Study of Phasing Plan of Kalimati Water Treatment Plant Installation in Sidoarjo

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Abstract. One of the programs to increase clean water supply services in Sidoarjo district is maximizing water sources to serve 5 sub-districts in Western Sidoarjo, including Prambon, Tarik, Tulangan, Krembung and Balongbendo sub-districts, by planning a Water Treatment Plant (WTP) with total capacity of 1,000 LPS. The planning stages begin with calculation of projected water demands in 5 sub-districts for 10 years ahead. The results of projected water demands will be compared with the installation’s capacity to obtain the actual and initial staging plan for Water Treatment Plan’s constructions. Therefore, the construction and investment of Kalimati Water Treatment Plan could be arranged efficiently.

1. Introduction
The demand for drinking water in Sidoarjo is significantly increasing along with the increase of population of the city every year. Since 2013, the population of Sidoarjo has increased from 2,090,619 to 2,207,600 in 2017 (Central Bureau of Statistics of Sidoarjo Regency, 2018). A rapid growth of industrial and commercial sites is also one of many factors that increases the need for drinking water supply. Reported by Radar Surabaya (2017), five Water Treatment Plants (WTP) namely Tawangsari WTP, Kedunguling WTP, Krian WTP, Siwalanpanji WTP and Porong WTP with total production of 1,300 LPS were still not able to fulfill the water demands of the regency. The city government is in the midst of mobilizing various projects to improve clean water service which only served 37%. In addition to the difficulty of reaching remote areas, the availability of water resources is also one of the impediments in expanding Regional Water Utility Company of Sidoarjo’s service.

According to the Sidoarjo City Water Supply System Master Plan (Rencana Induk Pengembangan Sistem Penyediaan Air Minum/ RISPAM), Kalimati River is one of the potential surface water bodies that can be utilized. Administratively, Kalimati River is located on the borderline of Sidoarjo and Mojokerto. With its upstream in Kwatu Village (Mojoanyar Subdistrict, Mojokerto), it lies athwart along the villages of Mojokerto and Sidoarjo to Prambon Village (Prambon subdistrict, Sidoarjo). It was called Kalimati because the river was ‘dead’ so several actions will be needed to maximize the potential of Kalimati River as the main water source of West Sidoarjo.

To utilize Kalimati River, the city government initiated to build a Long Storage (LS) of Kalimati River. This Long Storage will later accommodate a portion of Brantas River’s flow to be used as raw water source for the water supply of Mojokerto and Sidoarjo. The Long Storage has a length of 5 km, capable to carry 1.6 million m³ of water from Brantas River, uses box culverts with an open-close system so that it could stop the water from overflowing when the LS has reached maximum capacity. The development of the Long Storage has been going on for almost two years since 2017 and is...
planned to be completed in 2019, which will later become a new source of raw water to improve water supply services in Sidoarjo City (Radar Surabaya, 2017).

Sidoarjo’s Regional Water Utility Company targeted Prambon to be the first subdistrict to receive water from the new expansion of water supply system in Western Sidoarjo. Prambon subdistrict is located in the west area of Sidoarjo with an area of 34.23 km² and population reaching 83,125. Consisting of 20 villages, most of the population in Prambon utilize shallow artesian wells independently or by the Association of Drinking Water Users (Himpunan Penduduk Pemakai Air Minum/HIPPAM) which are spread in most villages in Prambon subdistrict. Prambon subdistrict becomes the first target of new service improvement because Prambon is included in K2 Order where the K1 Order consisted of Waru and Sidoarjo subdistricts which had been served by the Regional Water Utility Company. The city order is related to the determination of development centers of the city. The status of K2 Order is small urban but a priority because it had been predicted to develop into bigger mass with the development of industrial activities, services and trades (Sidoarjo City Water Supply System Master Plan, 2014). For 2020, the Sidoarjo Regional Water Utility Company had planned to build a new Water Treatment Plant that is capable of producing 1,000 LPS of drinking water and will begin to operate in 2023.

Along with the detailed plan of the new WTP installment, it would be necessary to perform a feasibility study to complete the preliminary research and analysis so the construction of the WTP will take place efficiently in every aspect (technically and financially). The feasibility study will include the water balance calculation and phasing plan of the 1,000 LPS WTP installment.

2. General Description
Kalimati Water Treatment Plant was planned to cover five subdistricts of Western Sidoarjo, namely Prambon, Tarik, Krembung, Tulangan and Balongbendo.

2.1. Prambon
Prambon will be the first subdistrict which receives 100% coverage of water supply from Kalimati WTP. With an area of 3,417.9 Ha, Prambon consisted of 20 villages. Administratively it is located between Tarik and Tulangan subdistricts. The total populations in 2017 was 68,557 people. The administrative boundaries of Prambon are as follows.
- North side : Krian and Wonoayu subdistricts
- East side : Tulangan and Krembung subdistricts
- South side : Mojokerto city
- West side : Tarik subdistrict

Prambon is designated as a rural area and urban settlement area. The urban system also set Prambon as K2 order or, according to the urban hierarchy, a small urban area. Areas that receive priority water services are areas that are included in the priority area development plan where Prambon is included as priority area for underdeveloped areas and border areas.

2.2. Tarik
Tarik is the westernmost subdistrict of Sidoarjo city. The area of Tarik is 3,606 Ha and it consisted of 20 villages. The total population of Tarik subdistrict is 68,557 people. The administrative boundaries of Tarik are as follows.
- North side : Balongbendo subdistrict
- East side : Prambon subdistrict
- South side : Prambon subdistrict
- West side : Mojokerto city

Tarik is determined as a rural area and urban settlement area. According to the urban hierarchy, Tarik is categorized as a small urban area. Areas that receive priority water services are areas that are included in priority area development plan where Tarik is included for underdeveloped areas and border areas.
2.3. Krembung
Krembung subdistrict has a total area of 2,955 Ha, consisting of 19 villages. The population of Krembung reaches 70,998 inhabitants with a density that has a fairly wide range between 17 – 35 inhabitants/Ha. Administrative borders of Krembung are as follows.
- North side : Tulangan sub-district
- East side : Porong sub-district
- South side : Mojokerto sub-district
- West side : Prambon sub-district

Krembung is designated as a rural area and urban settlement area. The urban system also sets Kremung as K2 order or, according to the urban hierarchy, a small urban area. Areas that receive priority water services are areas that are included in the priority area development plan, which Krembung is included for underdeveloped areas and border areas.

2.4. Tulangan
Tulangan sub-district has a total area of 3,121 Ha, consisting of 22 villages. Population density in Tulangan is quite evenly distributed, in the range of 18-55 inhabitants/ Ha or an average of 33.08 inhabitants/ Ha. Administrative borders of Tulangan are as follows.
- North side : Wonoayu subdistrict
- East side : Candi and Tanggulangin subdistricts
- South side : Krembung subdistrict
- West side : Prambon subdistrict

Tulangan is designated as a rural area and urban settlement area. The urban system also defines Tulangan as K3 order or, according to the urban hierarchy, a small urban area. Areas that receive priority water services are areas that are included in the priority area development plan where Tulangan is not included.

2.5. Balongbendo
Balongbendo sub-district has a total area of 3,140 Ha and consisted of 20 villages. The population density of Balongbendo is fairly even at 14-40 inhabitants/Ha or an average of 24.54/Ha. Administrative borders of Balongbendo are as follows.
- North side : Gresik city
- East side : Krian sub-district
- South side : Tarik sub-district
- West side : Gresik and Mojokerto city

Balongbendo is designated as a rural and urban settlement area. According to urban hierarchy, Balongbendo is categorized as a small town. Areas that receive priority water services are areas that are included in the priority area development plan where Balongbendo is included as a low priority area and border area.

3. Material and Methods
The planning method contains the technical steps that carried out in the planning. The steps in this planning begin with the emergence of planning ideas, problem formulation, literature studies, data collection, data analysis, and conclusions.

3.1. Study of Literatures
Literature studies were conducted to get basic theories on the topic of planning, so that it becomes a reference in this research. References and literatures needed to arrange this planning are:
- Population Projection Method
- Public Facility Projection Method
- Domestic and non-domestic water needs
3.2. Initial Preparation

The preparation phase was carried out to prepare all the data required for the initial phasing planning of WTP construction, which consisted of:

- Obtaining survey permission and collecting data to Sidoarjo’s Regional Water Utility Company (*Perusahaan Daerah Air Minum Kabupaten Sidoarjo* PDAM)
  Survey and collection of secondary data related to water supply and service were necessary to develop a plan for the phase of Kalimati WTP construction.

- Obtaining data collection permission from National and Political Unity Agency (*Badan Kesatuan Bangsa dan Politik* BAKESBANGPOL) of Sidoarjo
  Further data retrieval from various government agencies and institution such as the Central Bureau of Statistics (*Badan Pusat Statistik* BPS) and the Regional Development Planning Agency (*Badan Perencanaan Pembangunan Daerah* BAPPEDA) of Sidoarjo required a cover letter from the National and Political Unity Agency of Sidoarjo.

3.3. Data Collection

Data collection in this planning was done in two ways, primary and secondary method. Primary data was obtained directly from the field through research, observation, laboratory analysis, surveys and interviews. While secondary data was obtained from literature studies, previous research, also from related institutions who had the authority to archive the data.

3.3.1. Primary Data

Real-time water needs per capita in the related subdistrict were obtained from field survey, or real demand survey. This survey targeted certain amount of sample from population in the related subdistrict. It used a standard questionnaire; the respondents were given the freedom to answer the questions based on the real situation with the interviewers’ guidance. The interviewers filled out the questionnaires upon the answers and summarized it so the answers would occupy the requisite information. The schemes of the questionnaire are listed below.

- Total resident per house
- Amount of water usage per house
- Period of water usage
- Existing source of drinking water
- Willingness to connect
- Ability to pay

Respondents were from **Prambon Subdistrict**, the number of respondents was obtained from The Guidelines of Feasibility Study of the Water Distribution System Development in Regulation of Minister of Public Works No. 18/2007. The formula to determine the number of respondents are addressed in equation (1) followed by equation (2) to complete the calculation.

\[
 n = \frac{Np \times (1 - p) \times \left\lfloor \left( N - 1 \right) \times D \right\rfloor}{p \times (1 - p)} 
\]  

(1)

\[
 D = B^2 \times t^2 
\]  

(2)

where:

- \(n\) = amount of respondents
- \(N\) = amount of populations (house connection)  
  \(= \) amount of house connections ÷ total resident per house
- \(p\) = factor’s ratio in sample that have the wanted characteristic  
  \(= 0,5\)
- \(B\) = deviation standard  \(= 6\%\)
- \(t\) = level of confidence  \(= 95\%\)
3.3.2. Secondary Data
Secondary data were obtained from several agencies including Sidoarjo’s Regional Water Utility Company.
- Total population and public facilities of planning area, collected from Central Bureau of Statistics of Sidoarjo
- Administrative maps of planning area, collected from Regional Development Planning Agency of Sidoarjo
- Spatial Planning and Territory (Rencana Tata Ruang dan Wilayah/RTRW) documents, collected from Regional Development Planning Agency of Sidoarjo
- Pipeline plan of the water distribution system development, collected from Sidoarjo’s Regional Water Utility Company

3.4. Data Processing
After obtaining the required data, the data was processed and analyzed to produce calculations according to the phasing plan procedure.
- Real demand survey would produce water needs per capita in Prambon subdistrict. The water needs will then be processed with projected populations to generate projected water needs in the planning area until 2026.
- Total populations and public facilities data would be the baseline reference to project the populations and public facilities until 2026.
- Maps of planning areas would be needed to conduct mapping illustration of the service expansion phasing plan.
- Spatial Planning and Territory document would be reference to analyze and arrange the construction phasing plan.
- Pipeline network plan of the water distribution system development would be processed as consideration to determine the phasing plan.

4. Results and Discussions
Water needs consisted of domestic needs and non-domestic needs. Domestic water needs are composed of house connections, namely the pipeline connection from the water distribution network directly to customers’ houses, and public hydrants, the public faucets that use temporary water reservoirs and are used by society around the hydrants location.
To determine domestic and non domestic water needs in the end of projection year, total population data was required.

4.1. Domestic and Non domestic Projection
The population projection used the arithmetic method for Tarik and Balongbendo, while the geometry method was used for Prambon, Tulangan and Krembung. Arithmetic method was selected based from the comparison of the correlation coefficient that was the closest to 1 and the smallest standard deviation. The following calculation elaborates projected population of Tarik in 2018 using arithmetic method.

\[
P_{2018} = P_0 + r(n)
\]
\[
= 68.557 + ( 697.75 \times (2018 – 2017) )
\]
\[
= 69.255 \text{ people}
\]

Population projection in Prambon is then calculated with the geometry method.

\[
P_n = P_0 ( 1 + r ) n
\]
\[
P_{2018} = 82.076 ( 1 + 0.68 )^{2018-2017}
\]
\[
= 82.611 \text{ people}
\]

The result of the calculation of population projection can be seen in the Appendix. The total population in Prambon, Tarik, Krembung, Tulangan and Balongbendo in 2026 was projected to be 450,467 inhabitants.
Public facilities projections used equivalency of population growth and facility growth trends. Calculation of public facilities projections area as follows.

Number of elementary schools in Prambon 2017

\[
F_n = 26 \\
F_n = (P_n \times F_0) \div P_0 \\
F_{2018} = (82.611 \times 26) \div 82.076 \\
= 26 \text{ units}
\]

The total number of education facilities from kindergarten to high school was predicted to be 438 units, health facilities 29 units, mosques 1,553 units and industries 588 units in the 5 districts in 2026.

4.2. Water Needs Projection

Water needs for house connections is to serve residential and hamlet household consumers. To determine the assumption of water demand per person, a direct survey (real demand survey) was conducted on 71 respondents in 9 villages of Prambon as the main catchment area of Kalimati Water Treatment Plant. Based on the survey, it was found that the average use of domestic water in Prambon and surrounding areas was around 100 liters/person.day. An example of domestic water needs of Prambon in 2023 can be calculated as follows.

Total population = 85,739 people

Number of population currently served by HIPPAM = 3,570 people

Percentage of Service = 98% (assuming 2% are houses that are not accessible and far from the center of the crowd)

Water needs = 100 liters/person.day

Total water demand = Total population \times water needs assumption = [(85.739 – 3.570) people \times 98\% \times 100 \text{ liters/people.day}] = 93.06 \text{ liters/second}

Calculation of water needs for non-domestic, for example, kindergartens in Prambon in 2023 is as follows.

Number of kindergartens in Prambon in 2023 = 38 units

Water needs = 40 liters/person.day

Assuming the number of people = 75 people/ kindergarten

Total water needs = Number of kindergartens \times Number of people \times Water needs = 38 \text{ units} \times 75 \text{ people/unit} \times 40 \text{ liters/person.day} = 114,000 \text{ liters/day} = 1.3 \text{ LPS}

In calculating water needs, there are several other factors that influence the total water demand, which is leakage factors originating from water losses both non-physical/ non-technical and physical/ technical or commonly referred to as Non-revenue Water (Minister of Public Works and Housing, 2007). Another factor is the maximum day factor, which is the highest water demand on a particular day in a year.

The following calculation is an example of total water demand, domestic and non domestic in Prambon in 2023 calculation.

Leakage factors (RISPAM, 2018) = 21.90%

Water demand = 108.60 \text{ liters/sec} \times (100\% + 21.90\%) = 108.60 \text{ liters/sec} \times (121.90\%) = 132.39 \text{ liters/sec}

Maximum day factor (D_{max}) (Regional Water Utility Company, 2019) = 130%

Maximum water demand = 132.39 \text{ liters/sec} \times 130\% = 164.83 \text{ liters/sec}
Thus, the water demand of Prambon in 2023 is 172.10 liters/sec. The recapitulation of total water needs in 5 sub-districts of the service area until 2026 are shown in Table 1.

| Sub-district | Maximum Water Demand (l/s) |
|--------------|-----------------------------|
|              | 2023 | 2024 | 2025 | 2026 |
| Prambon      | 164.83 | 165.92 | 167.02 | 168.12 |
| Tarik        | 171.18 | 173.00 | 174.81 | 176.62 |
| Krembung     | 176.99 | 180.34 | 183.69 | 187.04 |
| Tulangan     | 292.77 | 297.54 | 302.31 | 307.08 |
| Balongbendo  | 183.82 | 185.94 | 188.05 | 190.17 |
| TOTAL        | 989.60 | 1,002.74 | 1,015.88 | 1,029.02 |

4.3. Construction and Service Development Phasing Plan

Kalimati WTP construction will begin in 2020, after the construction of Long Storage is completed and it is able to operate as a dam. Currently, the construction has reached half of the workload and is planned for completion in early 2020.

According to RISPAM (2018), the percentage of clean water services for residents in Sidoarjo at the end of the planning year reaches 60% from 37%. Areas that need priority services and included in the priority area development plan are underdeveloped areas including Prambon and surrounding areas. Based on the land designation, underdeveloped residential areas are prioritized to receive clean water services, but planned as permanent settlements in the future. Besides residential areas, there are currently several industries that require clean water services as well. One of them is an industrial complex which is spread in Western Sidoarjo.

| Year | Sub-districts | Services |
|------|---------------|----------|
| 2023 | Prambon       | 100%     |
| 2024 | Tarik         | 100%     |
| 2025 | Krembung      | 100%     |
| 2026 | Tulangan, Balongbendo | 100%, 100% |

Source: Sidoarjo’s Regional Water Utility Company, 2019

Based on the information given, the planning of Kalimati WTP construction would be conducted in accordance with the water demand for domestic and non-domestic water needs that have been calculated based on the demographic distribution of the service area. According to Sidoarjo’s Regional Water Utility Company, Kalimati WTP would consist of 4 process buildings, each with a capacity of 250 LPS. Considerations in determining the phase of WTP are as follows:
1. Masterplan by the Regional Water Utility Company
2. Existing services, as can be seen in Figure 1
3. Pipeline network development plan, as can be seen in Figure 2
4. The geographical location of each district
5. The existing condition of the community
Figure 1. Existing Services and Pipeline

Figure 2. Service and Pipeline Network Development Plan
Phase 1
WTP is planned to operate and be able to serve 50% of water needs in Prambon and 30% of Tarik. With a planned WTP capacity of 250 LPS, while Prambon water needs in 2023 would be 83.06 LPS, and Tarik 52.99 liters/second, there would be a large idle capacity reaching 12.96 LPS. Considerations in determining the development of phase 1 services are as follows:
- Prambon is the main target of 100% service by Sidoarjo Water Utility Company in 2023
- Prambon is included into two categories of regions that receive priority water services, which are:
  (1) underdeveloped areas; and (2) border areas (Sidoarjo Government, 2009)
- Installation of pipelines starts from the location of WTP, which is located in Prambon village, Prambon. The first main distribution channel will be planted along the main road of Prambon (Figure 2)
- The main road of Prambon is in the easternmost of the subdistrict and directly borders with Tarik (Figure 1)
- Geographically, Tarik is the closest area to WTP after Prambon.
  - Phase 2
  With an idle capacity of 112 LPS in phase 1, service coverage in Prambon is planned to increase to 100% by 168.12 LPS, so the used capacity of plant 1 would reach 221.10 LPS. Considerations in determining the development of phase 2 services are as follows:
  - Improved services in Prambon up to 200%
  - Adjusting the stages of pipeline network development in Prambon
  - Phase 3
  The service area would extend to 50% of Tulangan and service improvement in Tarik would reach 100% with the addition of plant 2 with a capacity of 250 LPS. The total capacity used would be 217.15 LPS. Considerations in determining the development of phase 3 services are as follows:
  - Tulangan is located adjacent to Prambon
  - Tulangan is the closest in distance to downtown Sidoarjo
  - The population of Tulangan reached 100,037 inhabitants in 2017, making it the most populated compared to other districts.
  - Tulangan is the third sub-district to receive Kalimati water service, although it has the highest population because around 4-5 villages in it has been served by Kedunguling WTP
  - Phase 4
  The third installation is ready to operate expanded services in Tulangan District to 70% and Krembung District by 70%. The total installation capacity used is 301.78 LPS with a total idle capacity by 3 installations of 9 LPS. Considerations in determining the development of phase III services are as follows:
  - Krembung sub-district is geographically adjacent to Tulangan sub-district and Prambon sub-district.
  - The District Capital Lane from Tulangan sub-district is bordered by Krembung sub-district
  - Phase 5
  Phase 5 is the last phase in service improvement in Tulangan and Krembung Sub-Districts in which the service would reach 100% and it would pioneer new networks in Balongbendo District which borders Prambon with a service percentage of 80%. The total capacity used for the fourth installation would reach 205.96 LPS. Considerations in determining the development of phase 5 services are as follows:
  - Balongbendo sub-district is the farthest district from the Water Treatment Plant site.
  - Balongbendo sub-district still has a good groundwater source with a total of 91,215 groundwater wells (RISPAM, 2018).
Table 3. Phasing Plan of Kalimati Water Treatment Plant Installment

| Phase | WTP   | Total Capacity | Debit for Operational | Available Capacity | Services Coverage Percentage | Sub-districts | Water Needs | Idle Capacity |
|-------|-------|----------------|-----------------------|-------------------|-----------------------------|---------------|-------------|---------------|
| 1     | WTP 1 | 250            | 5%                    | 237.5             | 30%                         | Tarik         | 52.99       | 103.62        |
| 2     | WTP 2 | 250            | 5%                    | 237.5             | 70%                         | Tarik         | 123.63      | 20.35         |
| 3     | WTP 3 | 250            | 5%                    | 237.5             | 70%                         | Krembung      | 149.63      | 26.45         |
| 4     | WTP 4 | 250            | 5%                    | 237.5             | 30%                         | Tulangan      | 93.52       | 20.35         |
| 5     | WTP 5 | 250            | 5%                    | 237.5             | 30%                         | Balongbendo   | 92.13       | 32.21         |

Figures 3. Mapping Illustration of The Water Supply Development of Kalimati Water Treatment Plant

The water discharge used in the planning stage of this development is the discharge at the end of the planning year, which is 2026. The total capacity of Kalimati WTP until the final stage is planned to
be 1,000 LPS with four building installations of 250 LPS each. The total capacity will only able to meet the needs in 4 infiltration sub-districts and 80% of the Balongbendo sub-district so that the construction of the installation is declared unfeasible because it cannot meet the water needs in Balongbendo sub-district.

Regarding solutions to maximize services in West Sidoarjo, it is necessary to look for another new water source and to plan for a new WTP building. A summary of Kalimati's WTP service phasing plans can be seen in Table 3 and a visualization of the mapping of service development plans can be seen in Figure 3.

5. Conclusion
Water demand in five service area sub-districts until 2026 is estimated to reach 1,029 LPS, so that the total planned WTP capacity will only able to meet the needs at 100% of services in four of the service area plan sub-districts and 80% of Balongbendo sub-district. Phase 1 and 2 are planned to be able to serve 100% of Prambon sub-district and 30% of Tarik sub-district with water needs of 221.10 LPS. In Phase 3, 100% service development is to be carried out in Tarik sub-district and 50% in Tulangan sub-district with water demands of 217.15 LPS. In Phase 4 service development will extend to 80% of Tulangan and 80% of Krembung sub-district with a water requirement of 301.78 LPS and in the last stage, Phase 5, the service will increase to 100% of Krembung sub-district, 100% of reinforcement districts and 80% of Balongbendo sub-district with a total water demand of up to 250.96 LPS. The capacity used at the end of the stage will be 990.9 LPS with an idle capacity of 9.01 LPS.

References
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Appendices

Appendix A. Result of Projected Population in 5 Sub-districts

Table A1. Projected Population in Prambon

| No | Year | Projected population (inhabitant) |
|----|------|----------------------------------|
| 0  | 2017 | 82076                            |
| 1  | 2018 | 82611                            |
| 2  | 2019 | 83145                            |
| 3  | 2020 | 83679                            |
| 4  | 2021 | 84213                            |
| 5  | 2022 | 84748                            |
| 6  | 2023 | 85282                            |
| 7  | 2024 | 85816                            |
| 8  | 2025 | 86350                            |
| 9  | 2026 | 86885                            |

Table A2. Projected Population in Tarik

| No | Year | Projected population (inhabitant) |
|----|------|----------------------------------|
| 0  | 2017 | 70998                            |
| 1  | 2018 | 72413                            |
| 2  | 2019 | 73828                            |
| 3  | 2020 | 75243                            |
| 4  | 2021 | 76658                            |
| 5  | 2022 | 78073                            |
| 6  | 2023 | 79488                            |
| 7  | 2024 | 80903                            |
| 8  | 2025 | 82317                            |
| 9  | 2026 | 83732                            |

Table A3. Projected Population in Krembung

| No | Year | Projected population (Inhabitant) |
|----|------|----------------------------------|
| 0  | 2017 | 70998                            |
| 1  | 2018 | 72413                            |
| 2  | 2019 | 73828                            |
| 3  | 2020 | 75243                            |
| 4  | 2021 | 76658                            |
| 5  | 2022 | 78073                            |
| No | Year | Projected population (Inhabitant) |
|----|------|----------------------------------|
| 6  | 2023 | 79488                            |
| 7  | 2024 | 80903                            |
| 8  | 2025 | 82317                            |
| 9  | 2026 | 83732                            |

Table A4. Projected Population in Tulangan

| No | Year | Projected population (Inhabitant) |
|----|------|----------------------------------|
| 0  | 2017 | 100137                           |
| 1  | 2018 | 102154                           |
| 2  | 2019 | 104170                           |
| 3  | 2020 | 106186                           |
| 4  | 2021 | 108202                           |
| 5  | 2022 | 110218                           |
| 6  | 2023 | 112234                           |
| 7  | 2024 | 114250                           |
| 8  | 2025 | 116266                           |
| 9  | 2026 | 118283                           |

Table A5. Projected Population in Balongbendo

| No | Year | Projected population (Inhabitant) |
|----|------|----------------------------------|
| 0  | 2017 | 76970                            |
| 1  | 2018 | 78055                            |
| 2  | 2019 | 79139                            |
| 3  | 2020 | 80224                            |
| 4  | 2021 | 81308                            |
| 5  | 2022 | 82392                            |
| 6  | 2023 | 83477                            |
| 7  | 2024 | 84561                            |
| 8  | 2025 | 85645                            |
| 9  | 2026 | 86730                            |