Samoa Water Authority (SWA)

Summary Report

Independent State of Samoa

Pilot Survey for Disseminating SME's Technologies for Alaoa Water Treatment Plant Improvement Project

March 2016

Japan International Cooperation Agency

Fukuyama Shoji Co., Ltd.

1. BACKGROUND

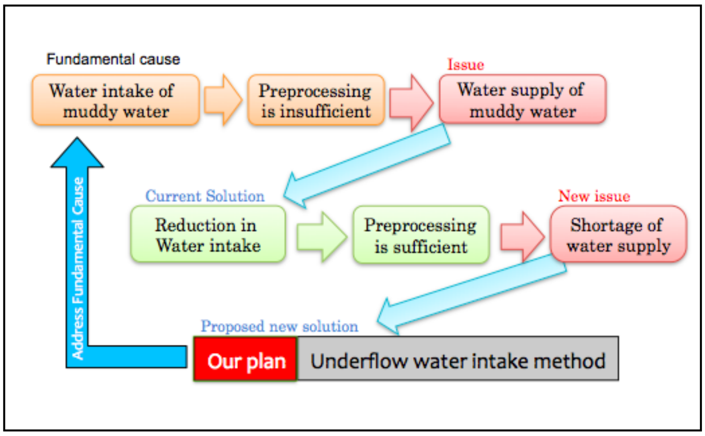
Independent State of Samoa (hereinafter referred to as “Samoa”) has insufficient access to safe water as one of its priority development agendas due to its geographical and climatic conditions. Samoa has received much international support in the field of water supply, but has met limited success. Therefore, provision of safe water through installation of water purification technology is an area that requires urgent intervention.

In the Okinawa 'Kizuna' Declaration ratified in the “6th Pacific Islands Leaders Meeting (PALM6)” held in Okinawa, Japan, on 25-26th May 2012, the Leaders reiterated the principles of mutual responsibility and ownership of the PALM process including Japan’s commitment to utilize the knowledge and experience of Okinawa in the field of water resources in the development process of the pacific islands.

JICA, as the principle agency which provides Official Development Assistance of Japan, has conducted numerous assistances in the field of water supply through Miyako-jima's Water Supply Model Project in Samoa. This Project conducted in Samoa aimed to customize the Miyako Island (Okinawa) model of water supply management.

As a member of the Okinawa Water Business Committee, Fukuyama Shoji Co., Ltd cooperated in the making of the PALM 6 proposal, also conducted the Project Formulation Survey in 2012 in Samoa and confirmed the potential for constructing a new pilot water intake facility to improve purification of water inflow into the Alaoa plant with turbidity monitoring capability.

The relevant development issue is that during periods of heavy rainfall, existing water treatment plants do not possess sufficient processing capacity to adequately purify the river water and hence muddy water can be supplied to the community. The only realistic solution at present was to reduce the volume of intake water during periods of high turbidity so that the treatment plants can handle the processing volume. However this could in turn cause a new shortage of water supply. This Pilot Survey (hereinafter referred to as “Survey”) aimed to provide a solution which addresses the fundamental cause of this development issue by utilizing the underflow water intake technology so that the turbidity of the intake water being supplied to the treatment plant is reduced to a level whereby the treatment plant can adequately process in sufficient volume.



2. OUTLINE OF THE PILOT SURVEY FOR DISSEMINATING SME'S TECHNOLOGIES

(1) Purpose

① To construct a new pilot water intake facility to improve purification of water inflow into the Alaoa plant, with turbidity monitoring capability

② To monitor and assess the effectiveness of the facility

(2) Activities

① Local Assessment (December 2013)

・Boring and Surveying

- Identified the existence and characteristics of the bedrock
- Determined the assessment process and conducted mapping from a plain table survey.

・Accident Prevention Measures

- Identified local differences in labor safety measures compared to Japan
- Adopted measures to compensate for those differences before construction commenced

・Understanding local legal system and liaising with local authorities regarding assessments etc.

-With the cooperation of Samoa Water Authority, conducted detail review of required assessments and construction permits with the Ministry of Natural Resources and Environment and the Water Resources Division

- Arranged workmen's compensation insurance related to the Survey

② Accident prevention measures（November 2013- December 2013）

Researched accident prevention measures in Japan) and proposed to local counterparties.

1.Appointment of health and safety manager (for overall construction management)

2.Appointment of sub-contractor health and safety manager (for local worker management)

3.Conduct hazard prediction activities

4.Conduct training for workers new to site

5.Prepare construction management organization chart (with photos)

Consulted with SWA, local consulting firm, local construction company and reached agreement on performing the above as appropriate in Samoa.

③ Local Legal System and Tax Research（November 2013-January 2014）

Prepared documents for necessary assessments and tariffs;

・based on referential research

・based local marketing research

④ Worker's health and safety considerations (November 2013 - December 2013)

Liaised with local parties to assess differences in worker's health and safety considerations between Japan and Samoa, and implement appropriate measures prior to commencement of construction works

- Conducted research on local laws and regulations
- Confirmed with local construction company for them to arrange worker's compensation as appropriate

⑤ Construction permission application (July 2014)

Upon discussions with PUMA, it was required to submit a Preliminary Environmental Assessment Report (PEAR) and a Development Consent Application. Upon submission of these documents PUMA issued a Development Consent as per below.

⑥ Application for tax concessions (August 2014)

Materials and equipment for the construction of the facility were exported from Japan. Discussions were held with the Samoan Ministry of Finance and Ministry of Revenue regarding the tax status of the Survey. Upon a letter being issued by the Managing Director of SWA to the Ministries along with the shipment list, duty concessions were applied to the shipment allowing for effectively tax-free import.

⑦ Preparation for construction, machine parts setting (August 2014 – September 2014)

- Exported equipment to Samoa from Japan
- Procured materials locally

⑧ Construction (September 2014 – October 2014)

- Constructed water intake facility

Installed turbidity meter and flow meter and data storage unit

	
Connection of water pipes	Installation of backwashing pipes

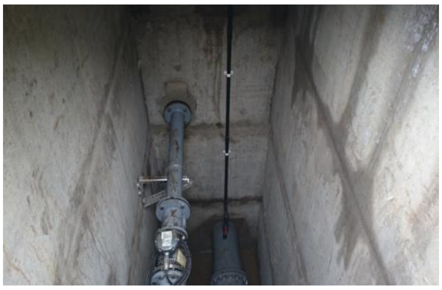
⑨ Repair works

◆ 1st Maintenance (November 2014)

・Installed air vent pipes to improve flow of water to the hydroelectric generator

・Replaced intake net of generator water pipes to improve durability and prevent clogging

・Cleaned out generator water pipes

	
Air vent pipes (left: outside chamber, right: inside chamber)	

◆ 2nd Maintenance (February 2015)

・Redesigned and constructed new structure for the intake section of the generator water pipes

New concrete structures were installed at the intake point of the generator water pipes to prevent clogging and improve water flow to the generator. However due to ongoing accumulation of mud and sand around the structure, it became impossible to maintain enough water flow to the generator to generate sufficient electricity to run the data monitoring equipment. Therefore works were conducted to connect the data monitoring equipment directly to EPC (Samoa Electric Power Company)'s electrical power lines upon completing electricity usage applications to EPC with the support of SWA.

⑩ PAC examination, machine parts setting confirmation (July 2015)

Performed PAC tests for nitrogen, nitrate nitrogen, nitrite nitrogen and iron. Levels were below detection levels for both raw river water and underflow water. Underwater cameras were used to monitor the underflow water collection chamber. Sediment buildup was negligible and no issues were found.

⑪ Data collection and analysis (March 2015 – July 2015)

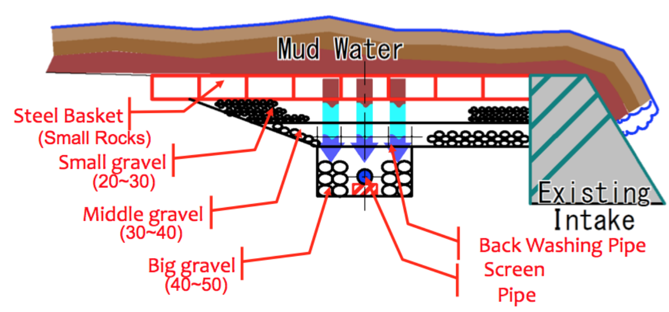
Turbidity and flow volume data was recorded by the data monitoring equipment installed onsite. The data was periodically collected and analyzed. The results of the analysis are described below in 3. ACHIEVEMENT OF THE SURVEY.

(3) Information on Product/Technology to be Provided

The water intake facility adopts the underflow water intake method whereby screen pipes are buried under the river bed and covered by layers of gravel. As dirt and debris is captured by the gravel layers before the underflow water enters the screen pipes, the turbidity of the intake water is reduced.

Small backwashing pipes with holes along the top are placed above the screen pipes. By periodically sending air through the pipes using portable air compressors, the air bubbles loosen and flush out the dirt and debris captured in the gravel layers upwards into the river stream, allowing the filtering effect of the gravel to be maintained.

A turbidity meter is used to monitor turbidity levels. The meter is powered by a small hydroelectric generator and hence does not require an external power source. The data collected is stored in a small memory device which is periodically retrieved for data extraction and analysis.



Underflow Water Intake Method Basic Structure
(Underflow water is filtered through gravel layers embedded in the riverbed and collected by underground screen pipes)

(4) Counterpart Organization

Samoa Water Authority (SWA)

(5) Target Area and Beneficiaries

Target area: Alaoa water treatment plant

Beneficiaries: User of the water from the Alaoa water treatment plant, SWA staff (knowledge improvement of the water processing technology)

(6) Duration

From November, 2013 to March, 2016

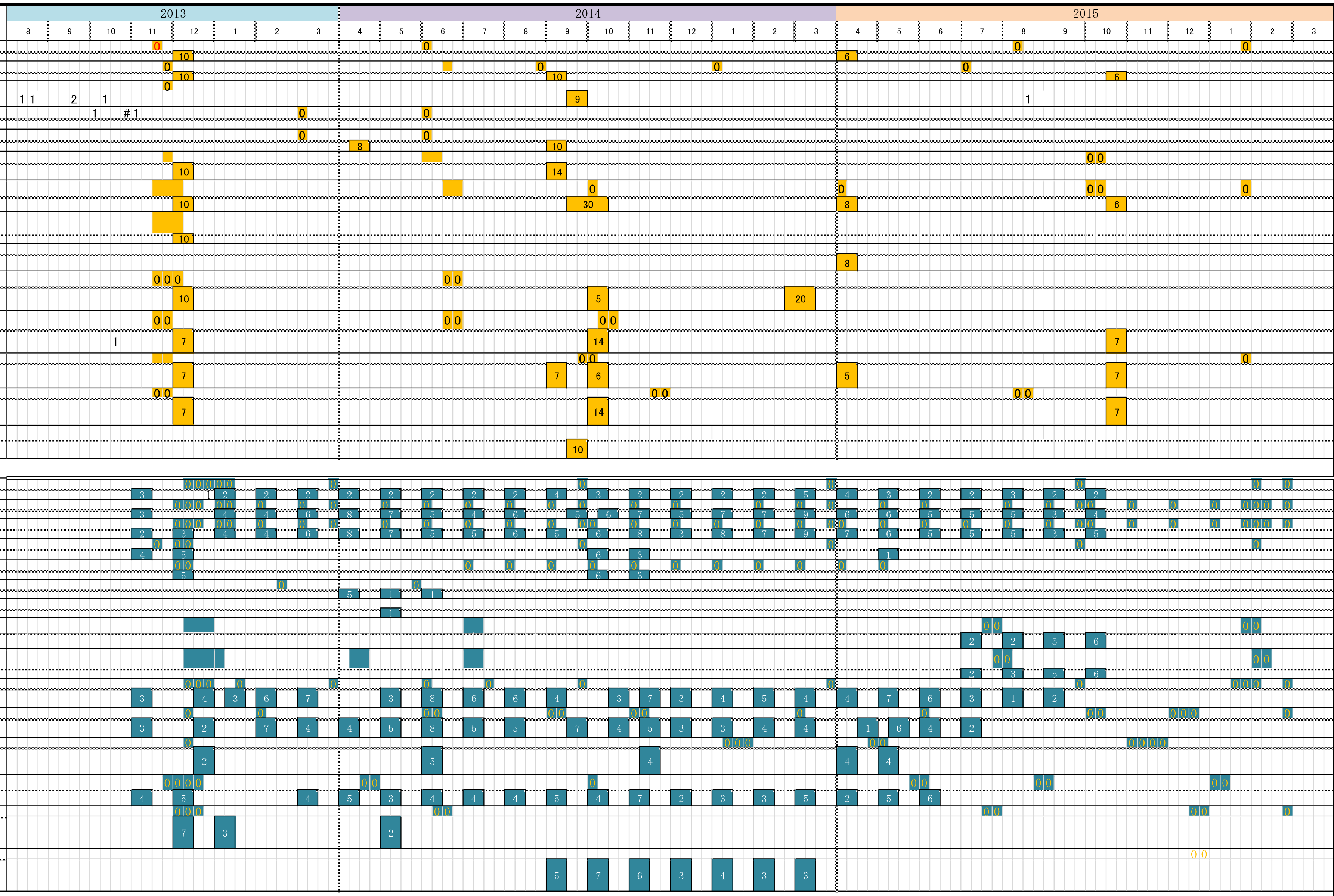
(7) Progress Schedule

Work item \ Period	2013					2014												2015											
	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
Local work																													
①Equipment Installation																													
Preparatory analysis			--- □	--- □	--- □	--- □	--- □	□	□	□																			
Geological sampling	--- □																												
Surveying	--- □																												
Assessment	--- □	--- □	--- □																										
Machine parts procurement			---	---	---	□	□	□																					
achine parts domestic transportation and departure procedure					---			□																					
marine transportation						---			□																				
Local safekeeping period							---			□																			
Accident prevention measures	--- □							---			□											---		--- □					
Equipment installation works								---			□																		
Pilot testing								---	---	---	---	--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □						
Demonstration								---			□					□		□											
②Education and training																													
Drafting operation manual								---			□	--- □	--- □		---	□		□				---	□	--- □					
Technical training of SWA staff								---			□	--- □	--- □		---	□		□				---		--- □					
Inspection training								---			□	--- □	--- □		---	□		□				---		--- □					
Maintenance and parts replacement training								---			□	--- □	--- □		---	□		□				---		--- □					
③Local study																													
Liaising with local authorities	--- □	--- □	--- □	--- □	--- □	--- □	--- □	□	□	□		--- □		---	□	□		□						--- □					
Study of local regulations and tax	--- □	--- □	--- □	--- □	--- □	--- □	--- □	□	□	□		--- □			□	□													
Study of local markets						--- □	--- □		□	□								□											
④Local Seminar																													
Open seminar to report on project results																		□				---		□					

Domestic work																													
⑤Designing		--- □	--- □	--- □	--- □	--- □	--- □	--- □	□	□																			
⑥Seminar																													
Selection of local participants																													
Create curriculum																			---	---	--- □	□	□						
Liasing with SWA and local private sector																			---	---	--- □	□	□						
Scheduling, arranging speakers																			---	---	--- □	□	□						
Conduct seminar																			---	---	--- □	□	□						
Other																													
Market research (local regulations, tax)	--- □	--- □	--- □	--- □	--- □	--- □	--- □							--- □	□	□	□							--- □					
Equipment manufacturing monitoring	--- □	--- □	--- □	--- □	--- □	--- □						--- □		--- □	□	□	□												
Arranging insurance for equipment installation	--- □	--- □	--- □	--- □	--- □	--- □									--- □	--- □	□	--- □	--- □	--- □	--- □	--- □	□						
Market analysis	--- □	--- □		--- □	--- □	--- □		--- □			--- □		--- □	--- □								---		--- □					
Create training manual			--- □	--- □	--- □	--- □					--- □				---							---		--- □					
Monthly report				--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □	--- □	---	---	---	---	
Progress report				--- □						---			□						---	□		---							
Final report draft																									---				
Final report																										---	---	---	

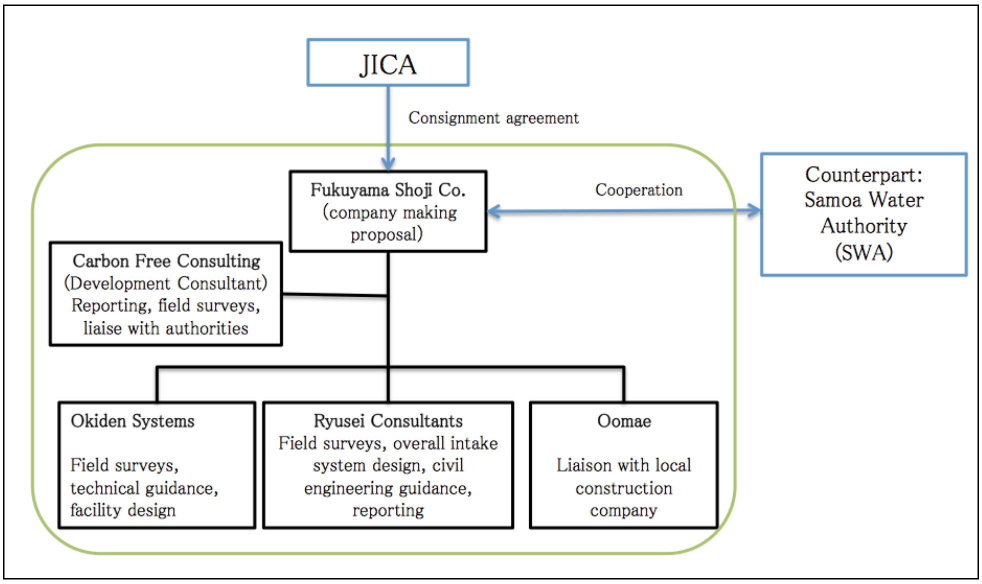
--- plan　　□ result

(8) Manning Schedule



	Role	Name	Organization	合計 現地 (plan)	合計 現地 (result)	合計 国内 (plan)	合計 国内 (result)
SAMOA	Project leader	Masayuki Fukuchi	Fukuyama Shoji Co., Ltd.	0.93	0.53		
SAMOA	Project sub-leader	Ichiro Fukuyama	Fukuyama Shoji Co., Ltd.	1.17	0.87		
SAMOA	Operations manager	Suguru Takaesu	Fukuyama Shoji Co., Ltd.	0.23	0.30		
SAMOA	Local partner cordinator	Ryunosuke Omae	Oomae Co., Ltd.				
SAMOA	Local partner liaison	Atsushi Kato	Oomae Co., Ltd.	0.47	0.60		
SAMOA	Chief Advisor (equipment design)	Hiroshi Ikemura	Ryusei Consultant Co., Ltd.	0.47			
SAMOA	Chief advisor sub (equipment design)	Keita Shinjyo	Ryusei Consultant Co., Ltd.	0.93	0.20		
SAMOA	Local study	Yoshikazu Miyagi	Ryusei Consultant Co., Ltd.				
SAMOA	Business model Development	Yoshirou Sakugawa	Okiden System Co., Ltd		0.26		
SAMOA	Equipment design, installation and operation	Masafumi Yonekawa	Okiden System Co., Ltd	1.17	1.17		
SAMOA	Consultant (Chief advisor)	Takeshi Nakanishi	Carbonfree Consulting Corporation	1.87	0.93		
SAMOA	Consultant (Chief advisor -sub)	Yasuhiro Yamaguchi	Carbonfree Consulting Corporation	1.40	0.90		
SAMOA	Consultant (Research staff)	Yuriya Muraishi	Carbonfree Consulting Corporation	1.40	0.93		
SAMOA	Field survey	Hiroaki Ishida	Carbonfree Consulting Corporation		0.33		
JAPAN	Project leader	Masayuki Fukuchi	Fukuyama Shoji Co., Ltd.			2.00	2.85
JAPAN	Project sub-leader	Ichiro Fukuyama	Fukuyama Shoji Co., Ltd.			8.00	6.35
JAPAN	Operations manager	Suguru Takaesu	Fukuyama Shoji Co., Ltd.			9.00	6.60
JAPAN	Business model Development	Yoshirou Sakugawa	Okiden System Co., Ltd			0.70	0.95
JAPAN	Reporting	Tomoe Nakamoto	Okiden System Co., Ltd			1.30	0.70
JAPAN	Local partner cordinator	Ryunosuke Omae	Oomae Co., Ltd.			0.50	0.35
JAPAN	Local partner cordinator	Atsushi Kato	Oomae Co., Ltd.				0.05
JAPAN	Chief Advisor (equipment design)	Hiroshi Ikemura	Ryusei Consultant Co., Ltd.			1.00	0.75
JAPAN	Chief advisor sub (equipment design)	Keita Shinjyo	Ryusei Consultant Co., Ltd.			1.00	0.80
JAPAN	Consultant (Chief advisor)	Takeshi Nakanishi	Carbonfree Consulting Corporation			3.50	4.95
JAPAN	Consultant (Chief advisor -sub)	Yasuhiro Yamaguchi	Carbonfree Consulting Corporation			4.00	4.30
JAPAN	Consultant (Research staff)	Yuriya Muraishi	Carbonfree Consulting Corporation			2.00	0.95
JAPAN	Consultant (local law, tax)	Mitsuyo Matsumoto	Carbonfree Consulting Corporation			2.50	3.75
JAPAN	Consultant (Technical Advisor, Monitoring)	Kosuke Ishikawa	Carbonfree Consulting Corporation				0.60
JAPAN	Consultanto (Technical advisor, Monitoring)	Ishikawa	Carbonfree Consulting Corporation			2.00	1.55
						37.50	35.50

(9) Implementation System



3. ACHIEVEMENT OF THE SURVEY

(1) Outputs and Outcomes of the Survey

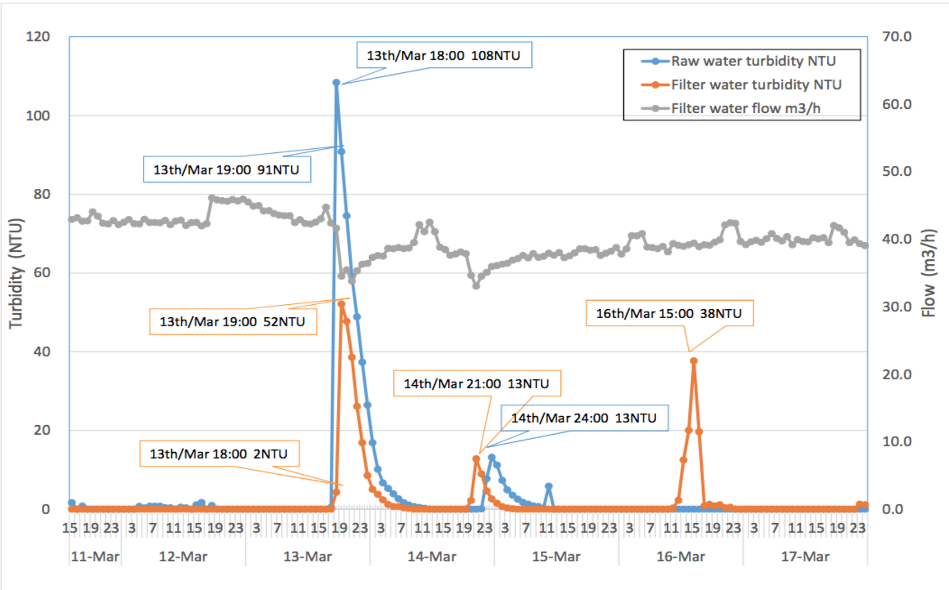
◆ **Data Collection and Analysis**

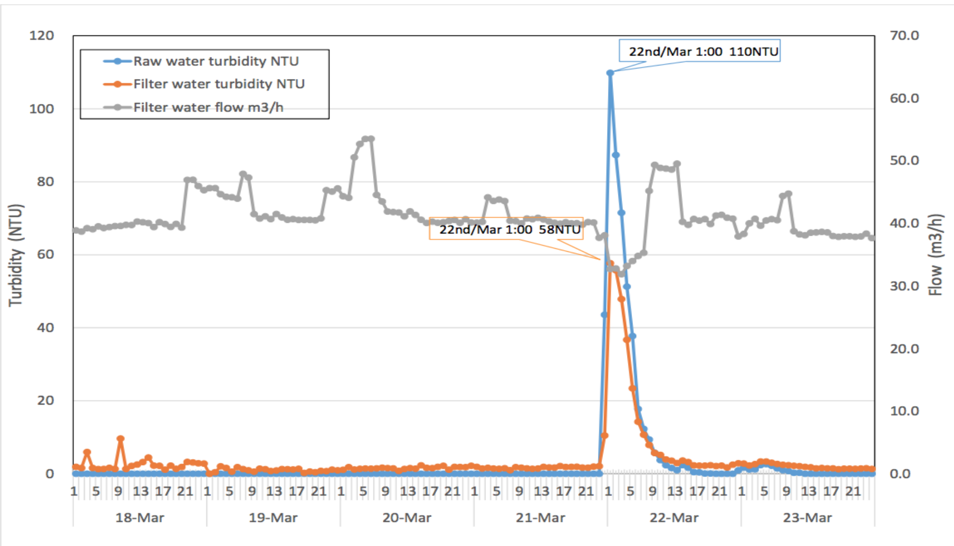
✓ Reduction in turbidity of intake water for Samoa's slow rate sand filtration pond (biological purification method)

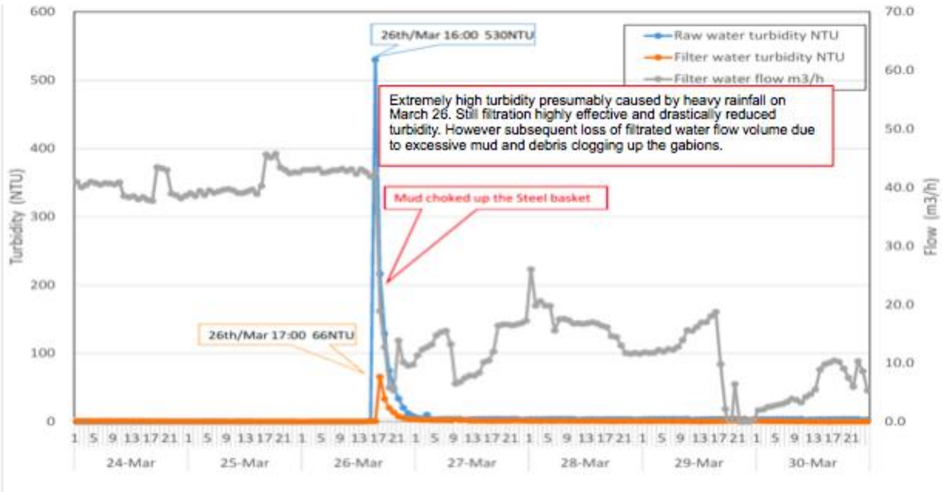
From the collected data below, it is clear that the filtrated underflow water turbidity is significantly lower than the raw water turbidity and can be reduced to around 60NTU and below even when the raw water turbidity increases up to 530NTU. This means the underflow water intake method is an effective method in reducing the turbidity of raw intake water. If the current pilot facility (water intake capacity of 1,000 m^3/day) can be scaled up to supply filtrated underflow water for the full amount required at the Alaoa water treatment plant, there will be a significant reduction in the burden on the treatment plant. By reducing the turbidity of the water flowing into the filtering tanks at the treatment plant, the frequency of maintenance work of cleaning the sand in the tanks to maintain effective filtration will be greatly reduced. Since the turbidity of the filtrated underflow water is capped at around 60NTU regardless of the increase in raw water turbidity, the size of particles managing to get through the gravel layers is thought to be limited.

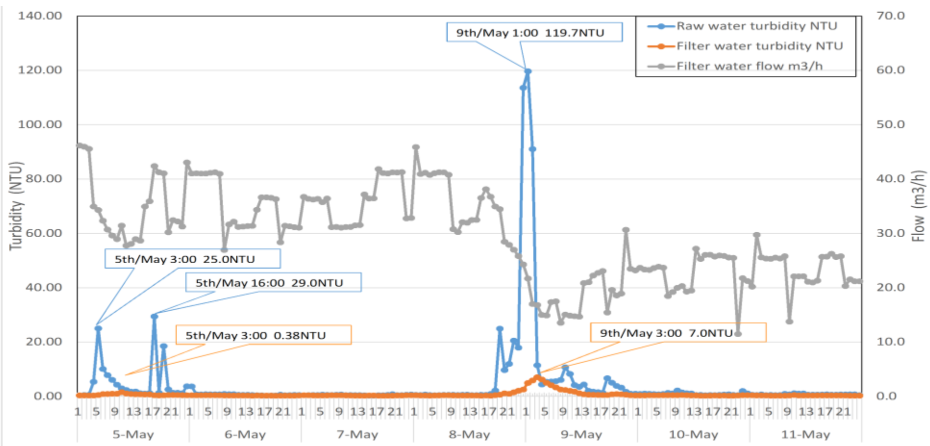
Date	Raw water Turbidity	Filtrate water Turbidity	Removal rate
13th Mar 19:00	108NTU	52.0NTU	51.9%
22nd Mar 1:00	110NTU	58.0NTU	47.3%
26th Mar 17:00	530NTU	66.0NTU	87.5%
9th May 1:00	119NTU	7.0NTU	94.1%
16th May 4:00	91NTU	6.5NTU	92.9%
18th May 3:00	67NTU	3.4NTU	94.9%
23rd May 3:00	412NTU	75.6NTU	81.7%
14th Jun 18:00	85NTU	17.5NTU	79.4%

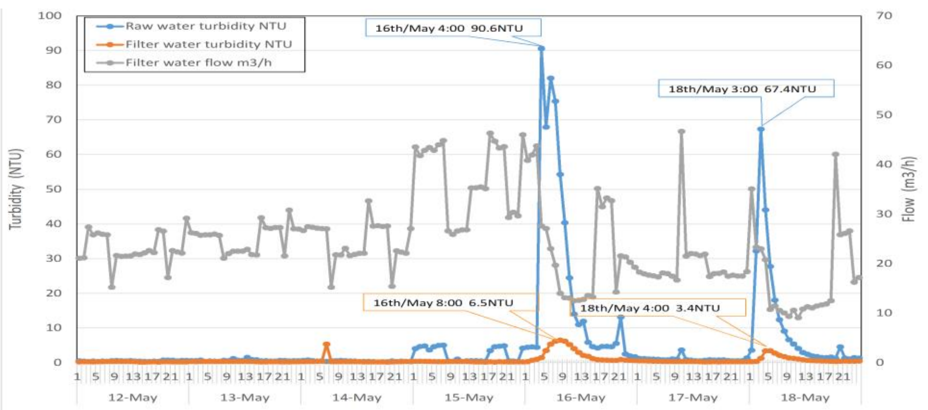
$$\text{Removal rate} = \frac{(\text{Raw water turbidity} - \text{Filter water turbidity})}{\text{Raw water turbidity}} \times 100\ (\%)$$

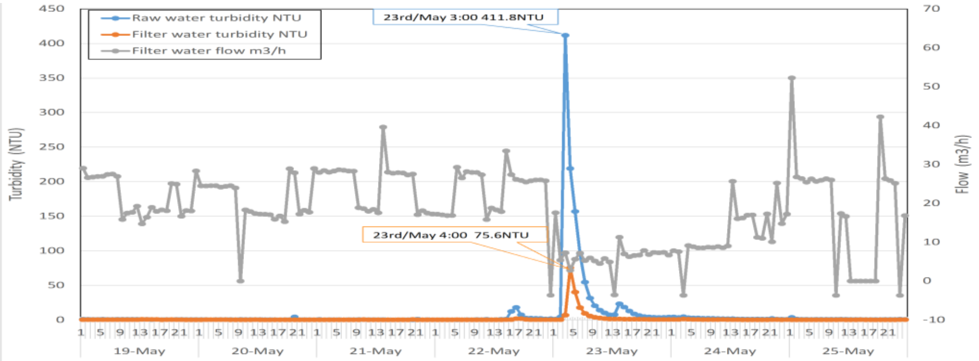


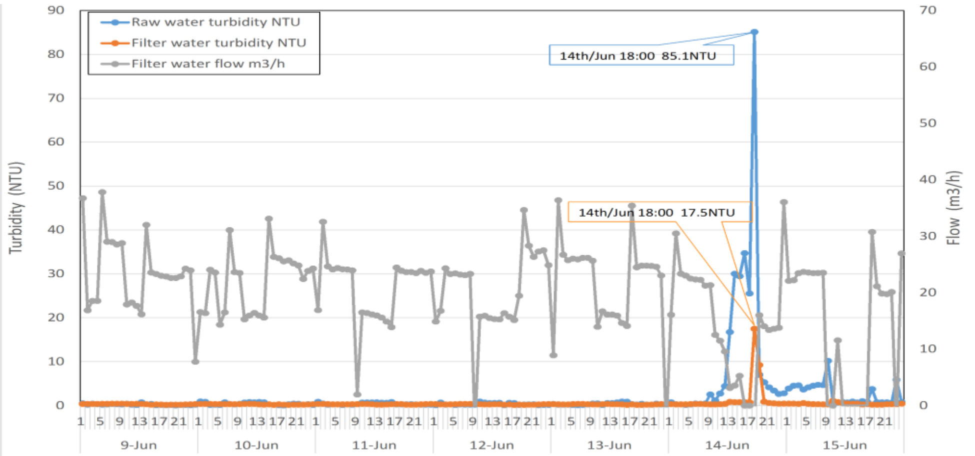



26th/Mar 16:00 530NTU
Raw water turbidity NTU
Filter water turbidity NTU
Filter water flow m3/h
Extremely high turbidity presumably caused by heavy rainfall on March 26. Still filtration highly effective and drastically reduced turbidity. However subsequent loss of filtrated water flow volume due to excessive mud and debris clogging up the gabions.
Mud choked up the Steel basket
26th/Mar 17:00 66NTU
Turbidity (NTU)
Flow (m3/h)
24-Mar
25-Mar
26-Mar
27-Mar
28-Mar
29-Mar
30-Mar


9th/May 1:00 119.7NTU
Raw water turbidity NTU
Filter water turbidity NTU
Filter water flow m3/h
5th/May 3:00 25.0NTU
5th/May 16:00 29.0NTU
5th/May 3:00 0.38NTU
9th/May 3:00 7.0NTU
Turbidity (NTU)
Flow (m3/h)
5-May
6-May
7-May
8-May
9-May
10-May
11-May


Raw water turbidity NTU
Filter water turbidity NTU
Filter water flow m3/h
16th/May 4:00 90.6NTU
18th/May 3:00 67.4NTU
16th/May 8:00 6.5NTU
18th/May 4:00 3.4NTU
Turbidity (NTU)
Flow (m3/h)
12-May
13-May
14-May
15-May
16-May
17-May
18-May





As can be seen from the collected data, significant contribution was achieved towards reduction in turbidity. The key feature of the pilot facility is that it provides stable reduction in turbidity even in cases of extremely high raw water turbidity. As noted previously in the table showing raw water turbidity, filtrated water turbidity and reduction rate, the reduction rate is over 80% even in times of high turbidity of over 300 NTU.

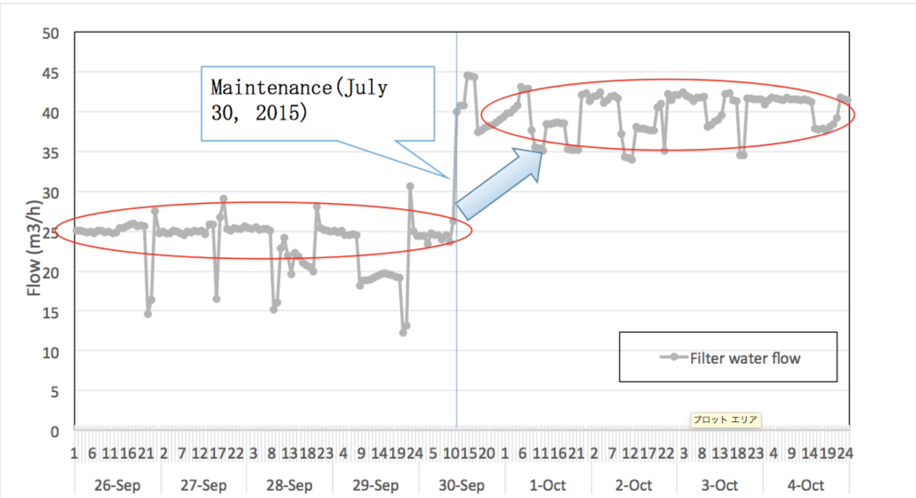
(e.g. as of 26 March 2015, the raw water turbidity was 530 NTU and filtrated water turbidity was 66 NTU resulting in a reduction rate of 87.5%. Also, as of 23 May 2015, the raw water turbidity was 412 NTU and filtrated water turbidity was 75.6NTU resulting in a reduction rate of 81.7%)

SWA was particularly impressed with this high level of turbidity reduction at the reporting meetings.

✓ <u>Stable supply of water from the backwashing system</u>

Under this Survey the target underflow water intake volume was 1,000 m^3/day, which is 1/10th of the total volume of intake water from the existing intake. Even if effective turbidity reduction is achieved, the system is not effective unless sufficient flow volume can be achieved as well. In this regard, the Survey verified that it is possible to maintain sufficient flow volume. Although the flow volume decreased considerably after heavy rainfall due to large amounts of dirt and mud accumulation, it was verified that proper maintenance works would recover the flow volume. The graph below shows the flow volume before and after maintenance works conducted on 30th July. Before the maintenance works the flow volume had reduced to around 25 m^3/hour (600 m^3/day), which is considerably lower than the target rate. After the maintenance, despite the fact that it was during the dry season and the river flow itself had decreased, the flow volume recovered to around 40 m^3/hour (960 m^3/day) , which is in line with the target rate.

Even if the turbidity reduction noted in 1 above is achieved, the overall effect of the proposed technology is diminished if the flow volume of intake water supplied to the treatment plant is reduced. From this perspective, the Survey verified that it was possible to achieve sufficient flow volume beyond the planned amount. However, it was also observed that in times of heavy rainfall and subsequent concentrated accumulation of mud and debris, the flow volume can significantly decline.



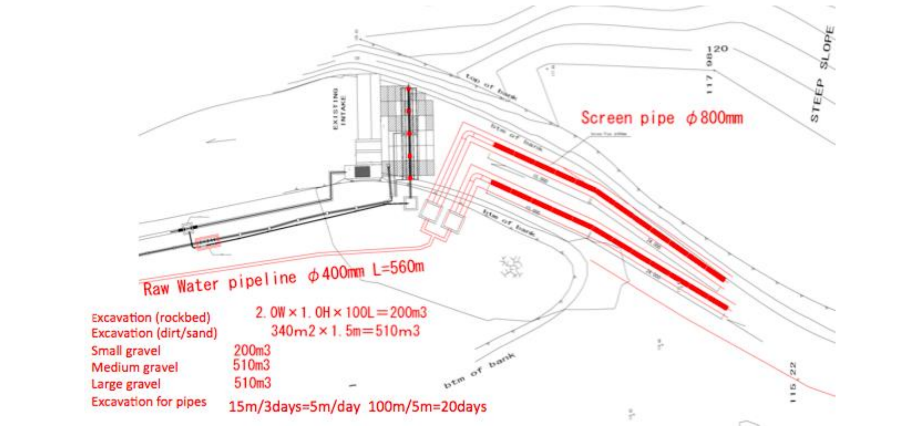
- ✓ <u>Improvement in operation and maintenance skills of SWA staff and the self-reliant operation of the facility by SWA</u>

One beneficial factor of the underflow water intake method is that frequency of maintenance work can be kept to a minimum and there is no need for any complex technique to be mastered to maintain the facility thanks to its simple design. As noted previously, the key maintenance procedures are to perform backwashing using portable compressors and washing away accumulated mud and debris from the riverbed rock layers using excavators. This has been demonstrated to SWA and their staff have been trained to conduct these procedures on their own. SWA has indicated that they highly value the fact that even if the facility was upgraded to a full scale facility the basic maintenance procedures will remain the same.

◆ **Discussions regarding potential future plans**

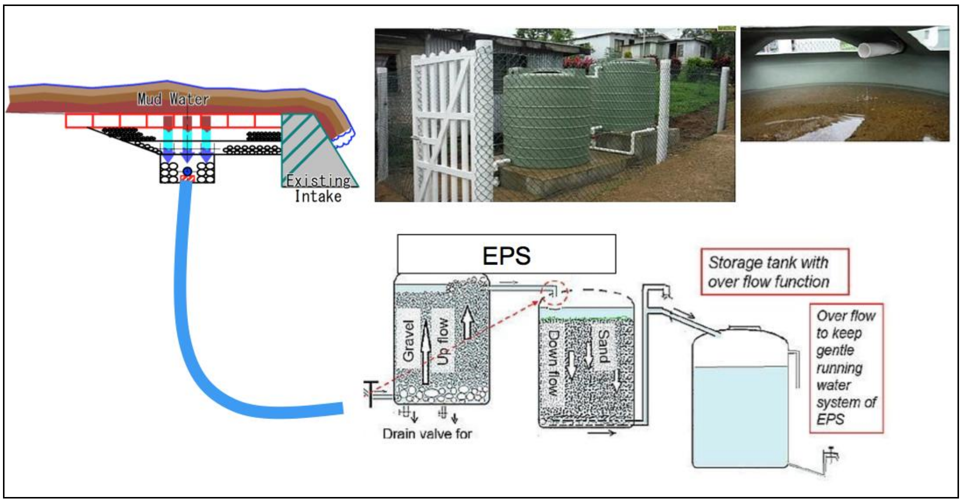
A preliminary proposal regarding a full scale upgrade of the current pilot facility to increase the underflow water intake water volume to 10,000 ㎥/day was presented. This capacity would be enough to completely replace the existing raw water intake for the Alaoa water treatment plant. Based on preliminary analysis, such an upgrade would require 80 m length screen-pipes assuming a pipe diameter of 800 mm. The proposed design actually envisages two parallel lines of screen-pipes of 40 m each to be laid beneath the riverbed. The total construction cost is estimated to be around 400 million Japanese Yen (7.58 million; Samoan Tala).

A question was asked of SWA whether a budget of this magnitude would be feasible. In reply, SWA commented that they are highly impressed by the results of the Survey and will consider the proposal including methods of financing the construction costs. Concerns remain over how SWA would be able to finance such a large scale project when currently the viability of their operations is completely reliant on overseas grants and budget support programs.



Preliminary design proposal for full-scale upgrade

Additionally, preliminary proposals for the introduction of the underflow water intake method to the Afiamahu intake were presented. It was proposed that the underflow water intake method could be combined with an Ecological Purification System (EPS). EPS is a small-scale filtration unit and can be installed efficiently at a very low cost. The existing Afiamahu intake is simply a PVC pipe laid down in the river supplying raw water directly to households, and upon inspection of the intake it was possible to see small insects and other organisms infesting the area surrounding the intake. Currently SWA is only removing leaves and other debris from the intake area on an adhoc basis and the introduction of the underflow water intake method would provide decent benefits in terms of turbidity reduction. However, the method alone will not provide purification benefits to prevent water borne diseases as can be provided with chlorine injection systems adopted at water treatment plants. Purification by EPS is ideal for a small-scale intake like Afiamahu and further purification can be achieved by chlorine injection to the water storage tank. SWA see the improvement of the Afiamahu intake as a high priority issue and showed strong interest in the proposal.



◆ **Benefits of the proposed technology**

The plain sedimentation methods and coagulating sedimentation methods are the common pre-processing technologies for turbidity reduction, but the proposed technology is also highly effective. The plain sedimentation methods and coagulating sedimentation methods are highly effective for the removal of hazardous materials from industrial waste water. The plain sedimentation methods are applied before the slow rate filtration pond to reduce the burden on the filtration pond. The plain sedimentation methods utilize simple gravity for the sedimentation of turbid material, hence referred to as natural sedimentation. Coagulating sedimentation methods utilize Polyaluminum Chlorides (PAC) to coagulate particles causing turbidity so that the coagulated particles become heavy enough for gravity to pull them down for sedimentation and removal. To further improve the efficiency of sedimentation, it is possible to install diagonally slanted boards to increase the sedimentation surface area and maximize efficiency of space usage. However, it is difficult to combine coagulating sedimentation methods with biological purification systems due to its negative impact on the microorganisms. Also, regarding the equipment lifespan, the fixtures and equipment for the proposed technology as well as for the plain sedimentation methods will last for 60 years, compared to only 12 years for the mechanical equipment required for the coagulating sedimentation method. This means the reconstruction costs for the coagulating sedimentation method becomes extremely expensive. Furthermore, when considering the impact of cyclones, the physical structure of the proposed technology is predominantly constructed underground and under the riverbed and hence highly tolerant against cyclone damage. The plain sedimentation method facilities are also structurally tough, but requires large land areas and can be exposed to flooding and landslide damage depending on its location. Coagulating sedimentation methods would require high costs of reconstruction in case of cyclone related damage to its mechanical equipment.

Comparison between proposed method and other preprocessing method

Item	Underflow water intake methods	Plain sedimentation methods	Coagulating sedimentation methods
Turbidity reduction effect	High	High	High
Required space	Main structure is constructed under the riverbed	Large area of land (49.5m x 31.5m) is necessary for construction of the sedimentation basin (5m x 25m)	Land area similar to the plain sedimentation method is necessary, including discharge tank, coagulation tank, sludge drying area
Cost of construction	Low Can procure most materials locally	Medium	High
Estimated cost of construction	7,545,034 WST (¥400,000,000) *	8,431,576 WST (¥447,000,000)*	14,146,940 WST (¥750,000,000)*
Construction complexity	Simple	Complex	Complex
Service life	60years	60years for structural parts	60years for structural parts, around 12years for machine parts
Maintenance difficulty	Easy	Moderate Requires expert staff due to more complex structure	High Requires management of coagulation agent dosage and sedimentation sludge treatment and disposal
Maintenance personnel required	1-2 people	Several people	Several people

Annual maintenance cost	Minimal 1,886〜3,773 WST (¥100,000-200,000) *	Minimal 1,886〜3,773 WST (¥100,000-200,000) *	69,792 WST (¥3,700,000) *
	Only requires fuel and machinery for backwashing	No need for chemicals or fuel, only heavy machine usage costs for periodic cleaning of sedimentation basin	Requires continuous and expensive supply of coagulation agents and electricity.
NPV of capital spending and maintenance cost	10-year capital spending (cost of construction mentioned above) and annual maintenance cost (assuming 3,773 WST a year) NPV: 7,567,236 WST (¥401,177,000) *	10-year capital spending (cost of construction mentioned above) and annual maintenance cost (assuming 3,773 WST a year) NPV: 8,465,114 WST (¥448,778,000) *	10-year capital spending (cost of construction mentioned above) and annual maintenance cost (assuming 69,792 WST a year) NPV: 14,767,330 WST (¥782,890,000) *
	30-year NPV: 7,619,938 WST (¥403,971,000) *	30-year NPV: 8,506,479 WST (¥450,971,000) *	30-year NPV: 20,338,150 WST (¥1,078,227,000) *
	NPV calculation method:	NPV calculation method:	NPV calculation method:
	Discount Rate: 2.2% of 10 years, 30 years 2.9% (cf. US Treasury yield)	Discount Rate: 2.2% of 10 years, 30 years 2.9% (cf. US Treasury yield)	Discount Rate: 2.2% of 10 years, 30 years 2.9% (cf. US Treasury yield)
	Residual value: not added	Residual value: not added	Residual value: not added
	Reinvestment：None	Reinvestment：None	Reinvestment：machine part reinstallation: year 12 and year 24
Environmental and social consideration	No waste generation	Large land area required for construction	Large land area required for construction and requires proper treatment and disposal of sedimentation sludge waste

*1WST=¥53.015　January 2016

The proposed technology is effective in reducing turbidity while maintaining sufficient intake flow volume. It does not require coagulation agents and related equipment and it does not require large areas of land, so there is no need for the procurement of large areas of land and there is little impact on the environment. Furthermore, due to its nature of turbidity reduction at the intake stage, it can improve the quality of water supplied to the slow rate filtration ponds at the treatment plant.

Based on the above, the underflow water intake method as a pre-processing technology is superior in terms of low construction and maintenance costs and low complexity of execution.

(2) Self-reliant and Continual Activities to be Conducted by Counterpart Organization

After the conclusion of the Survey, SWA will take ownership of the facility and conduct operations and maintenance. The following measures were taken in preparation for the handover.

① Maintenance of equipment

One feature of the underflow water intake method is that the cost and workload for ongoing maintenance is minimal. As noted previously, periodic backwashing combined with de-clogging of the upper riverbed stone layers using excavators as necessary is basically all that is necessary in terms of standard maintenance work. It is possible that the gabions are cut or broken due to hurricane damage but the gabions can be easily replaced from basic steel wires and stones that can easily be procured locally. Regarding the compressor used for backwashing, SWA was instructed to keep the compressor sheltered and to take care to not damage the machine when transporting to the site. It has been confirmed throughout the Pilot Survey period that these instructions have been followed. The transfer of these maintenance techniques to SWA has been completed through the handover process. Going forward, SWA will work towards passing on the knowledge internally and maintaining continuity.

② Data collection and related equipment

The flow meter and turbidity meter is currently being run on commercially supplied electricity. The cost of this electricity is around 3000 yen per month and has been paid for by us using a simple prepaid cash meter installed at the site. Going forward, SWA will need to pay for this cost if they decide to continue using the data monitoring equipment. At present, SWA is attracted to the benefit of being able to collect data around the clock automatically, in particular since at times of heavy rainfall during the rainy season the river can overflow making it impossible to physically approach the intake facility. The current view of SWA is that they will continue using the equipment at their own cost and will switch to a manual method of monitoring using portable monitoring equipment if and when necessary.

4. FUTURE PROSPECTS

(1) Impact and Effect on the Concerned Development Issues through Business Development of the Product/ Technology in the Surveyed Country

It is anticipated that business development will be based on introducing the underflow water intake method combined with EPS to various intakes in Samoa. Forming a business partnership with a local company is being considered. IPA, a local consulting firm, has been providing support through this Pilot Survey ranging from administrative processing, geological survey, construction management and data monitoring and backwashing. IPA has gained in-depth understanding of the underflow water intake method. They have worked with SWA on other projects and also have experience supporting projects in other pacific island countries. Therefore it is planned to enter into a business partnership agreement with IPA for them to provide marketing and business development support. Also, Bluebird Construction Company is another local firm that has been heavily involved in this Pilot Survey, in particular for all construction work as well as maintenance work. They have an outstanding market share in ODA and other overseas funded projects in Samoa. It is envisaged that both IPA and Bluebird will be engaged to provide support future business development upon clarifying their respective roles and business partnership structures.

Regarding the marketing and sales of sand washing machines and chlorine injection equipment, participation in bidding for grant aid “Urban Water Supply Improvement Plan” and for technical cooperation project “SWA Operations Management Improvement Project through Okinawa Collaboration” is being planned, encompassing neighboring island nations as well.

Projects such as installation of water usage meters and upgrading of water pipes to prevent leakage, or recycling of sludge generated at water treatment plants into roadbed and embankment material through granulated solidification, are potential business prospects but currently there is no concrete demand from the Samoan authorities. Through this Pilot Survey process, it has become clear that reducing costs associated with information gathering and research and developing an efficient business model by leveraging the expertise of local business partners is the best way forward. Hence, the plan is to pursue business opportunities through the development of close business partnerships with local companies.

In terms of organizational matters, upon completion of this Pilot Survey, the plan is to incorporate the “Water Business Discussion Forum” to become a new company possessing collective expertise provided by various Okinawa companies. Future business opportunities in Samoa shall be pursued through a joint venture between this new Japanese entity and a local business partner. The JV entity is expected to be incorporated as a Samoan registered company with 50/50 ownership between the new Japanese entity and a local business partner. The role of the new Japanese entity will be to provide construction planning and sales of equipment appropriate for Samoa in the water treatment, water supply and sewage areas as a company possessing a wide range of expertise in water business related designing and equipment. The role of the local business partner will be to provide marketing support leveraging its local networks as well as construction management services, licensing and other administrative support and engaging local construction companies.

① Reduction in turbidity of water supplied to slow sand filtration treatment plants (biological purification method)

The underflow water intake method will contribute towards improving the quality of water supplied to the slow sand filtration tanks through the reduction of turbidity of river water at the intake stage. This in turns contributes towards reducing the level of maintenance works necessary at the treatment plant and reducing the maintenance costs. At the Alaoa Treatment Plant, the current maintenance cost is estimated at around 5million Yen including labor costs and the purchase price of sand. Maintenance work (excavation and replacement of sand) is performed on one tank each month. This requires 5 workers and 2 excavators for a full day. Cost for the workers is 10WST/hr x 10hrs x 5 = 500WST and cost for the excavator hire is 220WST/h x 10hrs x 2 = 4,400WST, bringing the total cost over a year to 4,900WST/month x 12months = 58,800WST.

Maintenance work at Alaoa Treatment Plant

② Improvement in water supply stability and public health

By adopting backwashing for the underflow water intake, it becomes possible to prevent clogging and maintain a stable flow volume. Furthermore, by combining with EPS, smaller scale intakes can benefit from turbidity reduction as well as enhanced purification to prevent water borne diseases, which will contribute to public health improvement. There are considerable cost benefits in installing underflow water intake + EPS systems to smaller scale intakes compared to constructing water treatment plants. In the case of the Afiamahu intake, an underflow water intake + EPS system can be installed for around 10million Yen whereas an appropriate sized water treatment plant would cost around 60million Yen.

③ Improvement in operations and maintenance expertise of SWA staff

In the short term, the next step is to upgrade or newly install underflow water intakes for all intakes of Alaoa treatment plant as well for the Afiamahu intake. SWA have already gained basic knowledge of the underflow water intake method through this Pilot Survey but expanding the adoption of the system will allow for further transfer of operation and maintenance related knowledge and expertise. Furthermore, in the long term, if business development can be achieved in the secondary areas as noted previously, knowledge transfer in operation and maintenance of water meters and water pipes for leakage prevention can be achieved.

④ Others

At present, business development opportunities other than the expansion of the underflow water intake method and the bidding for treatment plant equipment is at a conceptual stage. However, installing water meters and upgrading and repairing water pipes can contribute towards reducing leakage rates and non-revenue water ratios. Furthermore a new recycling system for sludge waste can contribute towards controlling e-coli.

(2) Lessons Learned through the Survey

① Planning for repairs and maintenance of installed equipment

Throughout the Survey, more repairs and improvement work were necessary than initially anticipated. Compared to Japan, the heavy rainfall and different geological features of the river and surrounding mountains resulted in heavy accumulation of sediment at the intake point, which was the main reason for these works. Since unscheduled visits to Samoa can be extremely costly due to the travel distance and expensive airfare, it is necessary to budget for travel plans taking into account a decent margin for potential unscheduled visits due to unforeseen problems.

② Tax concessions

The government and the Ministries are very cooperative towards ODA projects and it is relatively easy to obtain duty concessions. Under the Survey, a letter was issued from the Managing Director of SWA to the Samoan Ministry of Finance and Ministry of Revenue requesting duty concessions be applied to materials and equipment imported for the project. After a detailed shipment list was provided to the Ministries, duty concessions were applied to the shipment allowing for effectively tax-free import.

③ Administrative procedures

Under this survey, it was necessary to obtain permits from MNRE (Ministry of Natural Resource and Environment) to conduct construction works in and around the river, but upon submitting the required documentation the application was processed without any issues. Also, the environmental assessment related documentation required was not excessive. As noted above, obtaining tax concessions was also straightforward. It seems that the reliance of the government budget on ODA funding helps to make the administrative process for these projects relatively easy.

④ Travel to Samoa

Frequent international conferences and festivities held in Samoa resulted in lack of accommodation availability on some occasions, forcing a change in travel plans. Flights between Japan and Samoa are also limited and seat availability can become quickly limited unless booked well in advance. It is therefore required to plan and prepare for visits early.

⑤ Climate and natural disasters

Potential risks mainly arise in the rainy season, when storms and cyclones can cause massive increase to river flow and flooding as well as causing delays in shipment arrivals. It is necessary to plan for sea freight to be shipped with plenty of time to spare. In 2009, there was extensive damage and loss of life due to a tsunami and cyclones are a common feature of the Samoan climate. Cyclones frequently cause heavy damage and it is necessary to take safety precautions and plan for disruptions. During the feasibility study for ODA project formulation, staff from Japan was in Samoa when Cyclone Evan hit and their hotel was heavily damaged, resulting in hotel being closed down.

⑥ Business and administrative culture

Due to cultural differences between Samoa and Japan, it is necessary to take into account Samoa's business practices and maintain thorough and detailed communications with local parties without presuming what is considered as common sense in Japan.

Pilot Survey for Disseminating SME's Technologies
Independent State of Samoa, Alaoa Water Treatment Plant Improvement Project

- Name of Proposing Company : Fukuyama Shoji CO., LTD
- Proposing Company Location : 4-14-17 Makinato, Urazoe City, Okinawa Prefecture
- Project Site : Independent State of Samoa, Alaoa Purification Plant
- Counterpart Imprementation Agency : Samoa Water Authority (SWA)
- Project Period : 14 November 2013～31 March 2016

Development Issues of Samoa

- High turbidity of water in rainy season, lack of water supply in dry season
- Due to the lack of water resources, efficient use of water is vital (improvement in quality of water supply)
- Improvement in maintenance management skills and proper operation through capacity development of counterparts

Matching

Technologies possessed by Proposing Company

①Underflow Water Intake System：
River underflow water is collected by screen pipes laid underground beneath layers of gravel in the riverbed which removes mud, leaves and other debris, reducing the turbidity of intake water

②Backwashing System：
Air bubbles rising from air pipes laid underground along the screen pipes removes mud and debris from the gravel layers and prevents clogging, allowing for a stable intake water supply

Contents of the Pilot Survey

- Construct a Underflow Water Intake System pilot facility alongside an existing intake at the Vaisigano River that provides water to the Alaoa Water Treatment Plant (Alaoa Road, Samoa)
- Install turbidity and flow meters at the facility, monitor and collect data on turbidity reduction and underflow water intake volume and analyze the system's effectiveness

Outcome of the Pilot Survey

- ①Reduction in the turbidity of water supplied to Slow Sand Filter (Ecological Purification System) treatment plant in Samoa ②Contribution towards a safe and stable water supply through reduced turbidity and stable underflow intake volume and improvement in public health ③Improvement in maintenance management skills of local workers of SWA and developing their capacity to operate the facility properly

Business Development

- Cooperation with Rehabilitation Plan for
- Expand to other water treatment plants in Upolu Island／Introduce technologies to neighboring island countries
- Further business development in areas of water meters, water pipeline upgrade and maintenance, treatment plant sludge recycling and sewage treatment

Impact on Development Issues

- Reduction in turbidity of water supply in urban area of Samoa
- Provide same benefits to isolated areas of Samoa, and spread to neighboring countries
- Improve overall water resource management from water supply to sewage treatment