

Livestock Waste Management in East Asia **LWMEA** (GCP/RAS/215/WBG)

The World Bank

Global Environment Facility

The Food and Agriculture Organization

Technical Backstopping on Manure Management & Environmental Monitoring

GuangDong(廣東), China(中國)

July 30 – August 02, 2007

Hong Lim Choi

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Under the terms of reference, Hong L. Choi, an international consultant for the FAO, took a mission trip to Guangzhou, China from July 30 through August 02, 2007. The objective of mission in China, was designed to evaluate and advise to the FAO and WB whether the eleven new pig farms, which had recently applied for participation of the LWMEA Project, were qualified.

The consultant visited ten candidate farms for three days. The first day, he visited four farms, Foling(佛嶺) #11, Modong(莫洞) farm #6, Dendaming(鄧達明) #7, Huantian(黃田) #2. The second day, he examined five farms including Longhu(龍湖)#8, Sanglang(上壆) #9, Xingfeng(新豐) #10, Luoxing(羅興) #4, Teimei(泰美) #1. On the last day, the consultant went to Xuhui (旭卉) #5, and Xikou(溪口) #3. The characteristics and geographical locations, and relative farm numbers of the farms are referred to in **Table 1.1** and **Figure 1.1**.

The new eleven demonstration farm should meet the criteria set by the **Annex 3 in Preparation Mission Aide-Memoire, March 14-26, 2004**, which appeared in **PIP China dated on October 25, 2005** rephrased by reflecting local situation in Guangdong, China.

A. The Criteria for the Selection of Project Farms

The proposed criteria for the selection of demonstration farms should embraces (a) achieving measurable pollution reduction within the duration of the project and (b) demonstrating good manure management practices for their replication in other areas. For these reasons, the farms (or areas) that will be implemented should:

- allow to measure, the reduction of pollution in surface water systems due to better livestock waste management at the end of the project,,

- be a representative of current and future environmental problems related to animal waste, so that there is a high likelihood that the results, and associated policies and the technological options will be transferable to other areas;

1. List of Proposed Criteria

The following is a list of proposed criteria to be used in identification and/or selection of suitable project sites (study areas) for the planned project.

1) Mandatory List

- Pig production must be dominant cause of water pollution in the area. Ideally, it should account for over 50% of the released nutrients (especially in terms of source of N, P and organic matter) *ie*: as much or more than all other livestock activity, domestic and industrialised pollution sources combined.
- The trend in the region should be one of increasing or steady pig livestock pig activity. A region with declining pig farming would not be suitable.
- The selected area should be a connecting basin representing a *single geographical catchment area*: (the boundaries should be easily identifiable, and there should be no in flow of water into the study area from neighbouring regions). In addition, the drainage of the area should run to a single surface stream to enable impact measurement.
- A local willingness must exist at both administrative level (local authorities are interested in the issue and demonstrate ownership) and the farmers level (at least 70-80% of the farms should cooperate). In addition, there must be a potential counterpart fund, and reasonable capacity in environmental management.
- The size of the study area should be enough to encompass between 50.000 and 150.000 pigs (SPP or standing pig population).

2) Optional List

- An area in which the level of underground water drainage is minimal (*ie.*, most of the collected rainwater + field drainage leave the study area by surface water)
- An area that has the capacity to include various types of pig production: for example, large modern production units, small family farms, community schemes etc.

- **The two study areas are preferably located in different agro-ecological zones to demonstrate potential differences of soil, climatic regime and environmental conditions.**
- The two selected areas should ideally have different main crops.
- A region where previous studies had been performed, on water, soil or public health (the collected data would be particularly useful, to the current project).
- A region that is reasonably accessible – no more than a 3 hours journey from Universities/Local Government offices providing technical support.
- The following is a list of proposed criteria to be used in identification and/or selection of suitable project sites (study areas) for the planned project

2. Localized Criteria for Selection of Project Farms in China

Demonstration of Livestock Waste Management Component would be implemented in one of the micro-watersheds in each country. Its focus and the result would demonstrate how practical and cost-effective manure management technologies could improve water quality.

The heart of the project lies with the introduction and operation of appropriate manure management technologies on a sufficient scale in selected areas to demonstrate the feasibility of sustainable pollution abatement. Individually, various manure management technologies have already been proven through earlier projects to benefit the region by reducing water pollution.

However unlike prior projects, the current project will deploy technology over a whole watershed or catchment area will demonstrate the impact of implementation over a larger area. These demonstration areas represent places where livestock agriculture especially from pig production is dominant. Areas are chosen where the net benefit of the particular technologies applied on the quality of water and other variables can most successfully be demonstrated.

The selected pilot area for demonstration in Guangdong Province(廣東省) is called Jiutang (九唐) region, comprise Boulo County(博羅縣). The ten new farms for project in there are dispersely situated, one each in Yuanzhou Zhen Township (園洲鎮), Taimei Zhen (泰美鎮), Longxi Zhen(龍溪鎮), Gongzhuang Zhen (公庄鎮), Luoyang Zhen (羅陽鎮), Yangcun Zhen (楊村鎮), two in Changyu Zhen (長宇鎮), three in Hu

Zhen(湖鎮). Each farms respective geographical locations and characteristics is depicted in **Figure 1.1** and **Table 1.1**.

The prevailing system for livestock manure treatment scheme in this area is the integration of pig farm-fish pond and/or fruit orchard. Most of the pig wastewater is discharged into the fish ponds which then flows into the Shahe river (沙河) by the ditches, or water streams, running into Dong Jiang (東江), and flows eventually into the Pearl River leading to the South China Sea. The pig farms are densely concentrated, as they are only separated by a distance of 300 to 1500 m between each other. Selection criteria of demonstration sites should be as follows :

- The farm shall comply with all provincial government regulations. The farms have to be located in either the blue or green line and must not be located within the lower delta (red line). The farms have to be located in blue or green line;
- Pig production should be one of the dominant causes of water pollution in the area;
- There should be an increasing or steady trend of livestock activity;
- Willingness to participate from local authorities and farmers, with a potential counterpart fund and environmental management capacity;
- The selected farms are representative of the various pig production technologies in Guangdong Province;
- Large farms according to national standards (at least 200 sows or 3000 finishers);
- The selected farms for demonstration should possibly be clustered;
- The farm is well managed and can prove satisfactory financial situation;
- The farm currently pollutes a stream (river or canal) that is a primary or secondary tributary of the Pearl River.

B. Assesement of the 11-Candidate Pig Farm with Township

The objective of this mission in China was designed to evaluate and advise the FAO and WB whether the ten new pig farms which had recently applied for participation of the LWMEA Project were qualified. It was even not an easy task for the consultant to examine all eleven farms within three days which included the transportation time from Guangzhou to Bolou county and vice versa.

The consultant exchanged thoughts with Dr. *Ai Shaoying* about spots, parameters, and methods for **Monitoring and Evaluation (M&E)** in the farms to explore the reduction of the pollution and System Technical Support were not occurred.

The task was to judge the suitability of inclusion in LWMEA Project. The judgement was based on the 9 clauses suggested by Guangdong PMO, as shown in Section 2 of this page. The assessment clauses include most importantly, the impact of pig wastewater from farm to waterstreams and the clusterness in a limited region. The next priorities may go sequentially into local government and the pig farmers' willingness and cost fund sharing, suitability of a standard technical design, and the farm size and trend in future.

The evaluation scale is classified into five grades of each clauses ,in **Table 2-1**, for instance, in a way that 'very good' receives the highest grade '5', '4' for 'good', '3' for 'moderate', '2' for 'poor', '1' for 'very poor'.

The criteria suggested by Guangdong PMO in **Table 2-1**, also categories an additional five groups which include 'L' standing for 'Location of the farm', 'WQ' for water quality, 'M' for management, 'W' for 'willingness of local government and producers', 'T' for technology suitability.

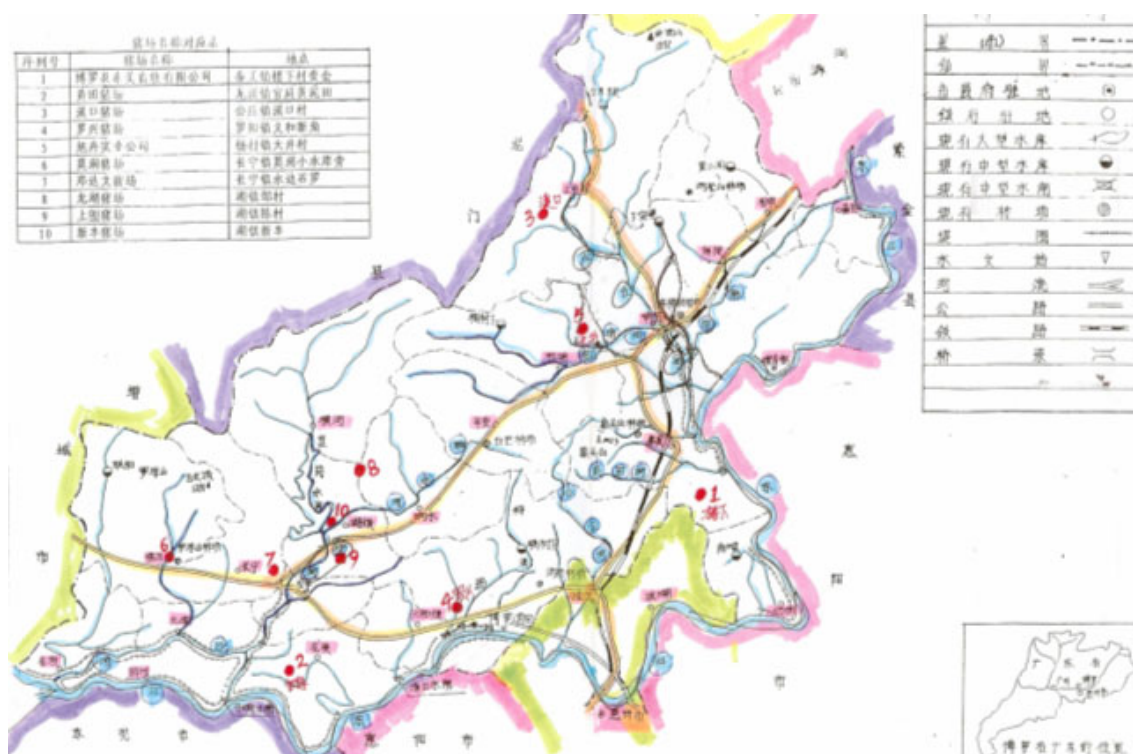


Figure 1.1. Locations of the New Pig Farms in Boluo County, Guangdong Province, China

Table 1.1. Characteristics of Candidate Farms in Boulo County, Guangdong Province'

No	Township	Name of farm	Total no. of pig, head	No. of sow head	Fish pond area, mu	Crop/Fruit land area, mu
1	Taimei	Taimei	8000	1200	80	40
2	Longxi	Huangtian	6000	550	130	100
3	GongZhuang	Xikou	3250	306	50	60
4	Luoyang	Luoxing	9000	1000	200	50
5	Yangcun	Xihui	1500	200	100	200
6	Changyu	Modong	5800	800	120	200
7	Changyu	Dengda ming	2800	300	280	600
8	Hu	Longhu	4000	300	300	100
9	Hu	Shanglang	3000	250	70	
10	Hu	Xinfeng	5000	600	200	30
11	Yuanzhou	Foling Breeding	7000	700	40	6

1 mu = 667 m² = 200 坪

However, because some of the clauses may overlap each clause of the criteria list in **Table 2-1** does not clearly distinguish those into the five categories. In this case, the clause may overlap their functions. In case, the clause is placed in the category which seems to be the most significant.

1. Taimei Township (泰美鎮)_Bolou County Pig Farm Limited (博羅縣泰美牧畜有限公司)

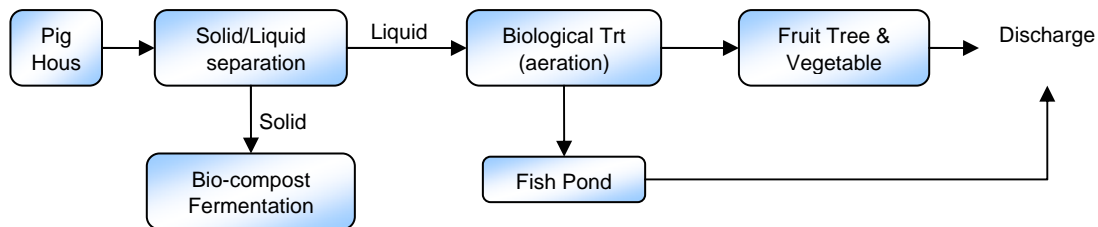
The major characteristics of Taimei Pig farm and Taimai Township are as follows:

- i. **Climate** : sub-tropical region, rainfall range of 1700-2400mm, annual mean temperature of 21°C.
- ii. **Livestock state** : the township produces pigs at about 90,000 head/year and unloads 50,000 head/year to market. The pig production amounts to approximately 21% of total revenue of the township. According to the pig production data, the township is predominated by medium and small scale farms that produce anywhere from 100-300 heads. As a result of the aforementioned data, it is reasonable to infer that pig farms were distributed in a closer geographic proximity. This pattern of farm distribution may be detrimental for proper treatment of livestock waste because a smaller farm generally does not treat waste properly and easily turns into a non-point source.
- iii. **Treatment Scheme and Technical System** : a typical scheme of a pig wastewater treatment system in the township integrates a fish pond with a fruit field. The overflow of wastewater may run into streams that leads to Dong Jiang (東江), shown in Figure 1-1.

The objective of this mission in Guangdong, China, was for the consultant to examine whether the 11 farms were eligible for participation of the LWMEA project. **Monitoring and Evaluation (M&E)** and **Technical Review** of the pig slurry treatment system with corresponding pig farms were not carried out because selection decisions generally must be carried out first before M&E and Technical support tools can be considered in the next phase. Although the consultant exchanged thoughts about M&E with Dr. Ai Shaoying, PMO staff and advised the site, parameters, and methods of sampling in part. The consultant was not able to perform any technical review for candidate farms because the sketches or technical blue-prints were not available to him (the only source that was made available was a standard anaerobic digester with a capacity of

150 ton). If anything was to be considered, the overall process of the system shown in Mini-PIP was reviewed and suggested.

Present Scheme a



Future Scheme b

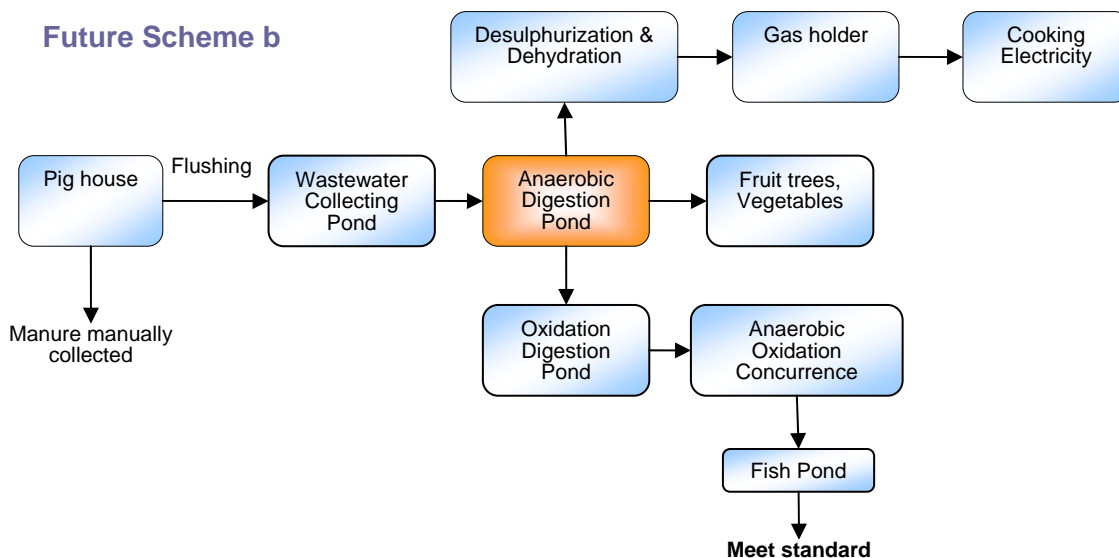


Figure 1-1a The present(a) and future(b) wastewater treatment scheme of Taimei pig farm

- i. **Checkpoints for Technical Design** : 5 days for HRT of anaerobic digester seemed to be shorter although it operates at thermophilic state, as Kurt Roos pointed out. Especially it does so when it ferments in the pond where precise control may not be possible.

Table 2-1 Numeric Significance Assessment of Criteria for Candidacy for Taimei farm

Component	Assessment Clause	Observations & Analysis	Score
L	① if farm situates in blue or green line	• The farm does <u>not</u> sit in redline (lower delta) area	5
L	② if the candidate farm forms a cluster with other farms in operation	• It is not sure if the farm was clustered, because of <u>lack of information</u> and time in the field. However the consultant easily conjectured that the farm may form a cluster, based on the livestock state (i) of the township.	3
WQ	③ if farm wastewater causes major pollution source of waterstream	• It was not easy to examine the clause ③ <u>due to lack of basic data</u> . However, one thing is for sure that pig wastewater may be the major available pollution source. Because industrial wastewater, domestic wastewater, and irrigation water for crop farming contribute stream pollution are minimal in rural area.	4
WQ	④ if the farm currently pollutes a stream that is a primary or secondary tributary of the Pearl River	• Taimei farm sits in about 500m away from 良田河. It is for sure that the wastewater introduced into 良田河, flows into Dong river, and eventually leads to Pearl River, although the wastewater turns to non-point source..	5
WQ	⑤ if livestock operation tends to increase	• Pig farms in Bolou county, in general, were found that the producers have a strong interests in increasing the size of farms. Because pork price have been staying quite good for an extended period of time, and and will maintain good. It is quite natural that Chinese people may demand more pork with increase of their income, thus more pigs produced, that unfortunately creates more serious pollution problem, unless they take an effective measure immediately. Therefore it is important to include this farm into LWMEA Project..for abatement of pollution.	5
M	⑥ if the farm operates at medium/large scale, that grows more than 200 sows or 3000 finishers	• Taimei pig farm produces far more than the suggested criteria in farm size.	5
M	⑦ if the candidate farm is financially healthy	• It is impossible for the consultant if the management and financial situation of Taimei pig farm are well. Because he was constrained <u>by not only time but also availability of basic data</u> . However, the consultant easily infers it keeps both well from the fact that it extends its size	4
W	⑧ if local authority and farmers shows strong <u>willingness</u> to participate	• The consultant found that Guangdong PMO, Bolou county authority, and pig producers were very keen to participate in the LWMEA Project.	5
W	⑨ if local authority and farmers are <u>willing to invest</u> a potential counterpart fund and environmental management capacity	• The consultant found that Guangdong PMO, Bolou county authority, and pig producers were ready to share costs for installation of treatment system. The producers the consultant met in the mission showed much stronger interests in participation than any other groups.	5
T	⑩ the selected farms are representative of the	• Guangdong PMO has developed a standard treatment system which does not match with the	3

	various pig production technologies in Guangdong Province	scheme shown in Figure 2-2.. The details of the treatment system seemed to be done but <u>not available</u> for technical review. HRT of AD pond of 5 days should extend to longer 10-15 days.	
	Total Score		45

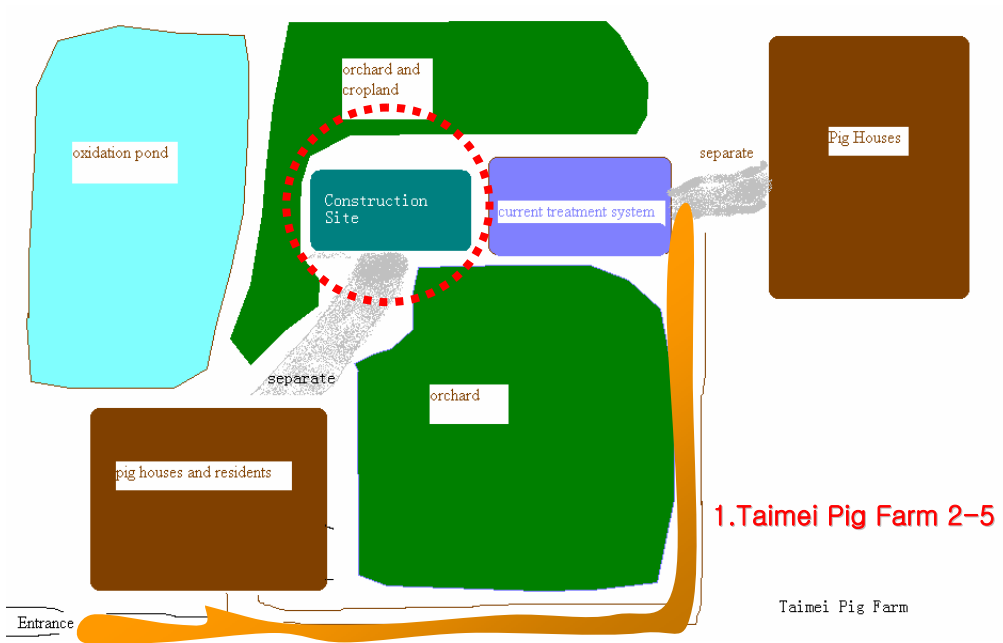


Figure 2.1b Arrangement of Taimei Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China



Figure 2.1c Present pig wastewater treatment system of Tamei Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China

2. Longxi Township (龍溪鎮)_Huangtian Pig Farm (黃田豬場)

The major characteristics of Huangtian Pig farm and Longxi Township are as follows:

- i. **Climate** : sub-tropical region, rainfall range of 1700-2400mm, annual mean temperature of 21 °C.
- ii. **Livestock state** : the township produces pigs of about 78,000 head, and unloads 50,000 head/year to market, that amounts to 34% of total revenue of the township. The contribution proportion is much higher than that of Taimei township. The fact that medium and smaller pig farms are densely populated seems true in not only Longxi Township but also other township in Bolou county.
- iii. **Monitoring and Evaluation (M&E)** : the consultant discussed M&E with Dr. Ai Shaoying, and advised the sites, parameters, and methods of sampling in part. Thorough review should take place in next stage.
- iv. **Treatment Scheme and Technical Support** : a typical scheme of pig wastewater treatment system in the township integrates with fish pond and/or fruit field. The overflow of wastewater may run into streams that leads to Dong

Jiang (東江), As shown in Figure 1-1, Huangtian farm sits in very close to one tributary of Dong Jiang. The consultant was not able to perform any technical review for treatment system of Huangtian pig farm due to unavailability of information. The details of technical design may take place in next stage.

- v. **Checkpoints for Technical Design** : 10 days for HRT of anaerobic digester seemed to be reasonable. However it would be better to extend HRT to 15 days because it operates in a sap-type reinforced concrete structure of 600 m³ that is relatively large volume.

Present Scheme a

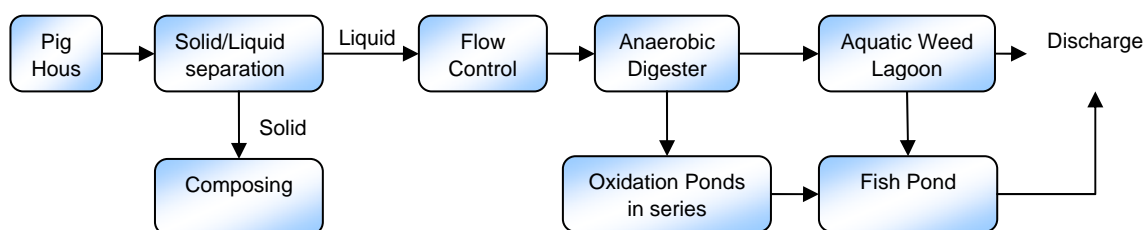


Table 2-2 Numeric Significance Assessment of Criteria for Candidacy of Huangtian farm

Component	Assessment Clause	Observations & Analysis	Score
L	① if farm situates in blue or green line	• The farm does <u>not</u> sit in redline (lower delta) area	5
L	② if the candidate farm forms a cluster with other farms in operation	• It is not sure if the farm was clustered, because of <u>lack of information</u> and time in the field. However the consultant easily conjectured that the farm may form a cluster, based on the livestock state (i) of the township.	3
WQ	③ if farm wastewater causes major pollution source of waterstream	• It was not easy to examine the clause ③ due to <u>lack of basic data</u> . However, one thing is for sure that pig wastewater may be the major available pollution source. Because industrial wastewater, domestic wastewater, and irrigation water for crop farming contribute stream pollution are <u>minimal</u> in rural area.	3
WQ	④ if the farm currently pollutes a stream that is a primary or secondary tributary of the Pearl River	• Haungtian farm sits in about 300m away from one tuributary of DongJiang. and eventually leads to Pearl River, although the wastewater turns to non-point source..	5
WQ	⑤ if livestock operation tends to increase	• Pig farms in Bolou county, in general, were found that the producers have a strong interests in increasing the size of	5

		farms. The reasoning was described in detail in Taimei farm section. Therefore it is important to include this farm into LWMEA Project..for abatement of pollution.	
<i>M</i>	⑥ if the farm operates at medium/large scale, that grows more than 200 sows or 3000 finishers	• Huantian pig farm produces far more than the suggested criteria in farm size.	5
<i>M</i>	⑦ if the candidate farm is financially healthy	• It is impossible for the consultant if the management and financial situation of Huantian pig farm are well. Because he was constrained by not only time but also unavailability of basic data. However, the consultant easily infers it keeps both well because the producer is ready to invest new treatment system.	3
<i>W</i>	⑧ if local authority and farmers shows strong <u>willingness</u> to participate	• The consultant found that Guangdong PMO, Bolou county authority, and pig producers were very keen to participate in the LWMEA Project.	5
<i>W</i>	⑨ if local authority and farmers are <u>willing to invest</u> a potential counterpart fund and environmental management capacity	• The consultant found that Guangdong PMO, Bolou county authority, and pig producers were ready to share costs for installation of treatment system.	5
<i>T</i>	⑩ the selected farms are representative of the various pig production technologies in Guangdong Province	• Guangdong PMO has developed a standard system, shown in Figure 2-2. consultant found that Guangdong PMO, Bolou county authority, and pig producers	4
	Total Score		43

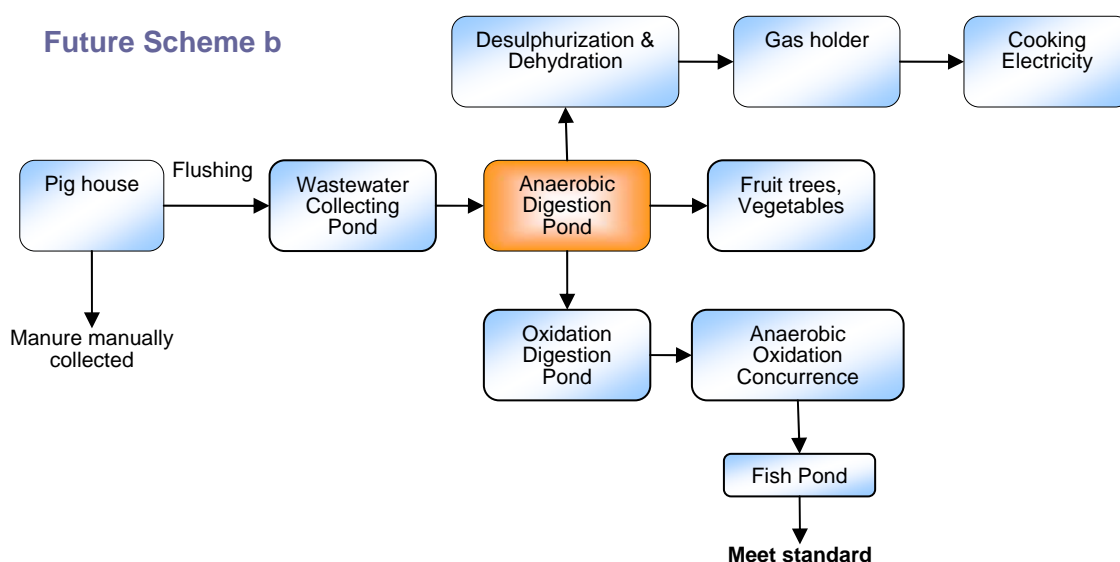


Figure 1-2 The present (a) and future (b) wastewater treatment scheme of Huangtian pig farm

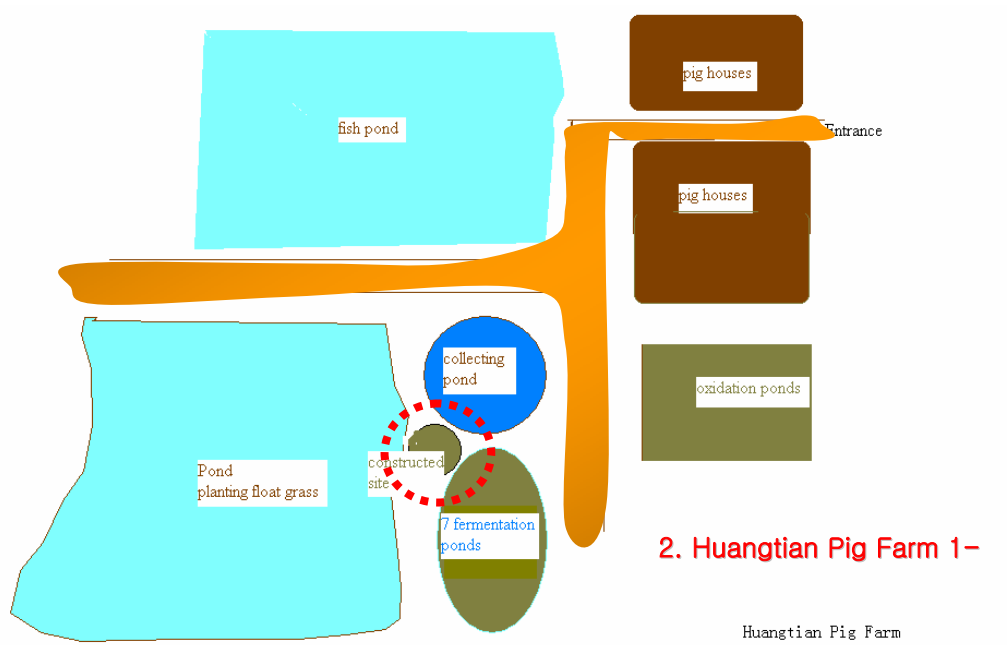


Figure 2.2b Arrangement of Huangtian Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China



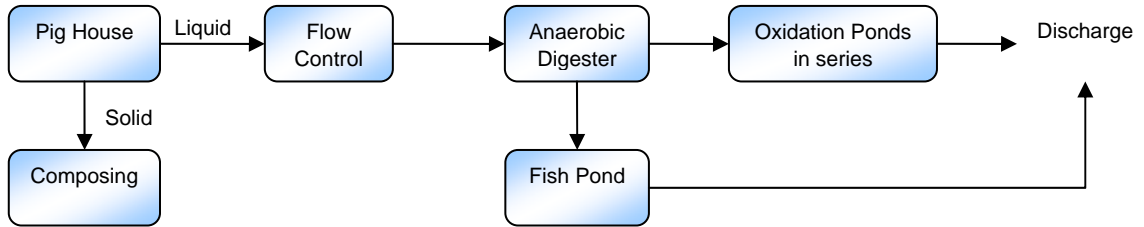
Figure 2.2c Present pig wastewater treatment system of Huantian Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China

3. GongZhuang (公庄鎮) Xikou Pig Farm (溪口豬場)

The major characteristics of Xikou Pig farm and Gongzhuang Township are as follows:

- i. **Climate** : sub-tropical region, rainfall range of 1700-2400mm, annual mean temperature of 21 °C.
- ii. **Livestock state** : the township produces pigs of about 52,400 head, and unloads 31,000 head/year to market, that amounts to 22% of total revenue of the township. The contribution proportion is much the same as that of Taimei township. Medium and smaller pig farms are less populated in Gongzhuang township unlikely Longxi and Taimei township in Bolou county.
- iii. **Monitoring and Evaluation (M&E)** : the consultant discussed M&E with Dr. Ai Shaoying, and advised the sites, parameters, and methods of sampling in part. Thorough review should take place in next stage.
- iv. **Treatment Scheme and Technical Support** : a typical scheme of pig wastewater treatment system in the township integrates with fish pond and/or fruit field. As shown in Figure 1-1, Xikou farm sits in very close to Gongzhuang river which is one major tributary of Dong Jiang. The consultant was not able to perform any technical review for treatment system of Xikou pig farm due to unavailability of information. The details of technical design may take place in next stage.
- v. **Checkpoints for Technical Design** : 7 days for HRT of anaerobic digester seemed to be a bit shorter. However it would be better to extend HRT to 10-15 days because it operates in a sap-type reinforced concrete structure of 400 m³ that is relatively large volume.

Present Scheme a



Future Scheme b

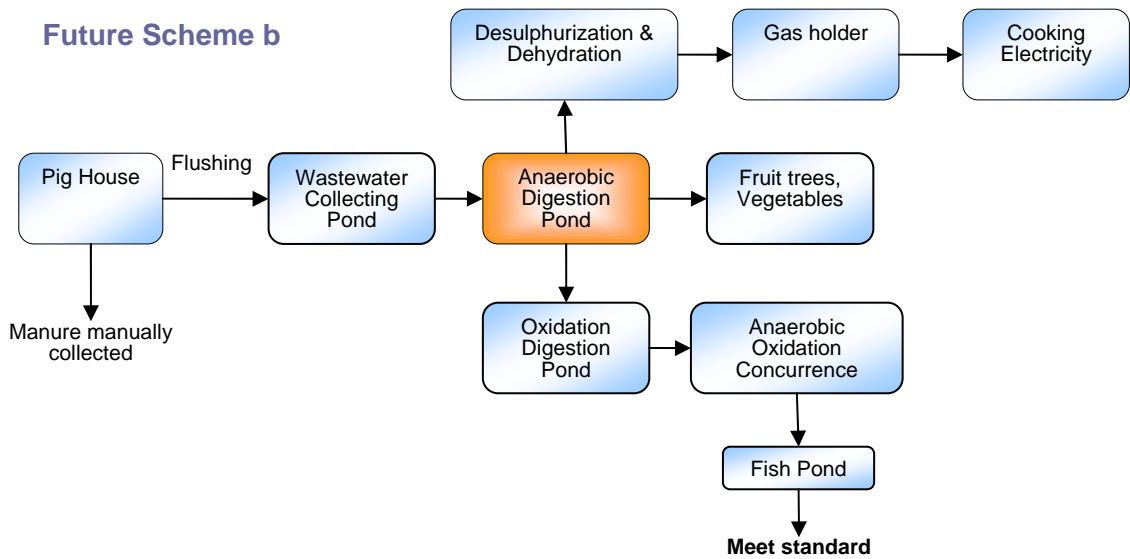


Figure 2-3a The present(a) and future(b) wastewater treatment scheme of Xikou pig farm

Table 2-3 Numeric Significance Assessment of Criteria for Candidacy of Xikou farm

Component	Assessment Clause	Observations & Analysis	Score
L	① if farm situates in blue or green line	• The farm does <u>not</u> sit in redline (lower delta) area	5
L	② if the candidate farm forms a cluster with other farms in operation	• It is not sure if the farm was clustered, because of <u>lack of information</u> and time in the field. However the consultant easily conjectured that the farm may form a cluster, based on the livestock state (i) of the township.	3
WQ	③ if farm wastewater causes major pollution source of waterstream	• It was not easy to examine the clause ③ <u>due to lack of basic data</u> . However, one thing is for sure that pig wastewater may be the major available pollution source. Because industrial wastewater, domestic wastewater, and irrigation water for crop farming contribute stream pollution are <u>minimal</u> in rural area.	3
WQ	④ if the farm currently pollutes a stream that is a primary or secondary tributary of the Pearl River	• Xikou farm sits in about 300m away from one tributary of DongJiang. and eventually leads to Pearl River, although the wastewater turns to non-point source..	5
WQ	⑤ if livestock operation tends to increase	• Pig farms in Bolou county, in general, were found that the producers have a strong interests in increasing the size of farms. The reasoning was described in detail in Taimei farm section. Therefore it is important to include this farm into LWMEA Project..for abatement of pollution.	5
M	⑥ if the farm operates at medium/large scale, that grows more than 200 sows or 3000 finishers	• Xikou pig farm produces far more than the suggested criteria in farm size.	5
M	⑦ if the candidate farm is financially healthy	• It is impossible for the consultant if the management and financial situation of Xikou pig farm are well. Because he was constrained by not only time but also <u>unavailability of basic data</u> . However, the consultant easily infers it keeps both well because the producer is ready to invest new treatment system.	3
W	⑧ if local authority and farmers shows strong <u>willingness</u> to participate	• The consultant found that Guangdong PMO, Bolou county authority, and pig producers were very keen to participate in the LWMEA Project.	5
W	⑨ if local authority and farmers are <u>willing to invest</u> a potential counterpart fund and environmental management capacity	• The consultant found that Guangdong PMO, Bolou county authority, and pig producers were ready to share costs for installation of treatment system.	5+
T	⑩ the selected farms are representative of the various pig production technologies in Guangdong Province	• Guangdong PMO has developed a standard system, shown in Figure 2-2. consultant found that Guangdong PMO, Bolou county authority, and pig producers	4
	Total Score		45

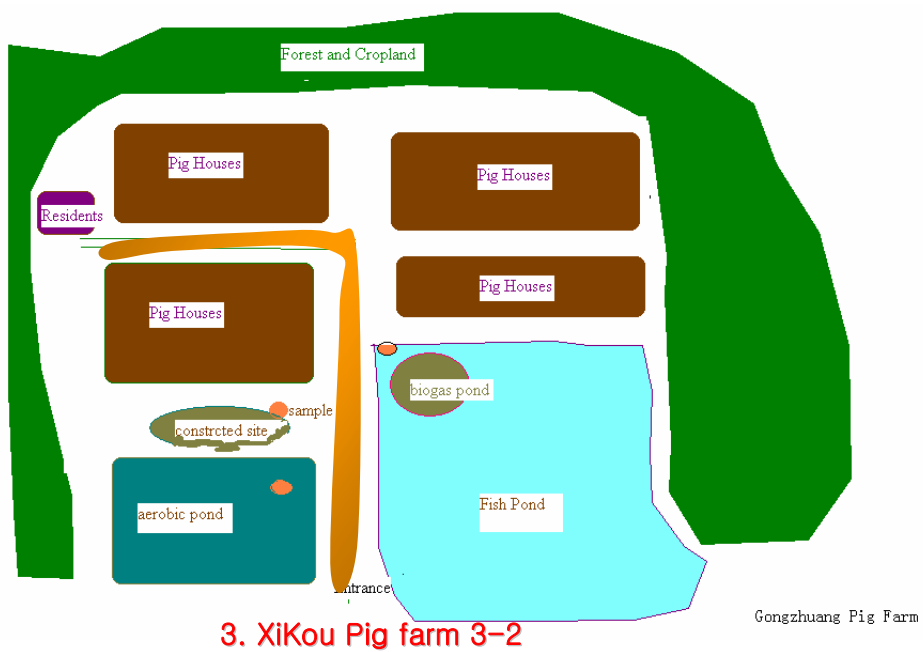


Figure 2.3b Arrangement of Huangtian Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China



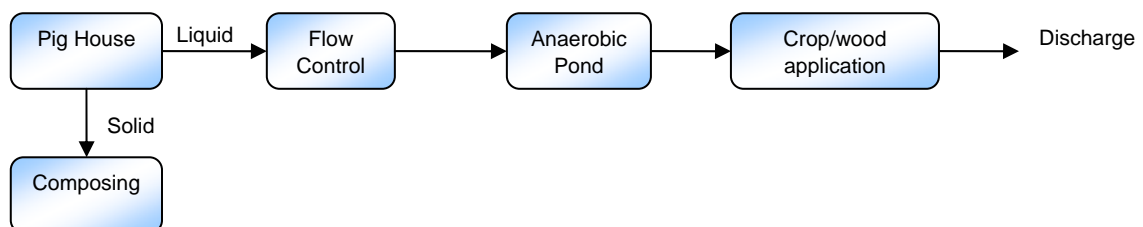
Figure 2.3c Contemporary pig wastewater treatment system of Xikou Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China

4. Louyang Township (羅陽鎮)_Louxing Pig Farm (羅興豬場)

The major characteristics of Xikou Pig farm and Gongzhuang Township are as follows:

- I. **Climate** : sub-tropical region, rainfall range of 1700-2400mm, annual mean temperature of 21 °C .
- II. **Livestock state** : the township produces pigs of about 102,800 head, and unloads 73,800 head/year to market, that amounts to 21% of total revenue of the township. The contribution proportion is much the same as that of Taimei township. Medium and smaller pig farms are densely populated in Louyang township like Longxi and Taimei township in Bolou county.
- III. **Monitoring and Evaluation (M&E)** : the consultant discussed M&E with Dr. Ai Shaoying, and advised the sites, parameters, and methods of sampling in part. Thorough review should take place in next stage.
- IV. **Treatment Scheme and Technical Support** : a typical scheme of pig wastewater treatment system in the township integrates with fish pond and/or fruit field. As shown in Figure 1-1, Louxing farm sits by Dong Jiang so that impact of improper treatment may be much more serious than any other farms. The consultant was not able to perform any technical review for treatment system of Louxing pig farm due to unavailability of information. The details of technical design may take place in next stage.
- V. **Checkpoints for Technical Design** : 6 days for HRT of anaerobic digester seemed to be much shorter. It would be advisable to extend HRT to 10-15 days because it operates in a sap-type reinforced concrete structure of 800 m³ that is relatively large volume.

Future Scheme b Scheme



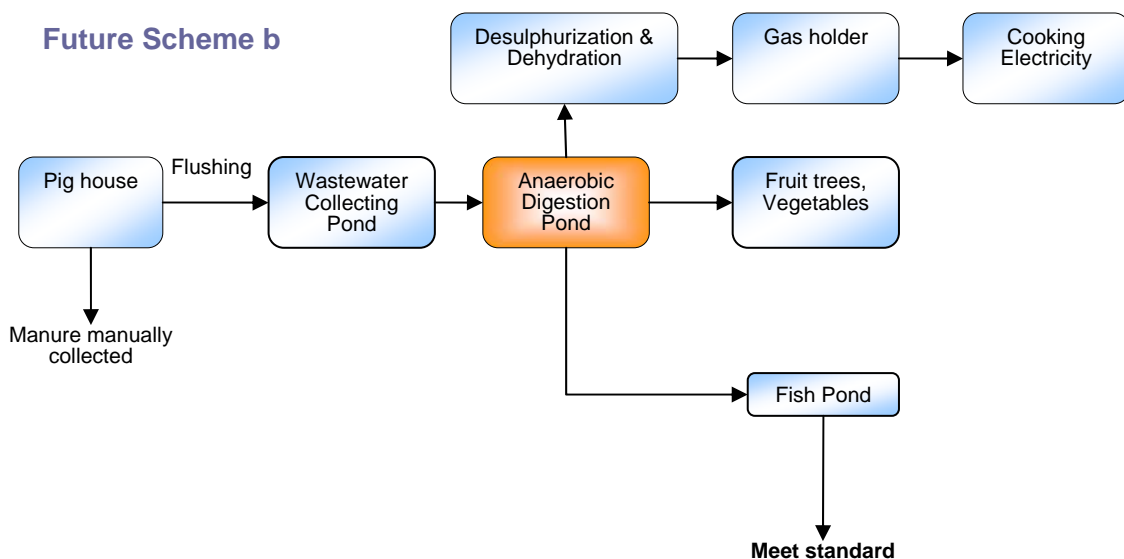
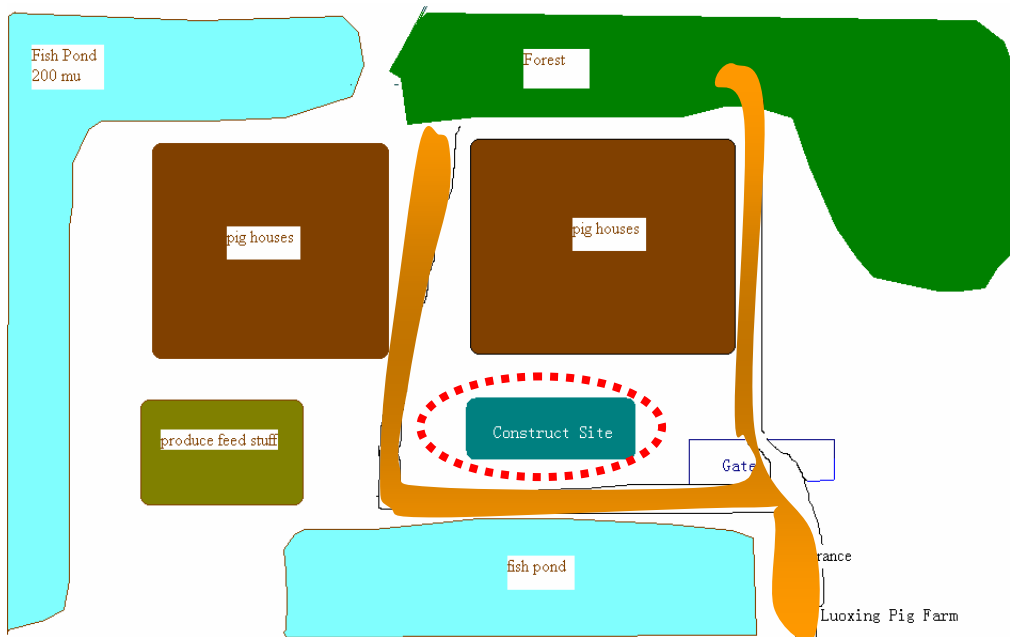


Figure 2-4a The present(a) and future(b) wastewater treatment scheme of Xikou pig farm

Table 2-4 Numeric Significance Assessment of Criteria for Candidacy of Louxing farm

Component	Assessment Clause	Observations & Analysis	Score
L	① if farm situates in blue or green line	• The farm does <u>not</u> sit in redline (lower delta) area	5
L	② if the candidate farm forms a cluster with other farms in operation	• It is not sure if the farm was clustered, because of <u>lack of information</u> and time in the field. However the consultant easily conjectured that the farm may form a cluster, based on the livestock state (i) of the township.	3
WQ	③ if farm wastewater causes major pollution source of waterstream	• It was not easy to examine the clause ③ <u>due to lack of basic data</u> . However, one thing is for sure that pig wastewater may be the major available pollution source. Because industrial wastewater, domestic wastewater, and irrigation water for crop farming contribute stream pollution are minimal in rural area.	5
WQ	④ if the farm currently pollutes a stream that is a primary or secondary tributary of the Pearl River	• Louxing farm sits by DongJiang. and eventually leads to Pearl River, although the wastewater turns to non-point source..	5
WQ	⑤ if livestock operation tends to increase	• Pig farms in Bolou county, in general, were found that the producers have a strong interests in increasing the size of farms. The reasoning was described in detail in Taimei farm section. Therefore it is important to include this farm into LWMEA Project..for abatement of pollution.	5
M	⑥ if the farm operates at medium/large scale, that	• Louxing pig farm produces far more than the suggested criteria in farm size.	5

	grows more than 200 sows or 3000 finishers		
<i>M</i>	⑦ if the candidate farm is financially healthy	<ul style="list-style-type: none"> It is impossible for the consultant if the management and financial situation of Xikou pig farm are well. Because he was constrained by not only time but also <u>unavailability of basic data</u>. However, the consultant easily infers it keeps both well because the producer is ready to invest new treatment system. 	5
<i>W</i>	⑧ if local authority and farmers shows strong <u>willingness</u> to participate	<ul style="list-style-type: none"> The consultant found that Guangdong PMO, Bolou county authority, and pig producers were very keen to participate in the LWMEA Project. 	5
<i>W</i>	⑨ if local authority and farmers are <u>willing to invest</u> a potential counterpart fund and environmental management capacity	<ul style="list-style-type: none"> The consultant found that Guangdong PMO, Bolou county authority, and pig producers were ready to share costs for installation of treatment system. 	5
<i>T</i>	⑩ the selected farms are representative of the various pig production technologies in Guangdong Province	<ul style="list-style-type: none"> Guangdong PMO has developed a standard system, shown in Figure 2-2. consultant found that Guangdong PMO, Bolou county authority, and pig producers 	3
	Total Score		45



4. Luoxing Pig Farm 2-4

Figure 2.4b Arrangement of Louxing Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China



Figure 2.4c Contemporary pig wastewater treatment system of Louxing Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China

5. Yangcun Township (陽村鎮)_Xuhui Pig Farm (旭卉豬場)

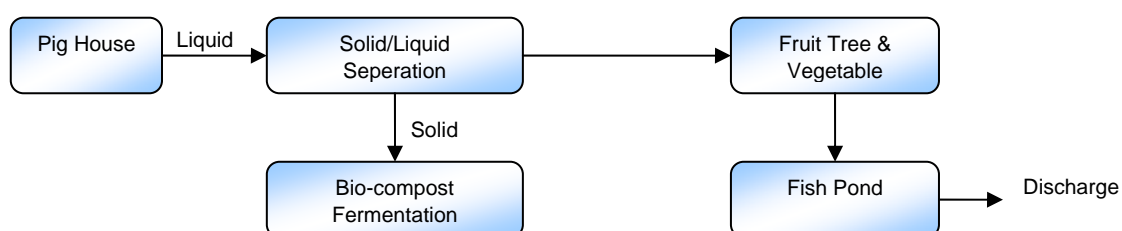
The major characteristics of Xuhui Pig farm and Yangcun Township are as follows:

- I. **Climate** : sub-tropical region, rainfall range of 1700-2400mm, annual mean temperature of 21 °C.
- II. **Livestock state** : the township produces pigs of about 42,600 head, and unloads 32,300 head/year to market, that amounts to 16% of total revenue of the township. The contribution proportion is a bit lower than other township. Medium and smaller pig farms seem to be less densely situated than any other township.
- III. **Monitoring and Evaluation (M&E)** : the consultant discussed M&E with Dr. Ai Shaoying, and advised the sites, parameters, and methods of sampling in part. Thorough review should take place in next stage.
- IV. **Treatment Scheme and Technical Support** : a typical scheme of pig wastewater treatment system in the township integrates with fish pond and/or fruit field. As shown in Figure 1-1, Xuhui farm sits near a tributary of Dong Jiang. The consultant was not able to perform any technical review for treatment system

of Louxing pig farm due to unavailability of information. The details of technical design may take place in next stage.

- V. **Checkpoints for Technical Design** : 7 days for HRT of anaerobic digester seemed to be a bit shorter. It would be advisable to extend HRT to 10-15 days because it operates in a sap-type reinforced concrete structure of 600 m³ that is relatively large volume.

Future Scheme a



Future Scheme b

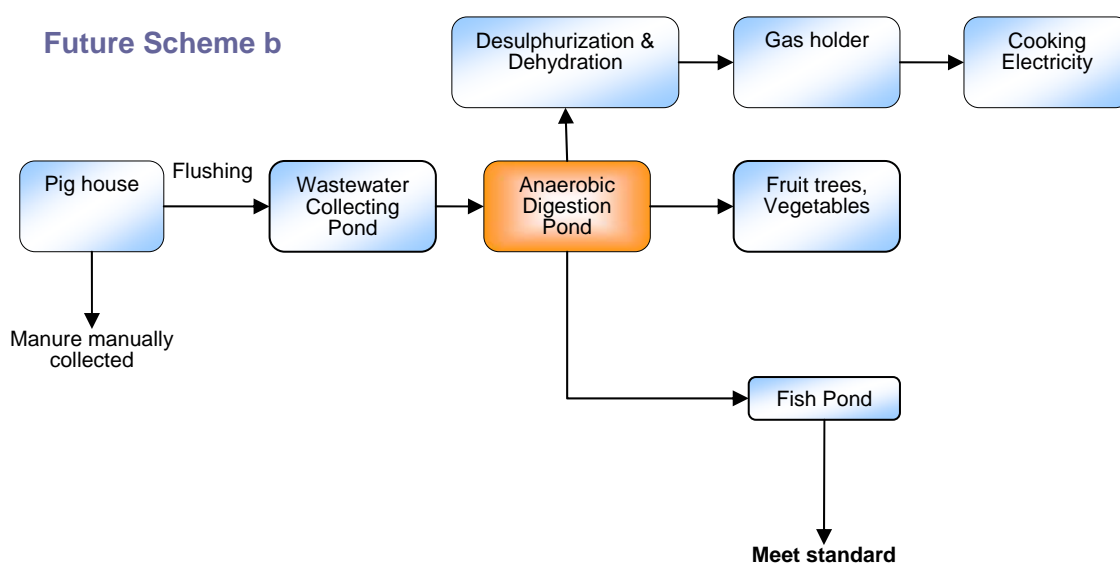
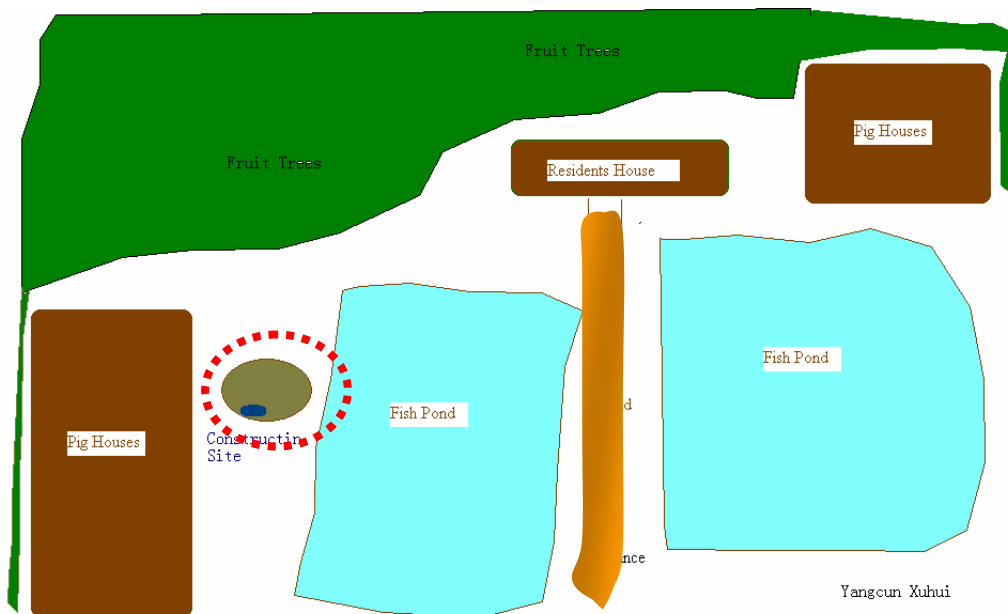


Figure 2-5a The present(a) and future(b) wastewater treatment scheme of Xikou pig farm

Table 2-5 Numeric Significance Assessment of Criteria for Candidacy of Xuhui farm

Component	Assessment Clause	Observations & Analysis	Score
L	① if farm situates in blue or green line	• The farm does <u>not</u> sit in redline (lower delta) area	5
L	② if the candidate farm forms a cluster with other farms in operation	• It is not sure if the farm was clustered, because of <u>lack of information</u> and time in the field. However the consultant easily conjectured that the farm may form a cluster, based on the livestock state (i) of the township.	3
WQ	③ if farm wastewater causes major pollution source of waterstream	• It was not easy to examine the clause ③ <u>due to lack of basic data</u> . However, one thing is for sure that pig wastewater may be the major available pollution source. Because industrial wastewater, domestic wastewater, and irrigation water for crop farming contribute stream pollution are <u>minimal</u> in rural area.	4
WQ	④ if the farm currently pollutes a stream that is a primary or secondary tributary of the Pearl River	• Xuhui farm sits near a tributary of DongJiang, and eventually leads to Pearl River, although the wastewater turns to non-point source..	4
WQ	⑤ if livestock operation tends to increase	• Pig farms in Bolou county, in general, were found that the producers have a strong interests in increasing the size of farms. The reasoning was described in detail in Taimei farm section. Therefore it is important to include this farm into LWMEA Project..for abatement of pollution.	4
M	⑥ if the farm operates at medium/large scale, that grows more than 200 sows or 3000 finishers	• Louxing pig farm produces far more than the suggested criteria in farm size.	5
M	⑦ if the candidate farm is financially healthy	• It is impossible for the consultant if the management and financial situation of Xikou pig farm are well. Because he was constrained by not only time but also <u>unavailability of basic data</u> . However, the consultant easily infers it keeps both well because the producer is ready to invest new treatment system.	3
W	⑧ if local authority and farmers shows strong <u>willingness</u> to participate	• The consultant found that Guangdong PMO, Bolou county authority, and pig producers were very keen to participate in the LWMEA Project.	5
W	⑨ if local authority and farmers are <u>willing to invest</u> a potential counterpart fund and environmental management capacity	• The consultant found that Guangdong PMO, Bolou county authority, and pig producers were ready to share costs for installation of treatment system.	5
T	⑩ the selected farms are representative of the various pig production technologies in Guangdong Province	• Guangdong PMO has developed a standard system, shown in Figure 2-2. consultant found that Guangdong PMO, Bolou county authority, and pig producers	3
	Total Score		41



5. Xuhui Pig Farm 3-1

Figure 2.5a Arrangement of Xuhui Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China



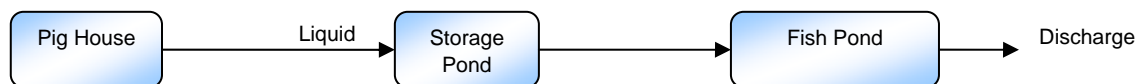
Figure 2.5c Contemporary pig wastewater treatment system of Xuhui Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China

6. Changning Township (長寧鎮)_Modong Pig Farm (莫洞豬場)

The major characteristics of Modong Pig farm and Yangcun Township are as follows:

- I. **Climate** : sub-tropical region, rainfall range of 1700-2400mm, annual mean temperature of 21 °C .
- II. **Livestock state** : the township produces pigs of about 50,800 head, and unloads 34,300 head/year to market, that amounts to 16% of total revenue of the township. The contribution proportion is a bit lower than other township. Medium and smaller pig farms seem to be less densely situated than any other township.
- III. **Monitoring and Evaluation (M&E)** : the consultant discussed M&E with Dr. Ai Shaoying, and advised the sites, parameters, and methods of sampling in part. Thorough review should take place in next stage.
- IV. **Treatment Scheme and Technical Support** : a typical scheme of pig wastewater treatment system in the township integrates with fish pond and/or fruit field. As shown in Figure 1-1, Modong farm sits on a tributary of Shahu river which merges to DongZhiang. The consultant was not able to perform any technical review for treatment system of Louxing pig farm due to unavailability of information. The details of technical design may take place in next stage.
- V. **Checkpoints for Technical Design** : 8 days for HRT of anaerobic digester seemed to be a bit shorter. It would be advisable to extend HRT to 10-15 days because it operates in a sap-type reinforced concrete structure of 600 m³ that is relatively large volume.

Future Scheme a



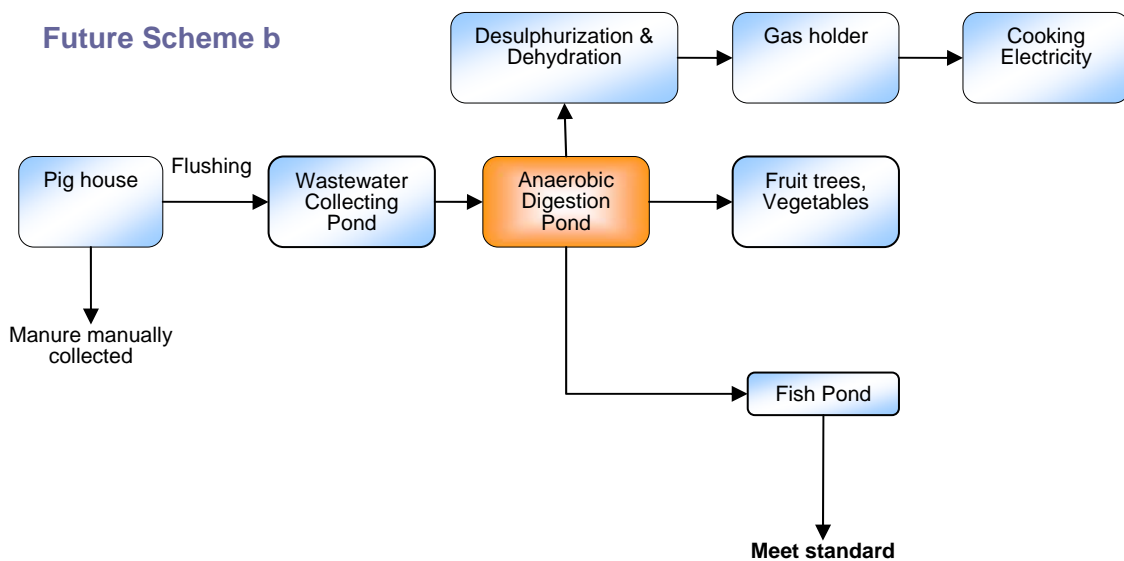


Figure 2-6a The present(a) and future(b) wastewater treatment scheme of Modong pig farm

Table 2-6 Numeric Significance Assessment of Criteria for Candidacy of Modong farm

Component	Assessment Clause	Observations & Analysis	Score
L	① if farm situates in blue or green line	• The farm does <u>not</u> sit in redline (lower delta) area	5
L	② if the candidate farm forms a cluster with other farms in operation	• It is not sure if the farm was clustered, because of <u>lack of information</u> and time in the field. However the consultant easily conjectured that the farm may form a cluster, based on the livestock state (i) of the township.	3
WQ	③ if farm wastewater causes major pollution source of waterstream	• It was not easy to examine the clause ③ <u>due to lack of basic data</u> . However, one thing is for sure that pig wastewater may be the major available pollution source. Because industrial wastewater, domestic wastewater, and irrigation water for crop farming contribute stream pollution are <u>minimal</u> in rural area.	4
WQ	④ if the farm currently pollutes a stream that is a primary or secondary tributary of the Pearl River	• Modong farm sits near a tributary of DongJiang. and eventually leads to Pearl River, although the wastewater turns to non-point source..	4
WQ	⑤ if livestock operation tends to increase	• Pig farms in Bolou county, in general, were found that the producers have a strong interests in increasing the size of farms. The reasoning was described in detail in Taimei farm section. Therefore it is important to include this farm into LWMEA Project..for abatement of pollution.	4
M	⑥ if the farm operates at medium/large scale, that	• Modong pig farm produces far more than the suggested criteria in farm size.	5

	grows more than 200 sows or 3000 finishers		
<i>M</i>	⑦ if the candidate farm is financially healthy	<ul style="list-style-type: none"> It is impossible for the consultant if the management and financial situation of Modong pig farm are well. Because he was constrained by not only time but also <u>unavailability of basic data</u>. However, the consultant easily infers it keeps both well because the producer is ready to invest new treatment system. 	4
<i>W</i>	⑧ if local authority and farmers shows strong <u>willingness</u> to participate	<ul style="list-style-type: none"> The consultant found that Guangdong PMO, Bolou county authority, and pig producers were very keen to participate in the LWMEA Project. 	5
<i>W</i>	⑨ if local authority and farmers are <u>willing to invest</u> a potential counterpart fund and environmental management capacity	<ul style="list-style-type: none"> The consultant found that Guangdong PMO, Bolou county authority, and pig producers were ready to share costs for installation of treatment system. 	5
<i>T</i>	⑩ the selected farms are representative of the various pig production technologies in Guangdong Province	<ul style="list-style-type: none"> Guangdong PMO has developed a standard system, shown in Figure 2-2. consultant found that Guangdong PMO, Bolou county authority, and pig producers 	3
	Total Score		42

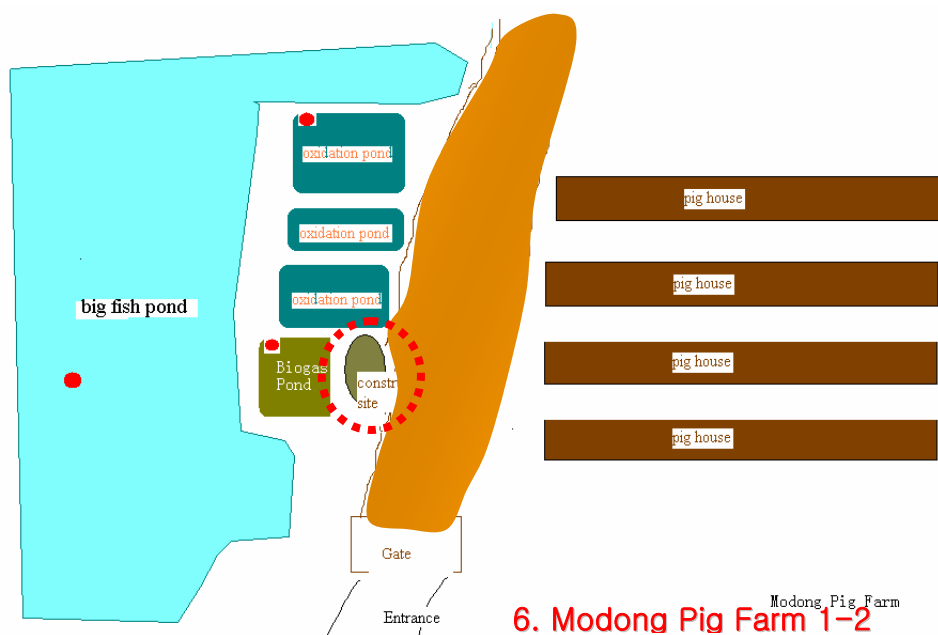


Figure 2.6b Arrangement of Modong Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China



Figure 2.6c Contemporary pig wastewater treatment system of Modong Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China

7. Changning Township (長寧鎮)_Dengdaming Pig Farm (鄧達明豬場)

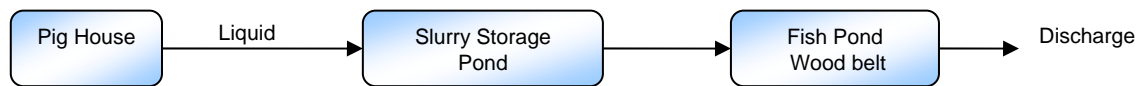
The major characteristics of Dengdaming Pig farm and Changning Township are as follows:

- I. **Climate** : sub-tropical region, rainfall range of 1700-2400mm, annual mean temperature of 21 °C .
- II. **Livestock state** : the township produces pigs of about 50,800 head, and unloads 34,300 head/year to market, that amounts to 19% of total revenue of the township. The contribution proportion is a bit lower than other townships. Medium and smaller pig farms seem to be less densely situated than any other township.
- III. **Monitoring and Evaluation (M&E)** : the consultant discussed M&E with Dr. Ai Shaoying, and advised the sites, parameters, and methods of sampling in part. Thorough review should take place in next stage.
- IV. **Treatment Scheme and Technical Support** : a typical scheme of pig wastewater treatment system in the township integrates with fish pond and/or

fruit field. As shown in Figure 1-1, Dungdaming farm sits nearby a tributary of Shahu river that merges to DongZhiang. The consultant was not able to perform any technical review for treatment system of Louxing pig farm due to unavailability of information. The details of technical design may take place in next stage.

- V. **Checkpoints for Technical Design** : 8 days for HRT of anaerobic digester seemed to be a bit shorter. It would be advisable to extend HRT to 10-15 days because it operates in a sap-type reinforced concrete structure of 400 m³ that is relatively large volume.

Future Scheme a



Future Scheme b

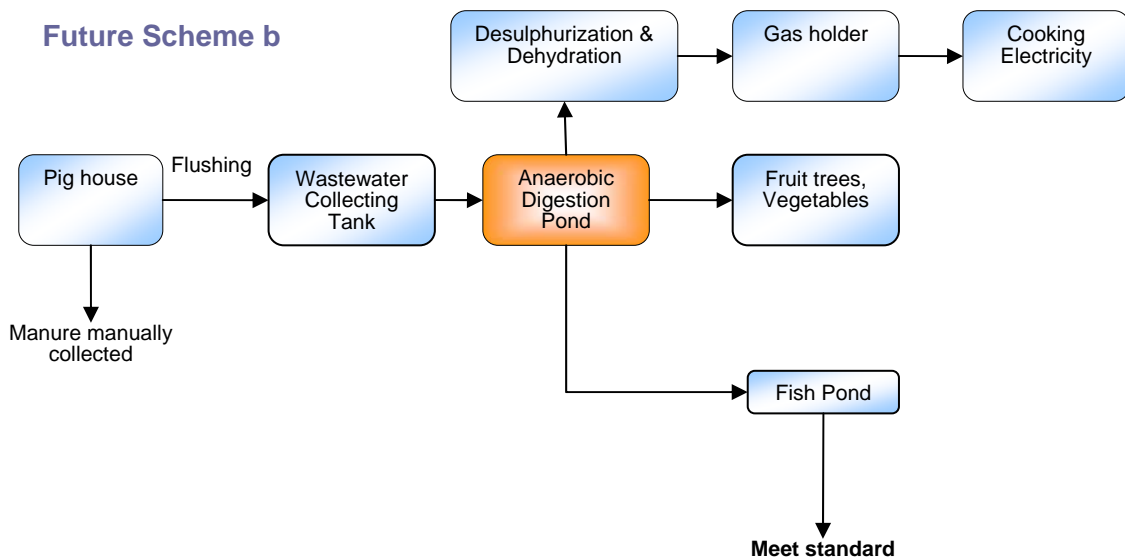
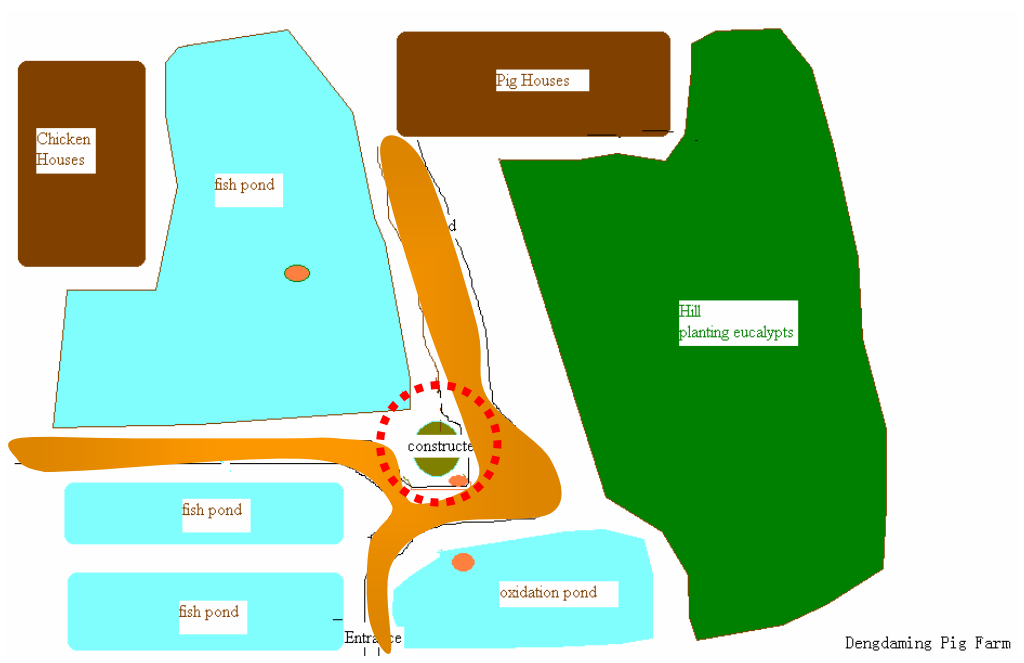


Figure 2-7a The present(a) and future(b) wastewater treatment scheme of Dengaming pig farm

Table 2-7 Numeric Significance Assessment of Criteria for Candidacy of Dengdaming farm

Component	Assessment Clause	Observations & Analysis	Score
L	① if farm situates in blue or green line	• The farm does <u>not</u> sit in redline (lower delta) area	5
L	② if the candidate farm forms a cluster with other farms in operation	• It is not sure if the farm was clustered, because of <u>lack of information</u> and time in the field. However the consultant easily conjectured that the farm may form a cluster, based on the livestock state (i) of the township.	3
WQ	③ if farm wastewater causes major pollution source of waterstream	• It was not easy to examine the clause ③ <u>due to lack of basic data</u> . However, one thing is for sure that pig wastewater may be the major available pollution source. Because industrial wastewater, domestic wastewater, and irrigation water for crop farming contribute stream pollution are <u>minimal in rural area</u> .	4
WQ	④ if the farm currently pollutes a stream that is a primary or secondary tributary of the Pearl River	• Dengdaming farm sits near a tributary of DongJiang. and eventually leads to Pearl River, although the wastewater turns to non-point source..	4
WQ	⑤ if livestock operation tends to increase	• Pig farms in Bolou county, in general, were found that the producers have a strong interests in increasing the size of farms. The reasoning was described in detail in Taimei farm section. Therefore it is important to include this farm into LWMEA Project..for abatement of pollution.	4
M	⑥ if the farm operates at medium/large scale, that grows more than 200 sows or 3000 finishers	• Dengdaming pig farm produces far more than the suggested criteria in farm size.	5
M	⑦ if the candidate farm is financially healthy	• It is impossible for the consultant if the management and financial situation of Dengdaming pig farm are well. Because he was constrained by not only time but also <u>unavailability of basic data</u> . However, the consultant easily infers it keeps both well because the producer is ready to invest new treatment system.	3
W	⑧ if local authority and farmers shows strong <u>willingness</u> to participate	• The consultant found that Guangdong PMO, Bolou county authority, and pig producers were very keen to participate in the LWMEA Project.	5
W	⑨ if local authority and farmers are <u>willing to invest</u> a potential counterpart fund and environmental management capacity	• The consultant found that Guangdong PMO, Bolou county authority, and pig producers were ready to share costs for installation of treatment system.	5
T	⑩ the selected farms are representative of the various pig production technologies in	• Guangdong PMO has developed a standard system, shown in Figure 2-2. consultant found that Guangdong PMO,	3

	Guangdong Province	Bolou county authority, and pig producers	
	Total Score		41



7. Dengdaming Farm 1-

Figure 2.7b Arrangement of Dengdaming Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China



Figure 2.7c Contemporary pig wastewater treatment system of Dengaming Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China

8. Hu Township (湖鎮)_Longhu Pig Farm (龍湖豬場)

The major characteristics of Longhu Pig farm and Changning Township are as follows:

- i. **Climate** : sub-tropical region, rainfall range of 1700-2400mm, annual mean temperature of 21 °C.
- ii. **Livestock state** : the township produces pigs of about 79,000 head, and unloads 44,800 head/year to market, that amounts to 19% of total revenue of the township. The contribution proportion is a bit lower than other townships. Medium and smaller pig farms seem to be densely situated than any other township.
- iii. **Monitoring and Evaluation (M&E)** : the consultant discussed M&E with Dr. Ai Shaoying, and advised the sites, parameters, and methods of sampling in part. Thorough review should take place in next stage.
- iv. **Treatment Scheme and Technical Support** : a typical scheme of pig wastewater treatment system in the township integrates with fish pond and/or fruit field. As shown in Figure 1-1, Longhu farm sits nearby a tributary of

Shahu river that merges to DongZhiang. The consultant was not able to perform any technical review for treatment system of Louxing pig farm due to unavailability of information. The details of technical design may take place in next stage.

- v. **Checkpoints for Technical Design** : 7 days for HRT of anaerobic digester seemed to be much shorter. It would be advisable to extend HRT to 10-15 days because it operates in a sap-type reinforced concrete structure of 800 m³ that is large volume.

Future Scheme a



Future Scheme b

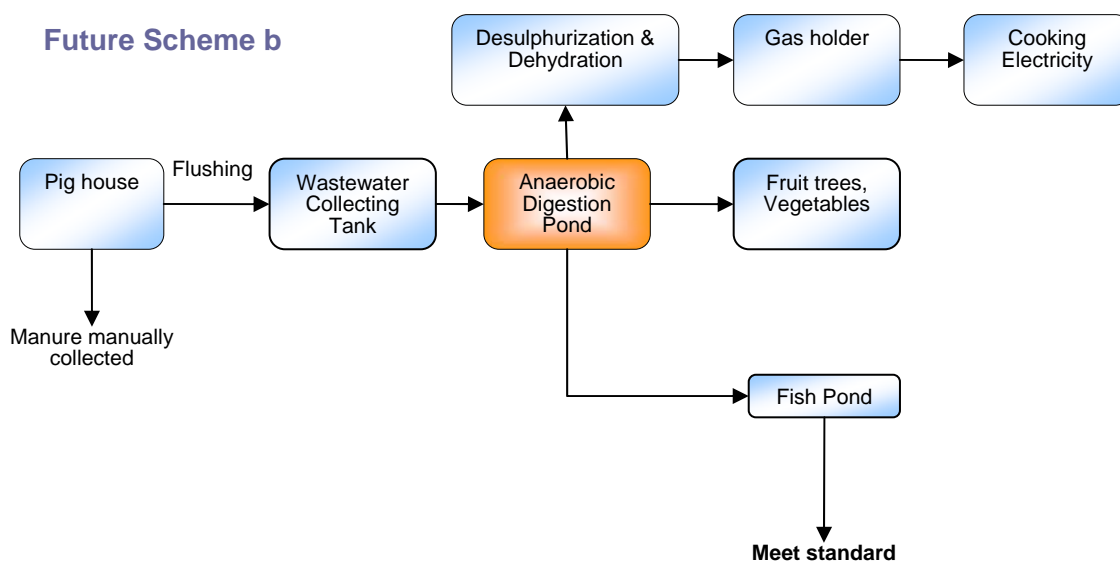


Figure 2-8a The present(a) and future(b) wastewater treatment scheme of Longhu pig farm

Table 2-8 Numeric Significance Assessment of Criteria for Candidacy of Longhu farm

Component	Assessment Clause	Observations & Analysis	Score
L	① if farm situates in blue or green line	• The farm does <u>not</u> sit in redline (lower delta) area	5
L	② if the candidate farm forms a cluster with other farms in operation	• It is not sure if the farm was clustered, because of <u>lack of information</u> and time in the field. However the consultant easily	3

		conjectured that the farm may form a cluster, based on the livestock state (i) of the township.	
WQ	③ if farm wastewater causes major pollution source of waterstream	<ul style="list-style-type: none"> It was not easy to examine the clause ③ <u>due to lack of basic data</u>. However, one thing is for sure that pig wastewater may be the major available pollution source. Because industrial wastewater, domestic wastewater, and irrigation water for crop farming contribute stream pollution are minimal in rural area. 	3
WQ	④ if the farm currently pollutes a stream that is a primary or secondary tributary of the Pearl River	<ul style="list-style-type: none"> Longhu farm sits near a tributary of DongJiang. and eventually leads to Pearl River, although the wastewater turns to non-point source.. 	3
WQ	⑤ if livestock operation tends to increase	<ul style="list-style-type: none"> Pig farms in Bolou county, in general, were found that the producers have a strong interests in increasing the size of farms. The reasoning was described in detail in Taimei farm section. Therefore it is important to include this farm into LWMEA Project..for abatement of pollution. 	4
M	⑥ if the farm operates at medium/large scale, that grows more than 200 sows or 3000 finishers	<ul style="list-style-type: none"> Longhu pig farm produces far more than the suggested criteria in farm size. 	5
M	⑦ if the candidate farm is financially healthy	<ul style="list-style-type: none"> It is impossible for the consultant if the management and financial situation of Longhu pig farm are well. Because he was constrained by not only time but also <u>unavailability of basic data</u>. However, the consultant easily infers it keeps both well because the producer is ready to invest new treatment system. 	4
W	⑧ if local authority and farmers shows strong <u>willingness</u> to participate	<ul style="list-style-type: none"> The consultant found that Guangdong PMO, Bolou county authority, and pig producers were very keen to participate in the LWMEA Project. 	5
W	⑨ if local authority and farmers are <u>willing to invest</u> a potential counterpart fund and environmental management capacity	<ul style="list-style-type: none"> The consultant found that Guangdong PMO, Bolou county authority, and pig producers were ready to share costs for installation of treatment system. 	5
T	⑩ the selected farms are representative of the various pig production technologies in Guangdong Province	<ul style="list-style-type: none"> Guangdong PMO has developed a standard system, shown in Figure 2-2. consultant found that Guangdong PMO, Bolou county authority, and pig producers 	3
	Total Score		40

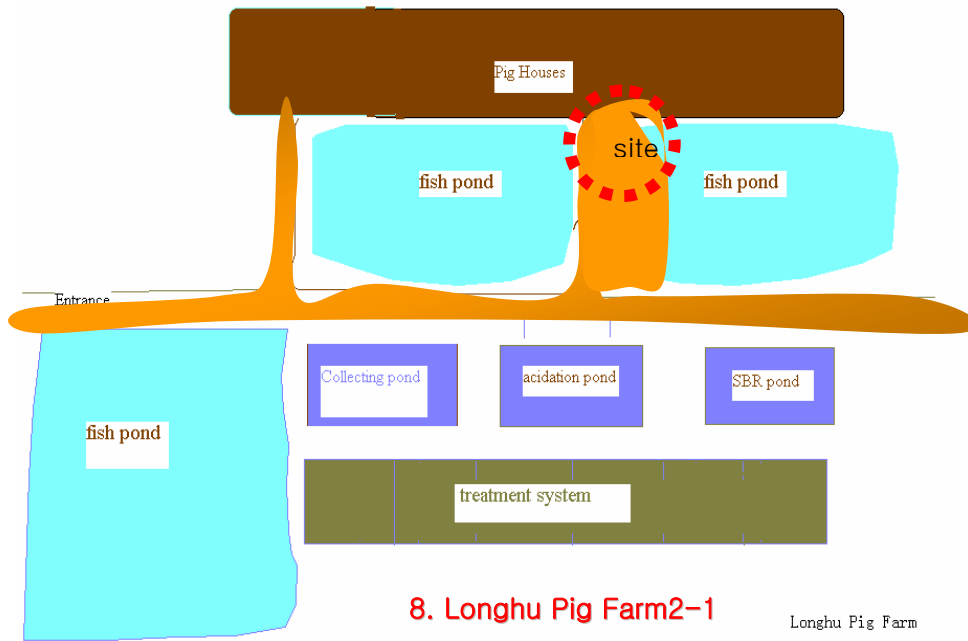


Figure 2.8c Contemporary pig wastewater treatment system of Longhu Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China

9. Hu Township (湖鎮)_ Sanglang Pig Farm (上壆豬場)

The major characteristics of Sanglang Pig farm and Hu Township are as follows:

- i. **Climate** : sub-tropical region, rainfall range of 1700-2400mm, annual mean temperature of 21 °C.
- ii. **Livestock state** : the township produces pigs of about 79,000 head, and unloads 49,000 head/year to market, that amounts to 24% of total revenue of the township. The contribution proportion is a bit higher than other townships. Medium and smaller pig farms seem to be densely situated than any other township.
- iii. **Monitoring and Evaluation (M&E)** : the consultant discussed M&E with Dr. Ai Shaoying, and advised the sites, parameters, and methods of sampling in part. Thorough review should take place in next stage.
- iv. **Treatment Scheme and Technical Support** : a typical scheme of pig wastewater treatment system in the township integrates with fish pond and/or fruit field. As shown in Figure 1-1, Longhu farm sits nearby Shahu river that merges to DongZhiang. The consultant was not able to perform any technical review for treatment system of Sanglang pig farm due to unavailability of information. The details of technical design may take place in next stage.
- v. **Checkpoints for Technical Design** : 8 days for HRT of anaerobic digester seemed to be much shorter. It would be advisable to extend HRT to 10-15 days because it operates in a sap-type reinforced concrete structure of 400 m³ that is large volume.

Future Scheme a



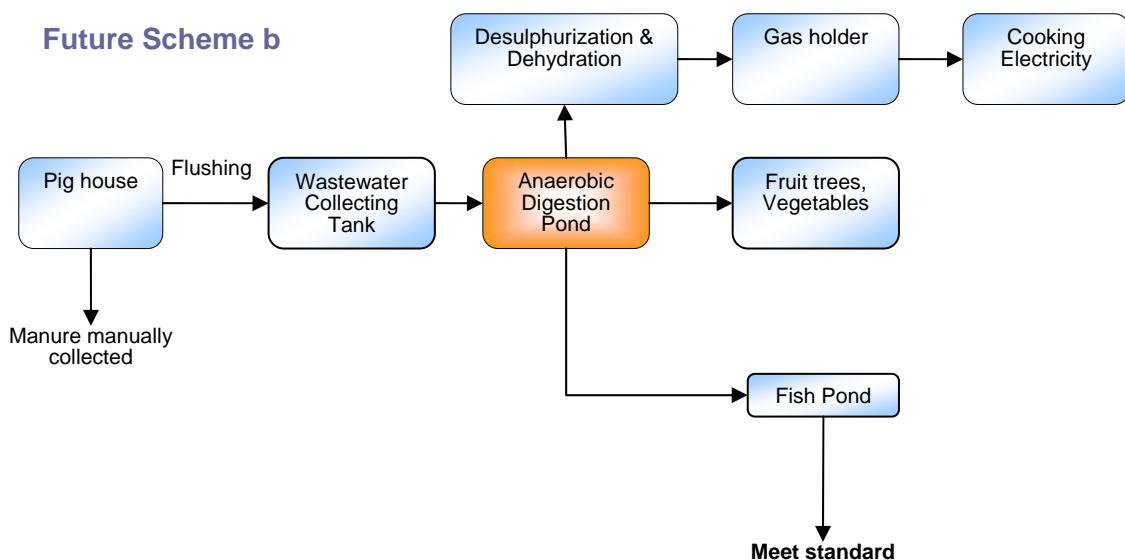


Figure 2.9a The present(a) and future(b) wastewater treatment scheme of Sanglang pig farm

Table 2.9 Numeric Significance Assessment of Criteria for Candidacy of Shanglang farm

Component	Assessment Clause	Observations & Analysis	Score
L	① if farm situates in blue or green line	• The farm does <u>not</u> sit in redline (lower delta) area	5
L	② if the candidate farm forms a cluster with other farms in operation	• It is not sure if the farm was clustered, because of <u>lack of information</u> and time in the field. However the consultant easily conjectured that the farm may form a cluster, based on the livestock state (i) of the township.	4
WQ	③ if farm wastewater causes major pollution source of waterstream	• It was not easy to examine the clause ③ <u>due to lack of basic data</u> . However, one thing is for sure that pig wastewater may be the major available pollution source. Because industrial wastewater, domestic wastewater, and irrigation water for crop farming contribute stream pollution are minimal in rural area.	5
WQ	④ if the farm currently pollutes a stream that is a primary or secondary tributary of the Pearl River	• Shanglang farm sits near a tributary of DongJiang. and eventually leads to Pearl River, although the wastewater turns to non-point source..	5
WQ	⑤ if livestock operation tends to increase	• Pig farms in Bolou county, in general, were found that the producers have a strong interests in increasing the size of farms. The reasoning was described in	3

		detail in Taimei farm section. Therefore it is important to include this farm into LWMEA Project..for abatement of pollution.	
<i>M</i>	⑥ if the farm operates at medium/large scale, that grows more than 200 sows or 3000 finishers	• Shanglang pig farm produces far more than the suggested criteria in farm size.	5
<i>M</i>	⑦ if the candidate farm is financially healthy	• It is impossible for the consultant if the management and financial situation of Shanglang pig farm are well. Because he was constrained by not only time but also <u>unavailability of basic data</u> . However, the consultant easily infers it keeps both well because the producer is ready to invest new treatment system.	3
<i>W</i>	⑧ if local authority and farmers shows strong <u>willingness</u> to participate	• The consultant found that Guangdong PMO, Bolou county authority, and pig producers were very keen to participate in the LWMEA Project.	5
<i>W</i>	⑨ if local authority and farmers are <u>willing to invest</u> a potential counterpart fund and environmental management capacity	• The consultant found that Guangdong PMO, Bolou county authority, and pig producers were ready to share costs for installation of treatment system.	5
<i>T</i>	⑩ the selected farms are representative of the various pig production technologies in Guangdong Province	• Guangdong PMO has developed a standard system, shown in Figure 2-2. consultant found that Guangdong PMO, Bolou county authority, and pig producers	3
	Total Score		43

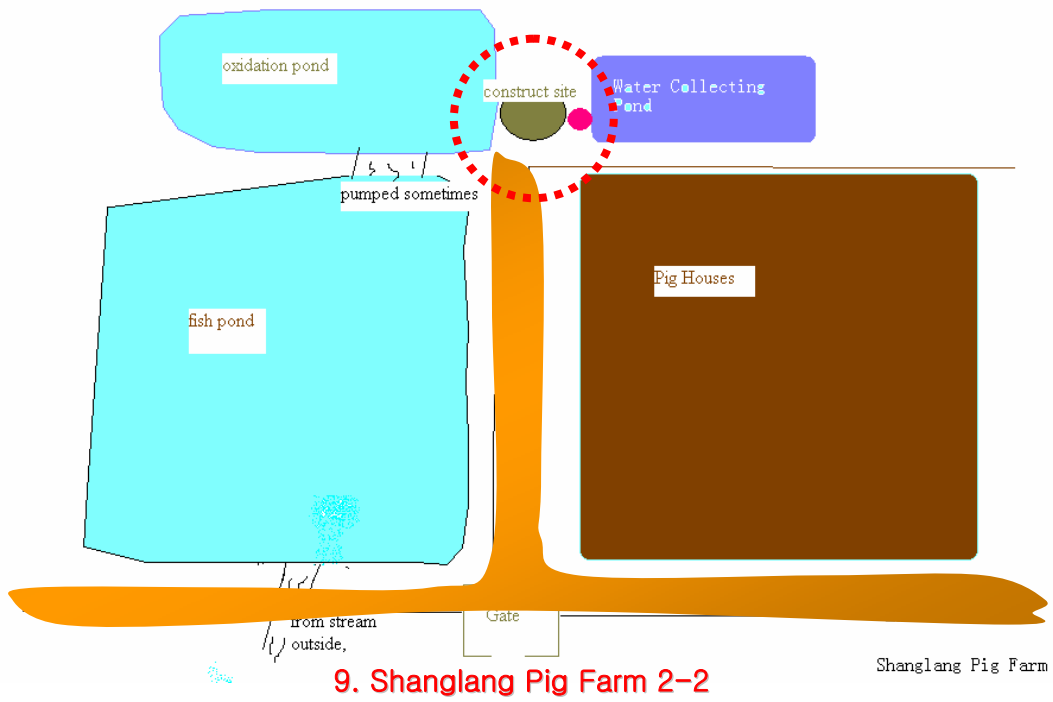


Figure 2.9b Arrangement of Sanglang Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China



Figure 2.9c Contemporary pig wastewater treatment system of Sanglang Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China.

10. Hu Township (湖鎮)_Xingfeng Pig Farm (新豐豬場)

The major characteristics of Sanglang Pig farm and Hu Township are as follows:

- i. **Climate** : sub-tropical region, rainfall range of 1700-2400mm, annual mean temperature of 21 °C.
- ii. **Livestock state** : the township produces pigs of about 79,000 head, and unloads 49,000 head/year to market, that amounts to 24% of total revenue of the township. The contribution proportion is a bit higher than other townships. Medium and smaller pig farms seem to be densely situated than any other township.
- iii. **Monitoring and Evaluation (M&E)** : the consultant discussed M&E with Dr. Ai Shaoying, and advised the sites, parameters, and methods of sampling in part. Thorough review should take place in next stage.
- iv. **Treatment Scheme and Technical Support** : a typical scheme of pig wastewater treatment system in the township integrates with fish pond and/or fruit field. As shown in Figure 1-1, Longhu farm sits nearby Shahu river that merges to DongZhiang. The consultant was not able to perform any technical review for treatment system of Sanglang pig farm due to unavailability of information. The details of technical design may take place in next stage.
- v. **Checkpoints for Technical Design** : 8 days for HRT of anaerobic digester seemed to be much shorter. It would be advisable to extend HRT to 10-15 days because it operates in a sap-type reinforced concrete structure of 400 m³ that is large volume.

Future Scheme a



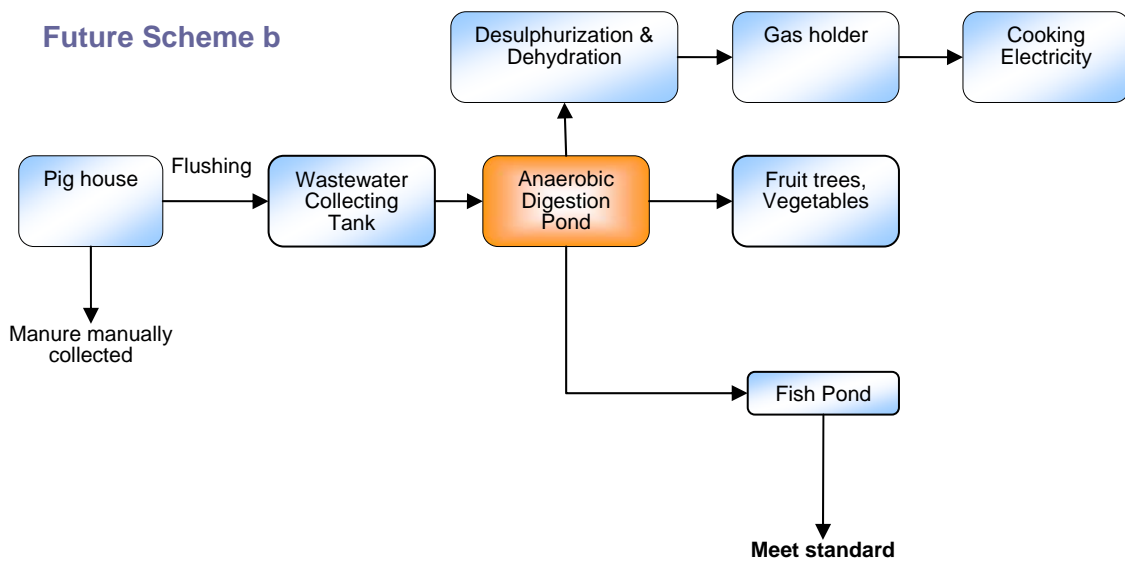
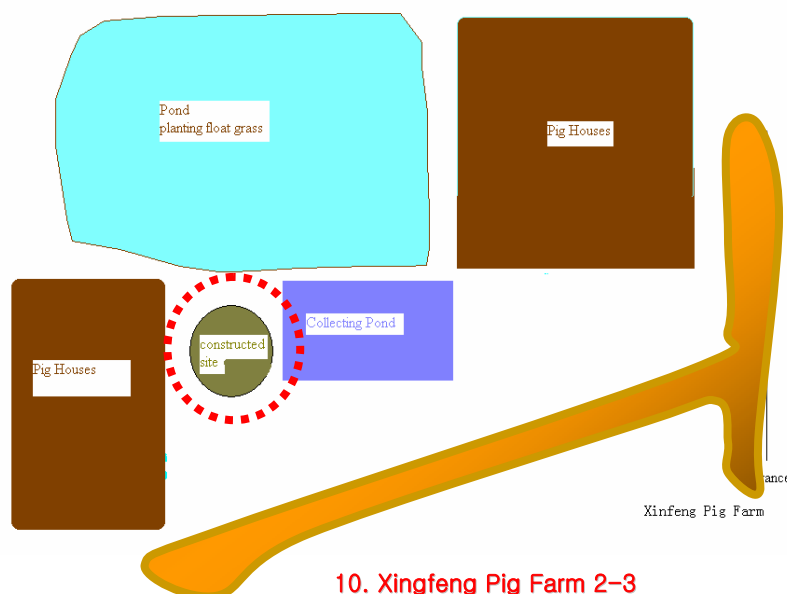


Figure 2-10a The present(a) and future(b) wastewater treatment scheme of Xinfeng pig farm

Table 2-10 Numeric Significance Assessment of Criteria for Candidacy of Xinfeng farm

Component	Assessment Clause	Observations & Analysis	Score
L	① if farm situates in blue or green line	• The farm does <u>not</u> sit in redline (lower delta) area	5
L	② if the candidate farm forms a cluster with other farms in operation	• It is not sure if the farm was clustered, because of <u>lack of information</u> and time in the field. However the consultant easily conjectured that the farm may form a cluster, based on the livestock state (i) of the township.	4
WQ	③ if farm wastewater causes major pollution source of waterstream	• It was not easy to examine the clause ③ <u>due to lack of basic data</u> . However, one thing is for sure that pig wastewater may be the major available pollution source. Because industrial wastewater, domestic wastewater, and irrigation water for crop farming contribute stream pollution are <u>minimal</u> in rural area.	5
WQ	④ if the farm currently pollutes a stream that is a primary or secondary tributary of the Pearl River	• Xinfeng farm sits near a tributary of DongJiang. and eventually leads to Pearl River, although the wastewater turns to non-point source..	5
WQ	⑤ if livestock operation tends to increase	• Pig farms in Bolou county, in general, were found that the producers have a strong interests in increasing the size of farms. The reasoning was described in detail in Taimei farm section. Therefore it is important to include this farm into LWMEA Project..for abatement of	5

		pollution.	
<i>M</i>	⑥ if the farm operates at medium/large scale, that grows more than 200 sows or 3000 finishers	<ul style="list-style-type: none"> Xinfeng pig farm produces far more than the suggested criteria in farm size. 	5
<i>M</i>	⑦ if the candidate farm is financially healthy	<ul style="list-style-type: none"> It is impossible for the consultant if the management and financial situation of Xinfeng pig farm are well. Because he was constrained by not only time but also <u>unavailability of basic data</u>. However, the consultant easily infers it keeps both well because the producer is ready to invest new treatment system. 	3
<i>W</i>	⑧ if local authority and farmers shows strong willingness to participate	<ul style="list-style-type: none"> The consultant found that Guangdong PMO, Bolou county authority, and pig producers were very keen to participate in the LWMEA Project. 	5
<i>W</i>	⑨ if local authority and farmers are willing to invest a potential counterpart fund and environmental management capacity	<ul style="list-style-type: none"> The consultant found that Guangdong PMO, Bolou county authority, and pig producers were ready to share costs for installation of treatment system. 	5
<i>T</i>	⑩ the selected farms are representative of the various pig production technologies in Guangdong Province	<ul style="list-style-type: none"> Guangdong PMO has developed a standard system, shown in Figure 2-2. consultant found that Guangdong PMO, Bolou county authority, and pig producers 	3
	Total Score		45



10. Xinfeng Pig Farm 2-3

Figure 2.10b Arrangement of Xinfeng Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China



Figure 2.10c Contemporary pig wastewater treatment system of Xinfeng Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China.

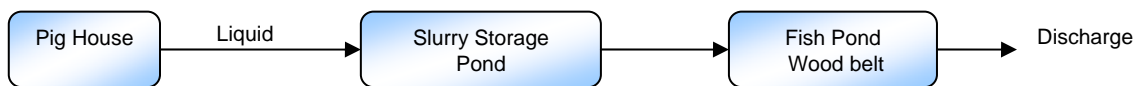
11. Yuanzhou Township (圓洲鎮)_Foling Breeding Pig Farm (佛嶺豬場)

The major characteristics of Sanglang Pig farm and Yuanzhou Township are as follows:

- i. **Climate** : sub-tropical region, rainfall range of 1700-2400mm, annual mean temperature of 21℃.
- ii. **Livestock state** : the township produces pigs of about 100,000 head, and unloads 60,000 head/year to market, that amounts to 30% of total revenue of the township. The contribution proportion is higher than other townships. Medium and smaller pig farms seem to be densely situated than any other township.
- iii. **Monitoring and Evaluation (M&E)** : the consultant discussed M&E with Dr. Ai Shaoying, and advised the sites, parameters, and methods of sampling in part. Thorough review should take place in next stage.

- iv. **Treatment Scheme and Technical Support** : a typical scheme of pig wastewater treatment system in the township integrates with fish pond and/or fruit field. As shown in Figure 1-1, Foling farm sits nearby and pollutants may direct flow into DongZhiang. The consultant was not able to perform any technical review for treatment system of Sanglang pig farm due to unavailability of information. The details of technical design may take place in next stage.
- v. **Checkpoints for Technical Design** : HRT of anaerobic digester and the volume of AD did not mention in Mini-PIP. It may be advisable to extend HRT to 10-15 days because it operates in a sap-type reinforced concrete structure and a relatively large volume.

Future Scheme a



Future Scheme b

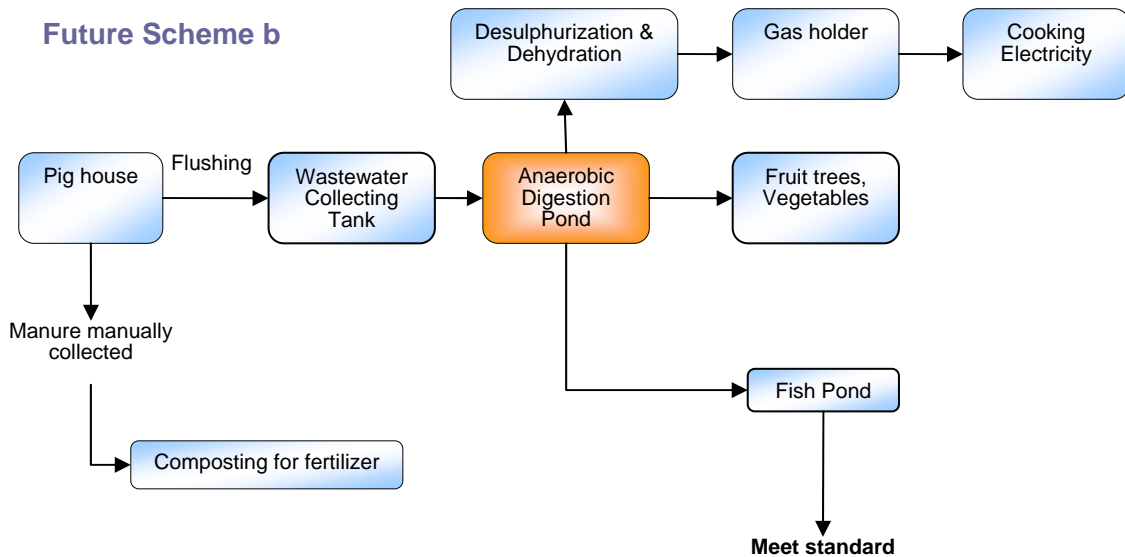
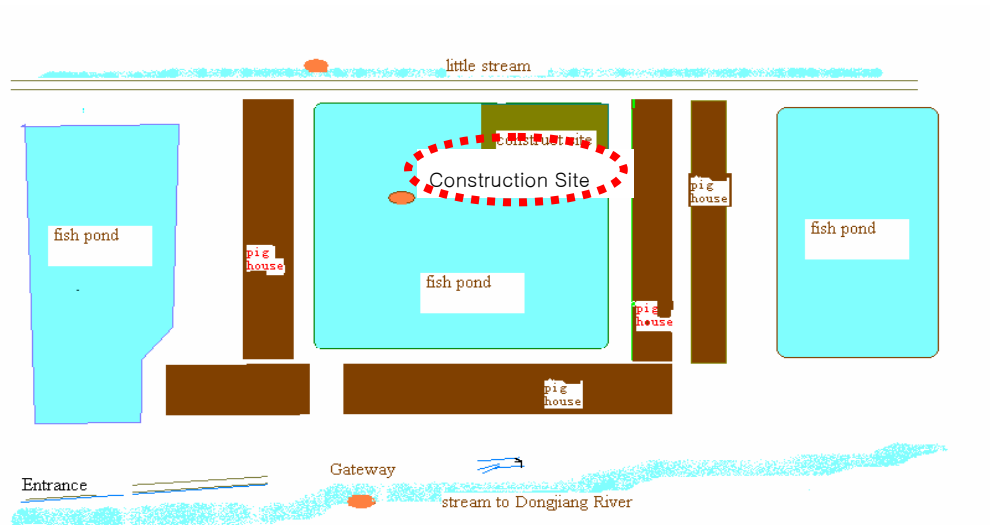


Figure 2.11a The present(a) and future(b) wastewater treatment scheme of Foling pig farm

Table 2-11 Numeric Significance Assessment of Criteria for Candidacy of Foling farm

Component	Assessment Clause	Observations & Analysis	Score
L	① if farm situates in blue or green line	• The farm does <u>not</u> sit in redline (lower delta) area	5
L	② if the candidate farm forms a cluster with other farms in operation	• It is not sure if the farm was clustered, because of <u>lack of information</u> and time in the field. However the consultant easily conjectured that the farm may form a cluster, based on the livestock state (i) of the township.	3
WQ	③ if farm wastewater causes major pollution source of waterstream	• It was not easy to examine the clause ③ <u>due to lack of basic data</u> . However, one thing is for sure that pig wastewater may be the major available pollution source. Because industrial wastewater, domestic wastewater, and irrigation water for crop farming contribute stream pollution are <u>minimal</u> in rural area.	5
WQ	④ if the farm currently pollutes a stream that is a primary or secondary tributary of the Pearl River	• Foling breed farm sits near a tributary of DongJiang. and eventually leads to Pearl River, although the wastewater turns to non-point source..	5
WQ	⑤ if livestock operation tends to increase	• Pig farms in Bolou county, in general, were found that the producers have a strong interests in increasing the size of farms. The reasoning was described in detail in Taimei farm section. Therefore it is important to include this farm into LWMEA Project..for abatement of pollution.	4
M	⑥ if the farm operates at medium/large scale, that grows more than 200 sows or 3000 finishers	• Foling breed pig farm produces far more than the suggested criteria in farm size.	5
M	⑦ if the candidate farm is financially healthy	• It is impossible for the consultant if the management and financial situation of Foling pig farm are well. Because he was constrained by not only time but also <u>unavailability of basic data</u> . However, the consultant easily infers it keeps both well because the producer is ready to invest new treatment system.	3
W	⑧ if local authority and farmers shows strong <u>willingness</u> to participate	• The consultant found that Guangdong PMO, Bolou county authority, and pig producers were very keen to participate in the LWMEA Project.	5
W	⑨ if local authority and farmers are <u>willing to invest</u> a potential counterpart fund and environmental management capacity	• The consultant found that Guangdong PMO, Bolou county authority, and pig producers were ready to share costs for installation of treatment system.	5
T	⑩ the selected farms are representative of the various pig production technologies in Guangdong Province	• Guangdong PMO has developed a standard system, shown in Figure 2-2. consultant found that Guangdong PMO, Bolou county authority, and pig producers	3
	Total Score		44



11. Foling Pig Farm 1-1

Foling Pig Farm

Figure 2.11b Arrangement of Bolou Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China



Figure 2.11c Contemporary pig wastewater treatment system of Bolou Pig Farm in Bolou County(博羅縣), Guangdong Province(廣東省), China.

C. Summary of Results from Assessment of 11 Candidate Pig Farms

The consultant tabulated numeric score of 11 candidate pig farms if the farm is eligible for participation of LWMEA Project. The nine clauses of selection criteria proposed by Guangdong PMO, was extended ten to differentiate willingness and practicality in installing a treatment system. The criteria were classified into the five categories including location, technology, water quality, management and finance, and willingness.

Although **Annex 3 in Preparation Mission Aide-Memoire**, March 14-26, 2004 clearly mentioned if it influences main waterstream in corresponding region, the wastewater originated from livestock farms mixes with other sources like domestic wastewater. It is soon to become **non-point source** so it is not easy to identify the main source of the pollution and to quantify its strength in any waterways at downstream. Thus a feasible measure to efficiently reduce pollution in waterways is to collect and treat the source at on-site.

- 1. Overall Score of the group:** The score of the 3 groups of six farms ranges from 39- 42, higher than 35 that the consultant sets the threshold score for selection. Each clause should fall in the class of 'moderate', 'good', or 'very good' that may provide the independent groups (pig farms, local and central government, FAO, and WB) with 'justification' for acceptance.

Table 3.1 Summary of Performace Score for the 11 Candidate Pig Farms

<i>No</i>	<i>Township</i>	<i>Name of farm</i>	<i>Total Score</i>	<i>Acceptance</i>
1	Taimei	Taimei	45	Yes
2	Longxi	Huangtian	43	Yes
3	GongZhuang	Xikou	45	yes
4	Luoyang	Luoxing	45	Yes
5	Yangcun	Xihui	40	Yes
6	Changning	Modong	42	Yes
7	Changning	Dengdaming	41	Yes
8	Hu	Longhu	40	Yes
9	Hu	Shanglang	43	Yes
10	Hu	Xinfeng	45	Yes
11	Yuanzhou	Foling Breeding	44	Yes

The score of the 11 farms ranges from 41- 45, much higher than 35 that the consultant sets the threshold value for selection. Each clause should fall in the class of ‘ moderate’ or ‘good’ that may provide the groups (Pig farms, local government, FAO, and WB) with ‘justification’ for acceptance.

2. Categorical Performance of each farm

The five categories, including location, technology, water quality, management and finance, and willingness, were featured to provide us with intuition for selection criteria of each farm.

