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# Application of the Porous water Receipt well to Reduce the Puddle in Passo Village, Ambon City

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***Abstract*— *The impact of land use change in developing areas, especially at Passo Village, Ambon Bay, is a serious problem if continuously ignored, and then RT (neighborhood) number 21.22 and 23 will experience inundation throughout the rainy season. This is because sea levels are higher than residential areas. In order not to experience a long puddle, the solution is to make a water catchment well by considering the condition of the existing drainage system that is no longer able to be burdened. From the results of the hydrological analysis in a residential area of 12.71 Ha, an average runoff coefficient of 0.85 was found with a rainfall intensity of 72.83 mm / hour. From the results of the discharge analysis for the return period of 2 years is 2.17 m3 / sec. Permeability for infiltration wells on site is 0.847 m / day, the calculation of the need for infiltration wells installed at the study site is based on the analysis of the width of the building roofs for types 36, 45, 50, 60.70 and 120. Construction of water infiltration wells made using two types of aggregates rough for non-sand concrete (non-structural concrete) with a mixture of 1 cement and 6 rocks or broken stone. Water infiltration wells installed from the calculation results for material from coral are 663 pieces and from 670 broken stones, individual infiltration wells are made in a circle with a sinking diameter of 1.25 meters and a depth of 2 meters, thus found reduced surface flow efficiency that can be reduced type 36 is 12.69% type 45 is 9.9%, type 50 is 8.82%, type 60 is 7.25%, type 70 is 6.15% and type 120 is 3.50% of infiltration wells made of rock.*
***Keyword*— Water catchment wells, concrete without sand, Passo Village.***

## I. INTRODUCTION

Changes in land use due to the growth of house buildings in a residential area, can indirectly damage the water catchment area. This results in the reduction of the rainwater catchment area which causes rain water to collect in the existing drainage channels.

These conditions will cause an increase in the volume of surface water which entering the drainage channel and overflow of water in the channel which can cause inundation or even flooding. Infiltration well is a means to collect rainwater and absorb it into the ground.

Infiltration wells function to provide artificial water recharge by injecting rainwater into the ground. The target location is the water infiltration area in the village of Passo, RT number 21.22 and 23 covering an area of 12.71 Ha. Water Infiltration Well Construction (SRA) can be used as an alternative in dealing with floods are Non-Sand Concrete, a mixture of 1 cement: 6 rocks of diameter 20 mm and Non-Sand Concrete mixed of 1 cement: 6 broken stones 20 mm in diameter. The purpose of this study is to reduce puddles by using non-sand concrete.

## II. REVIEW OF LITERATURE

**2.1 The benefits of recharge wells are**

1) Reducing surface runoff so that it can prevent / reduce the occurrence of floods and puddles.
2) Maintaining and increasing groundwater level
3) Reducing erosion and sedimentation
4) Reducing / resisting sea water intrusion for areas adjacent to coastal areas
5) Prevents land subsidence
6) Reducing the concentration of groundwater pollution.

**2.2 Procedures of Infiltration Wells**

The procedure of infiltration wells is to deliver and store rainwater into holes or wells so that water can have time to stay on the surface of the ground, so that the water can seep slowly into the ground. From the procedure it can be seen that the main purpose of infiltration wells is to enlarge the entry of water into soil aquifers as infiltration water. Thus, more water will enter the ground and less flow as surface (runoff).

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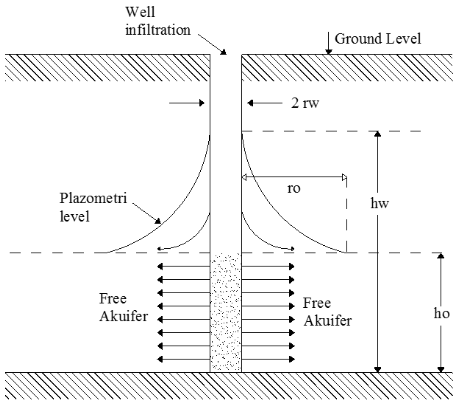


*Fig.1: Process of delivering water into the free aquifer*

$$Q = \frac{\pi.K(hw^2 - ho^2)}{\ln(ro/rw)} \qquad \text{(eq.1)}$$

The procedure for planning rainwater catchment wells refers to SNI 03-2453-2002. Calculation of flood share volume and number of wells needed is done using the equation

$$Vab = 0.85 * C * A * R \qquad \text{(eq.2)}$$

Notes :

Vab = flood share volume (m3)

C = Runoff coefficient

A = Area of drainage area (m2)

R = Average daily rainfall height (mm / day)

### 2.3 Rain Intensity (I)

Calculation of rainfall intensity is usually required as part of the formulation in the calculation of plan discharge using the Rational Method. The use and determination of the intensity formula must be considered several things, among others:

a. Available data
b. The simplicity and practicality of the formula used
c. Trust in the results to be achieved and the results can be justified. The amount of rainfall intensity can be calculated with the empirical formula of rainfall

$$I = \left(\frac{R_{24}}{24}\right)\left(\frac{24}{Tc}\right)^{\frac{2}{3}} \qquad \text{(eq.3)}$$

Notes :

I = rainfall intensity (mm / hour)

R24 = Maximum rainfall that is occur for 24 hours (mm)

Tc= concentration time (hours)

### 2.4 Soil Permeability

Permeability is the speed at which water seeps into the soil both through macro pores and micro pores both horizontally and vertically. The permeability value is taken from the average value of impregnation factor

$$K = \frac{1}{absorptionfactor} \qquad \text{(eq.4)}$$

*Table.1: Permeability Coefficients of Several Types of Soil*

| Land Texture | Infiltraton speed (mm/hr) | Criteria |
|---|---|---|
| Sandy Clay | 25 - 50 | Very Fast |
| Clay | 12.5 - 15 | Fast |
| Dusty loam | 7.5 - 15 | Moderate |
| Clay clay | 0.5 - 2.5 | Slow |
| Loamy | < 0.5 | Very Slow |

### 2.5 Porous Concrete

Porous concrete is an application of civil construction that is important for sustainable development to overcome one of the many impacts of standing water and flooding. With the development technique used, the application of pour concrete can also protect water quality in the soil which then becomes a guaranteed source of water due to good circulation. To replace infiltration space due to changes in land use, porous concrete is used.

Another advantage regarding porous concrete reduces the level of pollution of ground water, because the concrete mixture does not use a mixture of hazardous chemicals, then the potential for groundwater pollution becomes smaller, by using porous concrete pavement that can reduce the need for rainwater preparation ponds, drainage channels, and management facilities other rain water.

## III. METHODOLOGY

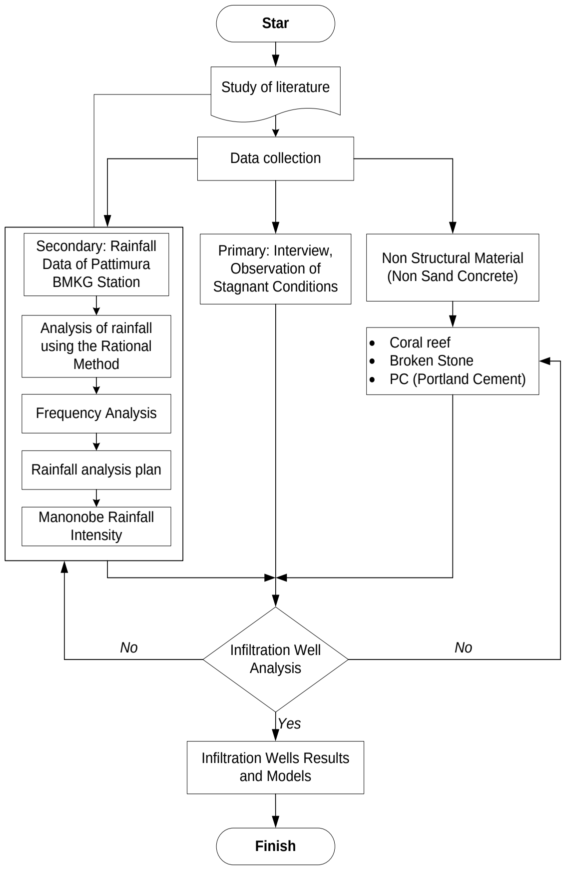


*Fig.2: Research Flow Diagram*

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## IV. RESULTS AND DISCUSSION

### 4.1 Hydrological Analysis

Rain analysis uses maximum daily rainfall data for 10 years from 2009 to 2018,

1) From the results of the calculation of the Distribution of Rainfall with Pearson Log III shows that the highest maximum daily rainfall each year ranges from 97.3 mm to 360.40 mm. The highest maximum daily rainfall occurred in January 2013 amounted to 360.40 mm.
2) The time of concentration (Tc) of runoff water into the channel is 0.775 hours or 46.50 minutes.
3) The value of rainfall intensity (I) for the 2-year return period is 72.83 mm / hour.
4) Calculation of flood peak discharge using the rational method. Peak Discharge (Q peak) is assumed to be a debit value rainfall that goes directly into the drainage channel. In the structural planning analysis, the infiltration well is used at a 2-year return period with peak discharge values occurring during the first 1 (one) hour 2.18 $m^3$ /s
5) Large infiltration of porous wells made of broken stone is 0.755 m / day (31.46 mm/hr) and coral material is 0.847 m / day (35.29 mm/hr)
6) Calculation of dimensions and infiltration well models as shown in the table below.

### 4.2 Calculation of Infiltration Wells

With theoretical analysis using the formula of Sunjoto (1988) for the dimensions of infiltration wells, the following calculations are carried out

$$H = \frac{Q}{FK}\left[1 - e^{\frac{-FKT}{\pi R^2}}\right] \qquad \text{(eq.5)}$$

The design plan dimensions of the infiltration well are designed based on technical data, namely:

1) Maximum infiltration well size will be used Ø 0,8 m and maximum 1,4 m with cylindrical section;
2) Size of well depth (H), which is 2 m;
3) Walls made of concrete without sand (a mixture of 1 cement: 6 rocks or broken stones 20 mm in diameter) with (D) 1.25 m and the rest is the face of the ground;
4) Inlet pipe size Ø 110 mm.
5) The bottom of the well is filled with sand, palm fiber and broken stone;
6) The well cover is made of a concrete plate with a thickness of 10 cm (a mixture of 1 cement: 2 sand: 3 broken stones).

Analysis of infiltration well needs is based on various parameters, namely the value of soil permeability, area size, groundwater level during the rainy season, rainfall intensity of an area, and so forth. The need for infiltration wells in RT number 21.22 and 23 at Passo villages is adjusted to the slope of the roof and the design of the cross section of the well. The calculation of infiltration well needs that should be installed in RT number 21.22 and 23 at Passo villages is based on the analysis of the width of the roof of a building type 36, 45, 50, 60.70 and 120 can be seen in table 2 and table 3

*Table.2: Total Infiltration Wells with Porous Rock Concrete*

| Roof Area (m2) | Total (pc) | C | K (m/hari) | Dwell (m) |
|---|---|---|---|---|
| *1* | *2* | *3* | *4* | *5* |
| 36 | 181 | 0.85 | 0.847 | 1.25 |
| 45 | 147 | 0.85 | 0.847 | 1.25 |
| 50 | 104 | 0.85 | 0.847 | 1.25 |
| 60 | 84 | 0.85 | 0.847 | 1.25 |
| 70 | 59 | 0.85 | 0.847 | 1.25 |
| 120 | 12 | 0.85 | 0.847 | 1.25 |
| Hdesign (m) | Tr2 (mm) | Awell (m2) | Vab (m3) | te (Jam) |
| *6* | *7* | *8* | *9* | *10* |
| 2 | 72.83 | 9.077 | 2.205 | 0.775 |
| 2 | 72.83 | 9.077 | 2.757 | 0.775 |
| 2 | 72.83 | 9.077 | 3.063 | 0.775 |
| 2 | 72.83 | 9.077 | 3.676 | 0.775 |
| 2 | 72.83 | 9.077 | 4.288 | 0.775 |
| 2 | 72.83 | 9.077 | 7.352 | 0.775 |
| Vinfil (m3) | Vstr (m3) | Htotal (m) | n (buah) | Total n (buah) |
| *11* | *12* | *13* | *14* | *15* |
| 0.248 | 1.957 | 1.596 | 0.80 | 144 |
| 0.248 | 2.508 | 2.045 | 1.02 | 150 |
| 0.248 | 2.815 | 2.295 | 1.15 | 119 |
| 0.248 | 3.427 | 2.794 | 1.40 | 117 |
| 0.248 | 4.040 | 3.294 | 1.65 | 97 |
| 0.248 | 7.103 | 5.791 | 2.90 | 35 |
| Total Wells | | | | **663** |

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*Table.3: Total Infiltration Wells with Broken Stone Porous Concrete*

| Roof Area (m2) | total (pc) | C | K (m/hari) | Dwell (m) |
|---|---|---|---|---|
| *1* | *2* | *3* | *4* | *5* |
| 36 | 181 | 0.85 | 0.755 | 1.25 |
| 45 | 147 | 0.85 | 0.755 | 1.25 |
| 50 | 104 | 0.85 | 0.755 | 1.25 |
| 60 | 84 | 0.85 | 0.755 | 1.25 |
| 70 | 59 | 0.85 | 0.755 | 1.25 |
| 120 | 12 | 0.85 | 0.755 | 1.25 |
| Hdesign (m) | Tr2 (mm) | Awell (m2) | Vab (m3) | te (Jam) |
| *6* | *7* | *8.000* | *9* | *10* |
| 2 | 72.833 | 9.077 | 2.205 | 0.775 |
| 2 | 72.833 | 9.077 | 2.757 | 0.775 |
| 2 | 72.833 | 9.077 | 3.063 | 0.775 |
| 2 | 72.833 | 9.077 | 3.676 | 0.775 |
| 2 | 72.833 | 9.077 | 4.288 | 0.775 |
| 2 | 72.833 | 9.077 | 7.352 | 0.775 |
| Vinfil (m3) | Vstr (m3) | Htotal (m) | n (buah) | Total n (buah) |
| *11* | *12* | *13.000* | *14* | *15* |
| 0.221 | 1.984 | 1.618 | 0.809 | 146 |
| 0.221 | 2.536 | 2.067 | 1.034 | 152 |
| 0.221 | 2.842 | 2.317 | 1.158 | 120 |
| 0.221 | 3.455 | 2.816 | 1.408 | 118 |
| 0.221 | 4.067 | 3.316 | 1.658 | 98 |
| 0.221 | 7.130 | 5.813 | 2.907 | 35 |
| Total Wells | | | | **670** |

From the analysis of infiltration wells on two non-structural concrete used, the number of infiltration wells made with coral is less when compared to non-structural concrete of broken stone. Thus, the infiltration well with coral material is selected by taking into account the cost aspects and using material in the form of local wisdom by taking into account the requirements or standards of the installation of infiltration wells based on SNI.

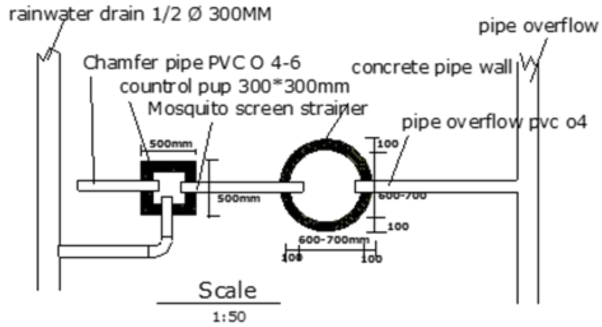


*Fig.3: Viewing dimensions of infiltration wells*

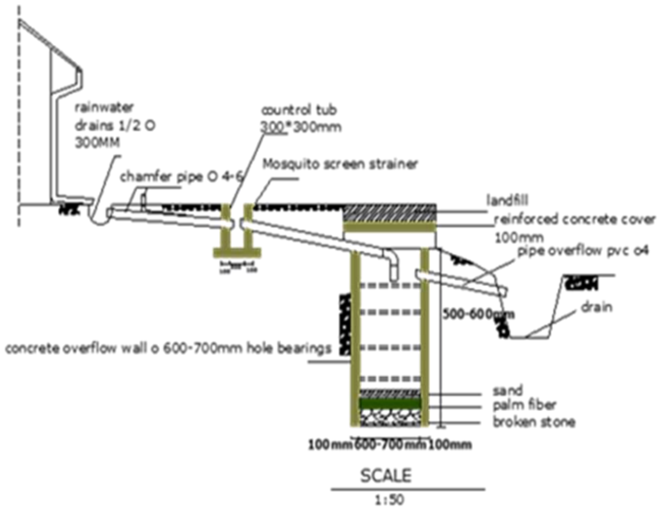


*Fig.4: Dimensional view of infiltration well dimensions*

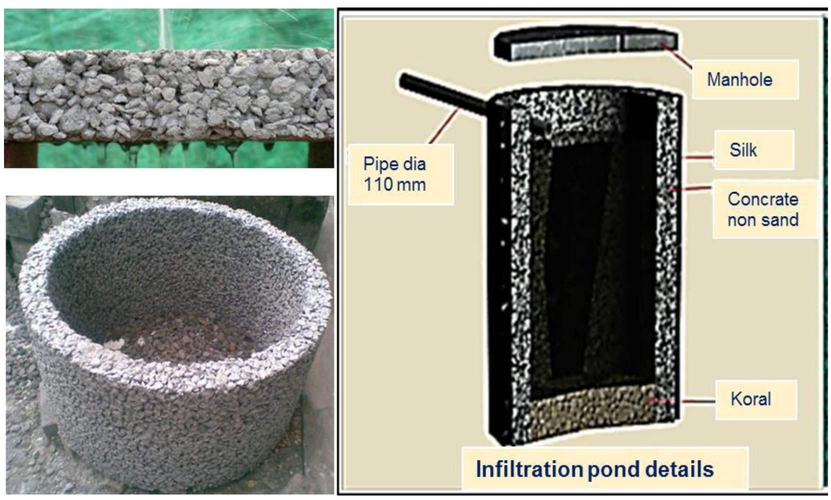


*Fig.5: Non-sand infiltration well model*

### 4.2 Characteristics

The compressive strength of porous concrete from the test results of the two test objects, the compressive strength of concrete in 28 days is obtained:

a) For broken porous rock concrete is 10MPa
b) For porous concrete rock is 4 MPa Strength of porous concrete will continue to increase

after the age of 28 days to be able to match the normal concrete.

Selection of concrete quality according to material specifications is important so that it does not experience wasteful costs and safe to use. Referring to the results of the concrete quality characteristics test, the non-rock concrete structure is sufficient to be used as an individual filtration well at the research sites RT. number 21.22 and 23 at Passo Village..

## V. CONCLUSION

1) With an area of 12.71 Ha in 3 RTs in Passo Village, the individual infiltration well made in a circle with a diameter of 1.25 meters and a depth of 2 meters, thus found a reduced surface flow efficiency for type 36 is 12.69% type 45 is 9 , 9%, type 50 is 8.82%, type 60 is 7.25%, type 70 is 6.15% and type 120 is 3.50% of infiltration wells made of rock
2) The compressive strength of porous concrete from the test results of the two specimens, the concrete compressive characteristics of 28 days for broken stone porous concrete are 10 MPa and porous rock concrete is 4 MPa (selected) in order to save costs because of the non-concrete concrete considered sufficient to be used as an individual recharge well.

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