rapidly drain O&M Committee bank accounts (see Table 10.8.1, line 2).

10.4 Was any routine maintenance (wear and tear and/or replacement of consumables) carried out on the sub-project, and what has been spent on maintenance each year since completion?

O&M committee members were questioned as to the routine maintenance activities that had been undertaken in the past. Following is a table that lists individual maintenance tasks for each SP type, along with some notes for each.

Table 10.4.1 –Routine Maintenance Activities typically conducted or not conducted

Building Routine O&M Activities (19 SP)	Roof repair	Mechanical	Plumbing	Concrete repair	Plaster repair	Washing	Painting	Drainage
	32%	0%	0%	26%	0%	0%	11%	26%
# of SPs	6			5		1	2	5

<u>Building routine maintenance notes</u>: It is revealing that no O&M Committees report any work on mechanical or plumbing – two systems that frequently break down (due to low quality materials having been purchased) – and that remain broken for long periods of time. Poorly functioning doorknobs, locks and faucets contribute to user frustration that promotes a lack of ownership of the facility, which leads to less active maintenance and a general degrading of all systems.

<table>
<tr><td colspan="9"><u>Routine maintenance strengthening:</u> Many buildings suffer from leaky roofs, malfunctioning hinges, locks and plumbing fixtures. PRF should provide further guidance to building O&M Committees with a booklet summarizing common problems, with clear sketches and explanations of techniques to avoid them, and how to fix them. The booklet should refer back to good design techniques, the purchase or local acquisition of quality materials, and the proper installation of them. It is important to clearly link the quality, ease of maintenance and user-satisfaction of the final product with the implementation steps leading to it.</td></tr>
<tr><td>Bridge Routine O&M Activities (2 SP)</td><td>Deck repair</td><td>Concrete repair</td><td>Drainage</td><td>Apron and road repair</td><td>Support structure</td><td>Railings</td><td>Erosion protection</td><td>Other</td></tr>
<tr><td></td><td>33%</td><td>0%</td><td>33%</td><td>100%</td><td>0%</td><td>100%</td><td>33%</td><td>0%</td></tr>
<tr><td># of SPs</td><td>1</td><td></td><td>1</td><td>2</td><td></td><td>2</td><td>1</td><td></td></tr>
<tr><td colspan="9">Bridge routine maintenance notes: The low percentage of active O&M Committees for most of these routine items may be an indication of unawareness of need (particularly erosion protection), inadequate resources, or lack of necessary skills. The PRF bridge SP sampling was quite small, so more research is warranted before making any conclusions.
<u>Routine maintenance strengthening:</u> Many bridges suffer from broken timbers, cracked or crumbling abutments and concrete foundations, poor drainage from road approaches, and failing erosion protection measures. Similar to buildings above, the PRF should provide further guidance to bridge O&M Committees with a booklet summarizing common problems, with clear sketches and explanations of routine maintenance techniques.</td></tr>
<tr><td>Water Supply Routine O&M Activities (24 SP)</td><td>Reservoir cleaning</td><td>Pipe repair</td><td>Pipe flushing</td><td>Valve exercising</td><td>Mechanical repair</td><td>Filter bed replacement</td><td>Drainage</td><td>Other</td></tr>
<tr><td></td><td>83%</td><td>83%</td><td>50%</td><td>58%</td><td>4%</td><td>8%</td><td>83%</td><td>0%</td></tr>
<tr><td># of SPs</td><td>20</td><td>20</td><td>12</td><td>14</td><td>1</td><td>2</td><td>20</td><td></td></tr>
<tr><td colspan="9">Water supply routine maintenance notes: Many of the common maintenance activities are being performed in an adequate fashion. It is noted that filter bed replacement is rarely being performed. Replacement of a filter bed, often high and remote in the hills above a village, is a big task and often made more difficult by poorly designed tank infrastructure. Villages often ignore the plugged filter bed and simply allow water to bypass it, flowing directly to the intake pipe untreated.</td></tr>
</table>

This becomes a poor design issue – does the water really need filtration? Large settlement tanks with appropriate baffles may do the job.

Mechanical/plumbing disrepair of faucets and tapstand piping is also very common in villages (the high Pipe Repair % above is more directed at mainline breaks). Poor quality faucets break within a year or two of installation and are many times not replaced, a wooden plug being used instead.

Routine maintenance strengthening: Many water supply systems suffer from poorly protected sources, ill-maintained filtration tanks, leaking pipes, and malfunctioning or broken faucets. Similar to above, the PRF should provide further guidance to water supply O&M Committees with a booklet summarizing common problems, with clear sketches and explanations of routine maintenance techniques.

Road Routine O&M Activities (8 SP)	Pot hole/surface repair	Erosion control of shoulders	Erosion control of slopes	Drainage	Vegetation removal	Signs	Minor repair culverts/walls	Regrading and re-gravelling
	100%	38%	38%	100%	75%	0%	38%	0%
# of SPs	8	3	3	8	6		3	

Road routine maintenance notes: While it is comforting to see high %'s for routine surface and drainage repair, it is noted that major repairs are also commonly required in these two areas. Routine efforts in regards to surface and drainage repair cannot correct a poorly constructed roadbed nor drain saturated areas where no downstream ditching or piping systems are in place. Additional commentary on this aspect of road building can be found below, in Section 11.4.

Erosion of road shoulders is a constant problem for rural roads, as is the control of runoff from adjacent lands, particularly on cut slopes above roads. Adequate road maintenance requires a lot of labour on a frequent basis. User fees are sometimes difficult to collect, so that there is little money for paid maintenance activities (Section 10.3 deals with this issue, below).

Routine maintenance strengthening: Roads are quite susceptible to erosion and muddy conditions developing as a result of poor design. PRF designers should visit and study road SPs to learn where difficulties are encountered. From this, some routine maintenance guidelines should be developed with attention to these areas. Similar to above, the PRF should provide further guidance to road O&M Committees with a booklet summarizing common problems, with clear sketches and explanations of routine maintenance techniques.

Irrigat'n Routine O&M Activities (7 SP)	Vegetation (aquatic and land)	Sediment removal	Mechanical gates, outlets	Canal repair	Embankment erosion protection	Fencing repair	Other	
	71%	71%	14%	71%	14%	0%	0%	
# of SPs	5	5	1	5	1			

Irrigation routine maintenance notes: The percentages gathered in this section of the evaluation are much as expected. Farmers are spending maintenance time on those items that they see as most greatly affecting the water flow. They are spending very much less time on the physical infrastructure.
Each irrigation SP is unique in its requirements for ongoing and regular maintenance of parts of the infrastructure.

<u>Routine maintenance strengthening:</u> Irrigation schemes generally have active O&M Committees that concentrate on vegetation and sediment removal, and canal repair. PRF should provide further guidance to irrigation O&M Committees with a booklet summarizing common problems that are not being commonly addressed, with clear sketches and explanations of routine maintenance techniques that will prolong the useful life of the infrastructure.

Discussion:
Much of the above is discussed in each SP type section.

It is interesting to **note that ten SP O&M Committees reported that no routine maintenance had been performed**. These include six buildings, two water systems and two irrigation schemes. A further 8 building committees indicated that they had addressed only one of the suggested items (there were no notes as to other routine tasks suggested by O&M Committee members). The reasons for these inactive committees are unknown; no commentary was recorded to explain the lack of interest of these villages in basic maintenance tasks of their village infrastructure. Further research of these particular villages would be valuable to understand why certain villages or perhaps certain SPs within a village experience low rates of participation in routine/major maintenance tasks.

The following table provides an overview of how much has been spent on SPs' maintenance each year. This information was provided by O&M Committee members during interviews, often without consulting records. Figures should be considered approximate since few O&M Committees keep well-organized, detailed records of yearly expenditures.

Table 10.4.2 – Annual O&M Costs by Sub-Project Type (Kip/year)

		Building	Bridge	Water Supply	Road	Irrigation	Average (Kip)
1	Annual O&M Costs (Average, Kip)	428,000	3,000,000 (1 SP)	900,000	5,880,000 - Note 1	740,000	1.4M

10.5 Were the O&M plans developed? If so, is the quality adequate? Do the O&M plans adequately cover the O&M requirements over 3 – 5 years of operation, and clearly spell out specific O&M works, responsible agencies and expected cost, breaking down clearly typical scheduled maintenance works including capital repair?

The O&M Plan for each SP was inspected by the TE team and discussed with the O&M committee members present. The Plans were generally found to be filled out and in proper order. Following is a list of the items verified during this examination:

Table 10.5.1 – O&M Plan Adequacy (% of SPs evaluated)

1	Multi-year maintenance plan (normally 3 years)	89% of O&M Plans contained this
2	Linkages to appropriate line Ministries	87% contained this
3	Clear division of responsibilities and costs	87% contained this
4	Routine maintenance costs	84% contained this
5	Major capital repair	47% contained this

Discussion:

The relatively high percentages for the first four items in the table above reflect the rote nature of the completion of O&M forms for SPs. The completion of these forms is part of the standard PRF SP preparation process and, from interviews that formed part of the training period, it is evident that few O&M Committee members fully understand or make use of the O&M Plan. It is considered likely that most O&M Plans were last consulted during a PRF training session at the conclusion of the SP construction period. Almost all responsibilities seem to be shouldered by villagers, at least until major capital repairs are required. When infrastructure works break or start to malfunction, then many committees do seek help from line Ministries or government agencies, with limited success (see below, Table 10.6.1, Village Implementation Arrangements).

The low percentage associated with the capital repair item is not a poor reflection on the village O&M Committee. Responsibility for this item lies most directly with

PRF staff who will have aided the village in this document's preparation. Estimation of major capital repair is a task best suited to senior engineers who will have an understanding of the average life expectancy for the various components of different rural infrastructures. The inclusion of an accurate major capital repair figure, with an explanation of its significance, may prompt O&M Committees to take better care of infrastructure to avoid or delay such expenditures.

Recommendation 21: PRF engineering staff should determine accurate major capital repair budgets for infrastructure components that occasionally require replacement or costly repairs. Accurate figures for these items, and average time lines attached to them, will spur discussions during O&M training sessions as to how a village committee can gather such sums via sufficient monthly user fees.

Only three SP O&M committees reported that the government had provided construction material inputs toward the O&M of their SPs (school roof materials in Nathong Por, Houaphan and in Nam Chaleun Xai, Xiang Khouang; and pipe materials for a water system in Phon Home, Xiang Khouang). All SP O&M committees reported that the labour had been 100% supplied by the villagers. Some Ministry equipment was provided for road repairs.

10.6 What are the implementation arrangements for the O&M? Are O&M committees in place and functioning? What are the roles and responsibilities (both financial and technical) of local governments/ line agencies and communities? Are roles and responsibilities, financial and technical, clearly spelled out for direct beneficiaries/ users and for the responsible government agencies? Are indirect beneficiaries also expected to contribute to the O&M?

Village O&M Committee implementation arrangements for O&M were noted through questioning village committee members about who is generally responsible for O&M tasks.

Table 10.6.1 – Village Implementation Arrangements by Sub-Project Type (% of SP)

	Who performed the work?	Building	Bridge (2 SP)	Water Supply	Road (3 SP)	Irrigation	All SP
1	Villagers	100%	50%	100%	33%	100%	89%
2	Contractor		50%		33%		5%
3	Government forces				33%		5%

As reported in Table 10.2.1, Major Repairs by Sub-project Type, **the O&M Committees are in place and functioning in close to 100% of recipient villages** – 95% of villages (excepting road sub-project villages where only 75% of SP villages are active).

The village SP documentation was studied for indications of the roles and responsibilities of the village O&M Committee vs. relevant government agencies and the PRF. Similar PRF forms had been completed in the majority of villages, **85% of SP documentation contained O&M schedules, operational statements and three-year financial projections. The forms made no specific reference to financial or technical contributions by any government/line agency**, implying that **such responsibilities lay with the direct beneficiaries, the village users** and O&M Committee. Notwithstanding this, many village committees stated that they had good relationships with local government agencies and line ministry personnel and that their occasional requests for assistance did not go unheeded. Commentary recorded by the evaluators from several SP sites indicates that O&M Committee members do tend to look toward relevant line Ministries for help, particularly with major road repairs and building roof replacement endeavors.

Table 10.6.2 – User Fees and Other Contributions (% of SP)

		Building	Bridge	Water Supply	Road	Irrigation
4	Indirect beneficiary fees (% of SP) – Note 1	16%	0%	4%	0%	14%
5	Contributions from other sources (% of SP) - Note 2	11%	67%	0%	0%	14%

Note 1: A minority of O&M fee schedules feature payments from indirect beneficiaries. This has been reported for a small percentage of building, water supply and irrigation SP. No commentary was recorded to explain these indirect fee collections. Discussions at a school in Thathom District, Xiang Khouang, confirmed that sometimes school user fees are collected from all households in village regardless if they have children in attendance or not. These are classified as indirect beneficiary fees under Building.

Note 2: No commentary was recorded to identify the 'other sources' for the building and irrigation SP. The bridge SP gathered contributions from surrounding villages (see inset box below).

Discussion:

The fees paid by indirect beneficiaries of building SPs refers to several villages where all households pay a flat rate as a contribution to the school O&M fund, whether or not they presently have children attending the school. A school committee in Thathom stated that the school was regarded as a valuable village asset and that the entire population agreed that it was worthy of public support. Irrigation and water supply SPs also occasionally feature a similar village agreement in regards to the income-generating land of the village and its water points, respectively.

No written commentary was provided to explain the small "contributions from other sources" that were recorded for building and irrigation SPs. For two of three bridge SPs, however, stories such as the one below were related by O&M Committees and copied onto a field report. It is evident that **contributions toward O&M activities from other sources accounts for less than 10% of the operational funds.**

Contributions from Other Sources

In Nongkham Village, Luang Namtha, a PRF suspension bridge has been used for a long time (built in Cycle 8, 2010) and its deck is in dire need of repair. The villagers are planning to replace the running surface of the bridge and also change parts of the cabling and fasteners that have degraded.

This rehabilitation has been estimated to cost approximately 23 Million Kip, however they have only 4,260,000 Kip in their village O&M account (collected from their village alone). The O&M Committee decided to collect money from the neighbouring villages that use the bridge from time to time, such as Ban Donyeng (5.6 Million Kip), Ban Luangphakham (4.5 Million Kip) and Chomcheng (9 Million Kip). The self-help effort will now go ahead.

10.7 Was any training provided to local communities on O&M (including refresher training), and if so, what types of training were provided? Did communities request and/ or receive technical support from local governments/ line agencies on O&M?

O&M Committee members were questioned about the O&M training that they had received and whether there was any budget allocated toward ongoing training.

The following table presents the data gathered in Field Tool 4.

Table 10.7.1 – O&M Training and Capacity Development (% of SPs)

	XKH	HPH	LNT	SVK	SRV	SKG	All Prov
O&M training received (% of SP Committees)	80%	80%	40%	100%	100%	90%	79%
Ongoing capacity development (% of SP)	50%	0%	0%	0%	0%	0%	8%
Annual training budget (Kip)	1,215,000 (1 SP)	0	0	0	0	0	0

Discussion:
Villagers reported that the training was generally received during and shortly after the SP construction, but that little in the way of refresher sessions have been offered afterwards (and they have made no requests). Training consisted of demonstrations of how the infrastructure operates (for water systems, irrigation facilities) and routine maintenance activities (cleaning of water reservoirs, clearing of vegetation from irrigation canals, repair of road potholes and shoulders, etc.) There were reportedly few O&M training sessions conducted for buildings.

There were five village committees in Xiang Khouang that reported on further capacity development activities; none of the rest of the sampled villages told the TE team that there have been ongoing sessions. There was a single village that indicated that they were aware of a training budget in these regards. There were no villages reporting that they had asked for or received government support on O&M.

Recommendation 22: O&M refresher courses should be provided to O&M Committees on a periodic basis. Most SP types would benefit from these additional courses on the first and third anniversary of completion of construction. The first refresher course should be offered after villagers have experienced the infrastructure in all seasons. The second session, after three years, will be more revealing of long term issues that must be resolved. These should be taught by the PRF designers themselves, so that they have first-hand knowledge of infrastructure deterioration issues and how better design can extend the life of a system. Engineering inspections of the systems should take place prior to these sessions so that the course material can be adjusted to suit.

10.8 Is an O&M fund in operation? Who holds the funds, and who contribute how much? What is the current value of these funds? Are those expected to contribute able and happy to contribute?

O&M Committee members were questioned about the ongoing expenses that are incurred during the operation and maintenance of the infrastructure. Many notes were recorded to the effect that O&M fees are not collected until specific tasks need to be undertaken, and then house-to-house collections take place.

The annual O&M costs for SP types (line 1, below) was also shown in Table 10.4.1, above. The following table provides other information about O&M user fees.

Table 10.8.1 – O&M Costs and Funds in Account

		Building	Bridge	Water Supply	Road	Irrigation	Average (Kip)
1	Annual O&M Costs (Average, Kip) Note 1	428,000	3,000,000 (1 SP)	900,000	5,880,000 - Note 2	740,000	1.4M
2	Current funds in O&M account (Average, Kip)	1,600,000	3,100,000 (1 village)	2,250,000	1,327,000	2,000,000	2.0M
3	O&M user fee in place (% of SP)	68%	100%	83%	63%	100%	77%
4	Affordability of User Fees (% that can afford)	99%	93%	98%	100%	98%	95%
5	% of O&M Committee with Funds	68%	66%	83%	25%	100%	70%

Note 1: Annual O&M Costs represent villager's estimate for recurrent and routine maintenance costs, not occasional capital repair costs.
Note 2: Only two SP were able to supply this information. One was 5,880,000 Kip and the other was 500,000 Kip. Neither set of data provided an explanation of activities undertaken with these sums.

Discussion:

O&M accounts are in place for an average of 70% of villages (line 5, above), although if road SPs are discounted as an outlier SP type, this approaches 80%. The funds, we were told, are uniformly held in a village account at the nearest bank. An average of 2,000,000 Kip are held in these accounts (with a high/low of 20M/119,000 Kip).

Village committees were quizzed as to the schedule of payments that they collected. Most villages collected a user fee once/month, usually 100 to 200 Kip (85% of villages reported this) regardless of SP type, with the remaining villages collecting a larger sum once per year (high/low of 6 SP reporting is 2,500/1,000 Kip/year).

Many villages (over 40%) stated that they collected a small amount via the regular user fees but that special collections of funds would be undertaken for occasional repairs that required purchase of materials. Many villages also expected labour-based contributions, for example: vegetation cutting along roads and irrigation ditches; filling of potholes with local sources of gravel; etc. Only anecdotal information is available on this aspect of user contributions; no specific data was collected on this aspect of user contribution.

The current value of funds within O&M Committee bank accounts is shown on line 2. Almost all O&M Committees report (line 3) that all village families can afford the fees. One comment was recorded where a committee member stated that if any family could not afford to make a monthly payment then it was forgiven, but that very few families were in such a poor financial state. Committee members seemed to agree that all villagers were happy with reasonable user fees of 100 to 200 Kip/month (particularly speaking of water and irrigation systems), as shown on line 4, above. No commentary was reported in regards to villagers' feelings re user fees for roads and it can be seen that road O&M Committees are fewer in number and activity.

It appears to be the habit of O&M Committees to institute low monthly user fees for village infrastructure and defer larger mid-term repairs and rehabilitations until special collections of larger sums can be done on a village-wide basis (sometimes Kumban-wide, depending on the infrastructure). The delays associated with these circumstances promote a slow degradation of the public infrastructure that can damage its long-term sustainability. This type of situation is apparent in buildings (leaking roofs are not fixed which causes further damage to ceilings); bridges (a single board in a bridge deck loosens and is not fixed, which contributes to greater forces on other boards and wide-spread failures); roads (stormwater runoff damage to roads is not promptly repaired using proper materials and methodologies (paying for labour if necessary), which leads to greater and sometimes irreparable erosion); and irrigation (erosion protection materials must be promptly replaced after scouring events or the entire infrastructure can be compromised in future storms).

Each type of infrastructure is unique in its routine, mid and long-term maintenance and capital repair requirements. The PRF Engineering department should provide O&M Committees with detailed financial estimations of these costs for each SP, along with time-lines for such anticipated expenditures and suggested user fee schedules that are appropriate for each village population or SP catchment area.

Recommendation 23: The PRF Engineering department should provide O&M Committees with a set of SP-specific estimated costs for routine, mid and long-term maintenance items that will promote the sustainability of the village infrastructure. These costs should be amortized over reasonable time periods and used to develop a sustainable user fee system where O&M Committees can collect sufficient funds to execute the maintenance tasks as necessary.

10.9 Is the O&M fund designed to cover all or most of the O&M works that should be conducted, including the cost of scheduled maintenance and capital repair?

The SP documentation studied by the TE teams did not make specific references to O&M funding sources nor provide any formula for the calculation of reasonable fees, such as a percentage of construction costs. Most scheduled routine maintenance tasks can be provided by villagers using labour-based methodologies so that costs for this work need not be calculated. Scheduled capital repair, however, often needs special inputs of materials or experienced labour, so that SP-specific costs should be provided in each O&M Plan.

Villager O&M Committees are allowed to make their own collective decision as to whether or not such a fund should be gathered, the amount of fees, schedule of payments, etc. It does not appear that the PRF O&M documentation is directive but rather is a suggested course of action.

Recommendation 24: The PRF should consider revising O&M Committee documentation to stipulate activities that must be undertaken according to a routine schedule, with realistic funds allocated for labour and materials.

10.10 *Assess whether applicable user fees are affordable to users and sustainable to finance longer term O&M. Did the line ministries contribute to O&M expenses?*

Line 4 in Table 10.8, above, provides detail in regards to the affordability of user fees (95% of O&M Committees report that all families can afford to pay the user fees). The collection of these fees has generated **an average of 2.0M Kip in O&M bank accounts** (line 2, Table 10.8) while the **average annual O&M cost is reportedly 1.4M Kip** (line 1). It would seem, therefore, that the long-term viability of the current user fee system is confirmed for routine maintenance for the average village SP O&M fund but not so for mid- and long-term capital repairs.

Mid and long-term O&M (i.e. capital repair of certain items for sustainability) is not assured with the current O&M user fee methods. O&M bank accounts have been shown to contain funds only slightly in excess of their needs (average account holds 2M Kip; average yearly expenditure is 1.4M). These O&M savings accounts do not reflect the routine labour-based contributions and are thus very unlikely to be able to fund mid and long-term repairs which will require more capital funding. This mid and long-term O&M funding deficit situation is further evidenced by the delay many O&M Committees display in undertaking major repairs (as described above in 10.2, Major Repair and shown in Table 10.2.1, line 3). From this evidence, it is clear that village O&M Committees are not sufficiently prepared to ensure short or mid-term sustainability of the infrastructure under their trust.

Line ministries almost uniformly did not contribute to O&M expenses (**55 of 59 SP report that village contributions constitute 100% of labour and materials**). Four SP reported that government agencies provided from 10% to 80% support for specific repairs (sometimes equipment for two road SPs).

Recommendation 25: The PRF should consider revising O&M plan to insert specific capital repair estimates. Estimates should be provided appropriate to SP type, for example, roof replacement for buildings, with options described to committees for the funding of such capital works.

10.11 Were necessary Government inputs (e.g., teachers and learning materials for schools, or health workers, drugs and equipment for dispensaries) provided adequately and in a timely manner?

There was a near-uniform feeling expressed by villager representatives (95% of building SP committees, educators and health workers) that the government was providing them with staff and equipment in an adequate and timely manner for schools and health clinics. Similar questions posed by the TE team in regards to other SP types, such as water systems (supply of parts for broken handpump) or road (provision of equipment for road repair), were not similarly answered. Requests of this nature from village committee members are frequently delayed or put aside, we were told. The government ministries for education and health, however, appear to support the work of the PRF with prompt supply of these necessary materials.

10.12 Did the community or contractor implementation modalities have any impact on O&M? What investment types are more suitable to community force account in terms of long-term cost effectiveness? What conditions have to be met to make the model of community force account cost effective in the long run?

All evaluated SPs were implemented by contractors. No commentary can be offered in regards to comparisons of contractor vs. community force account construction modalities.

10.13 Did the capacity development of beneficiary communities carried out by the PRF contribute to SP sustainability cost-effectively? Compare the total cost including the cost of community engagement and capacity development of investments financed by different sources, taking into account (i) the current conditions of infrastructure; (ii) initial condition of infrastructure after completion and (iii) O&M works done. Any indication that the PRF's investments in the capacity development of communities contribute to long-term sustainability of sub-projects? If such an indication is observed, how cost effective is the PRF community capacity development in long-term sustainability of infrastructure?

Village SP implementation and O&M Committee members were asked about the training and ongoing capacity development that were received as part of the SP construction and hand-over process. An average of 79% of SPs evaluated reported receiving O&M training, while less than 8% said that they receive ongoing assistance in these regards. Table 10.7.1 provides the data gathered during these interviews.

No specific costs for community engagement or capacity development were identified in the SP files examined. The SP budget information within village files did not contain line items for these activities. The TE teams also attempted to gather information from the CSP visited in regards to community involvement, capacity development, and associated costs. None of the sites visited were able to supply information in these regards. The initial condition of PRF infrastructure after construction was also impossible to gauge at the time of the evaluation.

It is noted that about 90% of SPs received O&M training in all provinces except for Luang Namtha, where the total was only 40%. A hypothesis might be that a lack of appropriate O&M training will contribute to a more-rapid degradation of the current conditions of a SP (and a lower overall technical rating).

The technical quality of the evaluated SPs in Luang Namtha can be found in Table 7.1.2 – 80% of the components of the SPs in LNT were found to Meet Spec (average for all PRF SPs evaluated is 76%). This comparison shows no correlation between lack of O&M training and technical quality, which can be extended to the sustainability of a SP. It is therefore difficult to conclude, based on the data gathered, that PRF's investments in community O&M capacity development contribute to the long-term sustainability of the rural infrastructure. Notwithstanding this data gap, however, **it does seem logical that community capacity development is a necessary and vital activity that will benefit the long-term sustainability of the rural infrastructures constructed.**

11 Economic Analysis – Summary (full report contained in Annex 9)

11.1 An economic analysis of PRF subprojects was performed for three types of infrastructure subprojects which will likely remain priority areas for investment, namely, farm to market road, water supply (gravity and pump) and school buildings.[1] The decision rule is to accept a project where the EIRR is greater than the hurdle rate of 11.25 percent and the NPV is greater than zero.

11.2 The benefits associated from road subprojects are 1) increase in farm incomes as a result of improved access to markets; 2) cost savings in transporting agriculture produce to the market; 3) additional earnings from a reduction in post-harvest losses; and 4) cost savings in transporting agricultural inputs to the farm site. A conservative analysis revealed an NPV of US$126,000 and EIRR of 44 percent. The benefits of new water supply includes 1) opportunity cost of time saved from fetching water, especially for children and women; and 2) increased water consumption for households. The health benefits are difficult to estimate and are not included in this analysis. A conservative analysis revealed an NPV of US$8,724 and EIRR of 20 percent for gravity supply and NPV of US$ 29,960 and EIRR of 126 percent for pump driven water supply, suggesting that returns from investment from water supply projects are very high. The benefits of new classrooms includes: 1) reduction in dropout rates; 2) increase in enrollment rates as a result of having more classrooms and teachers; and consequently 3) higher earnings over a lifetime as a result of increase in number of years with education. A conservative analysis revealed an NPV of US$34,000 and EIRR of 26 percent.

11.3 All three subprojects were tested for their sensitivity under three scenarios, namely: 1) reduction in the project lifetimes as result of poor infrastructure maintenance; 2) increase in construction cost by 20%; and 3) reduction in project benefits by 20%. Sensitivity analysis found that the water subproject (gravity) is sensitive to a reduction in project lifetime by 4 years; while pump water supply projects are robust under all scenarios as are the improved classrooms and new road projects. Other non-tangible benefits associated with the PRF, such as increased participation in village and local government planning and the impact of the livelihoods support, are not quantified in the economic analysis. Their impact has partially been captured by the Impact Evaluation which shows that PRF supported households perceive increased participation in and influence on village decision-making.

[1] The shadow wage rate (SWR) was used to reflect the true economic value of unskilled labor employed in the project. The value of unskilled labor in the PRF project areas is around LAK 41,000/day. The social discount rate (SDR), currently pegged by the Laos Central Bank at 11.25%, was used.

12 Best Practices/Recommendations/Lessons Learned

Following are the items to be addressed from the Terms of Reference, with commentary reported from the fieldwork (citing the SP type and village code) for each as available. Discussion and analysis are presented for each item as appropriate.

12.1 What examples of good practice can be drawn to enhance technical design quality, operation and maintenance and sustainability for future PRF SPs?

Water Supply, 13 04 13 05 – "The design and plan is very well done and it needs to be applied in other areas"
Water Supply, 13 05 27 05 – "The design and plan is very well done and it should be copied elsewhere."
Building (clinic), 13 05 33 06 – "The building design and construction is well done, since the construction completed in 2010, the O&M committee never do any maintenance because it is functioning very well."
Road, 14 08 13 02 – "The road operation and maintenance has been divided into segments between villages to be responsible for the annual maintenance and repair, which it is a good approach to apply in other projects."
Building (school dormitory), 14 08 13 06 – "The O&M committee in the village have to follow up with the teachers who are living in term of cleaning and maintenance daily as well as the tidy of the dormitory base."

Discussion:

Several SPs were cited as having especially well done designs and plans. These SP could be studied to determine their unique qualities that made them stand out in the evaluation.

The road and building SPs above demonstrate good practice where the actual users are being required to provide routine maintenance services. O&M Plans should make reference to these good practices.

12.2 What are the key threats to sustainability and what good practices can effectively address these threats?

Road, 14 08 13 02 – "The road is inaccessible in the rainy season"
Road, 15 01 03 09 – "The annual maintenance takes too much time and labor force"
Water Supply, 15 01 03 07 – "Watershed protection is poor and the intake is not well maintained"
Building (clinic), 13 07 05 03 – "There's no permanent water system and electricity in the dispensary."
Building (clinic) 13 06 13 02 – "There's no water system and electricity in the clinic, they use the Solar Cell."

Discussion:

The two road SP quotations are revealing in terms of the major drainage problems that are typical of PRF road SPs. The first remark reflects the poor state of certain spots along PRF roads where poor or nonexistent drainage infrastructure has caused wet, slippery and impassable conditions to arise. The second quotation shows how poorly designed roadworks are hard to maintain – muddy and eroded lengths of road are impossible for labour-based crews to successfully keep open. This report makes recommendations for spot improvements to replace lengthy road improvement schemes.

The protection of a watershed and water intake is of paramount importance to the longevity of water systems. Fencing around the immediate area of a water intake is important, as well as a roof over the catchment facilities.

The development of medical clinic facilities without permanent, suitable water and electricity connections may introduce expectations to villagers that cannot be feasibly satisfied. Should such SPs take place, villagers need to be fully informed about the lack of such services and the likelihood (or not) of water and electricity systems reaching the area.

12.3 What are the key lessons learned from the sub-projects undertaken? What practices should be replicated and/or avoided in future sub-projects?

Water Supply, 13 04 13 05 – "The spare part such as transmission pipe and other equipment should be stored in the village for emergency repair"

Discussion:

The evaluators noted at one water supply SP that a storage of spare parts, such as pipe or other replaceable system components, should be maintained for emergency repairs. Other SP types might also benefit from these stores, such as galvanized roof sheeting for buildings, replacement running boards and railings for bridges, stockpiles of gravel for road repair, etc. Other repair materials, such as cement, should not be stored for lengthy periods as it would be harden over time.

12.4 Provide a list of key recommendations based on these good practices and lessons learned for the future design, implementation and maintenance of future PRF SPs

Recommendation 26: O&M Plans should make reference to actual users of new infrastructure being responsible for routine maintenance activities.

Recommendation 27: The inclusion of watershed and water supply intake protection measures for gravity fed water supply systems should be highlighted in design documents and final inspection lists.

Recommendation 28: Early SP design conversations should define the likelihood for provision of water and electrical services to remote village building SPs.

Recommendation 29: The usefulness of spare parts and other equipment should be considered for certain SP types and be worked into Bills of Quantity.

12 Summary of Findings and Conclusions

Technical Quality

This Final Report of the 2015 Technical, Cost Effectiveness and Sustainability Audit of the Poverty Reduction Fund has found that the sub-project works evaluated in six provinces to be largely in conformance with the Sub-Project Proposals and the specifications as set out by PRF for the infrastructure.

Problems and key construction issues were highlighted by the technical evaluation teams as they rated the various components and aspects of each sub-project. Aggregates of this information were assembled, analyzed and presented in this report. The following recommendations are considered to be the most important for PRF III:

- PRF should convene a technical sharing session where provincial engineering representatives meet to exchange ideas on how SP designs and file documentation can be improved, presenting examples. Focus should be upon water supply and road design issues, as well as improvements to the survey, design, documentation and delivery of the other sub-project types.
- A DRM training course should be held to emphasize the responsibility of designers to more fully consider the forces of nature when planning rural infrastructures.
- PRF III should consider allocating additional resources to those districts with greater numbers of remote or very remote villages.
- All PRF environmental and social safeguard checklists and forms must be completed for each SP site. Environmental monitoring activities should be ongoing during the SP construction, with notes to file as appropriate. Refresher training courses should emphasize the importance of this documentation.
- The citation of improper materials being at least partially responsible for almost all of the major repairs should be studied further by the PRF Engineering Department. Substitutions for these poor materials may help reduce the incidence of major failures.
- O&M refresher courses should be provided to water supply O&M Committees on a periodic basis (first and third anniversary). These should be taught by the PRF designers themselves, so that they have first-hand knowledge of water system deterioration issues and how better design can extend the life of a system.
- The PRF should consider revising the O&M plan to stipulate activities that must be undertaken according to a routine schedule, with indicative costs and sources of funding.
- The PRF should consider revising the O&M plan to insert specific capital repair estimates. Estimates should be provided appropriate to SP type, for example, roof replacement for buildings, with options described to committees for the funding of such capital works.

- PRF SP menu should be altered to stipulate that road upgrades must normally be confined to spot improvements (drainage, culvert, small bridge, etc.) or steep road construction utilizing hard surfacing over short sections.

Cost Effectiveness

PRF building and irrigation sub-projects have been found to be cost effective when compared to similar infrastructures constructed by other agencies. PRF gravity-fed water supply SPs were found to cost roughly twice that of other agencies, but were noted to provide much better service to village households. PRF boreholes appear to be more cost effective than those drilled by other projects, although comparison of this type of infrastructure is highly dependent upon depths to water sources, etc.

Road SPs were not found to be cost effective investments because of the high rate of failure of road surfaces due to poor drainage.

There were not enough bridge SPs evaluated to draw any firm conclusions about the cost effectiveness of these PRF investments.

Environmental and Social Safeguards

The technical audit of PRF SP files in recipient villages showed that in several provinces village implementation committees and their PRF handlers have not completed ECOP or the Social Safeguards Checklist. Environmental screening checklists from the Engineering and Technical Guidelines have also been neglected in several provinces, as well as the form on Safeguard Compliance Monitoring.

Improvements in these regards should be a priority for PRF III.

Operations and Maintenance/Sustainability

The technical evaluators rated the SPs using the WB six-point system, mostly considering the existing condition of the infrastructure. They found that 90% of the SP were either Highly Satisfactory or Satisfactory, indicating that the O&M procedures had been adequately followed by local teams.

The sustainability of the SPs evaluated was, at least in the case of roads and bridges, not so certain. Major repairs for these two SP types were being delayed by O&M Committees, for different reasons. Bridge repair and rehabilitation requires sizable investments and O&M Committees did not, sometimes, have the abilities or methodologies to collect such sums from users. Road repairs are neglected for technical reasons, where poor design has not adequately addressed drainage issues, for example.

The funding for routine maintenance of building, water supply and irrigation SPs is good, however. Small, affordable user-fees charged at the majority of these villages were found to be adequate for the regular maintenance tasks of these infrastructures. Funding for mid-term repairs (important for sustainability) is largely lacking for all SP types, however. Special collections of funding for rehab or major repairs works was noted as a common practice.

Conclusions

Some of the results of this technical evaluation are uncertain and possibly inconclusive. Often this is a result of the small sample size. Special studies that restrict their sampling to road, bridge or irrigation SPs may be valuable to further define problems and opportunities.