# 6 SELECTION OF PRIORITY PROJECTS FOR FS

## 6.1 Project Components of Selected Road Network

Figure 6.1.1 shows the selected road network alternative as mentioned in Chapter 5 (Alternative 3). It is divided into 12 project components as shown in Figure 6.1.1 and enumerated in Table 6.1.1 with corresponding costs preliminarily estimated.

From these project components, the priority projects were chosen.

**Figure 6.1.1 Road Project Components in the Selected Road Network Alternative**

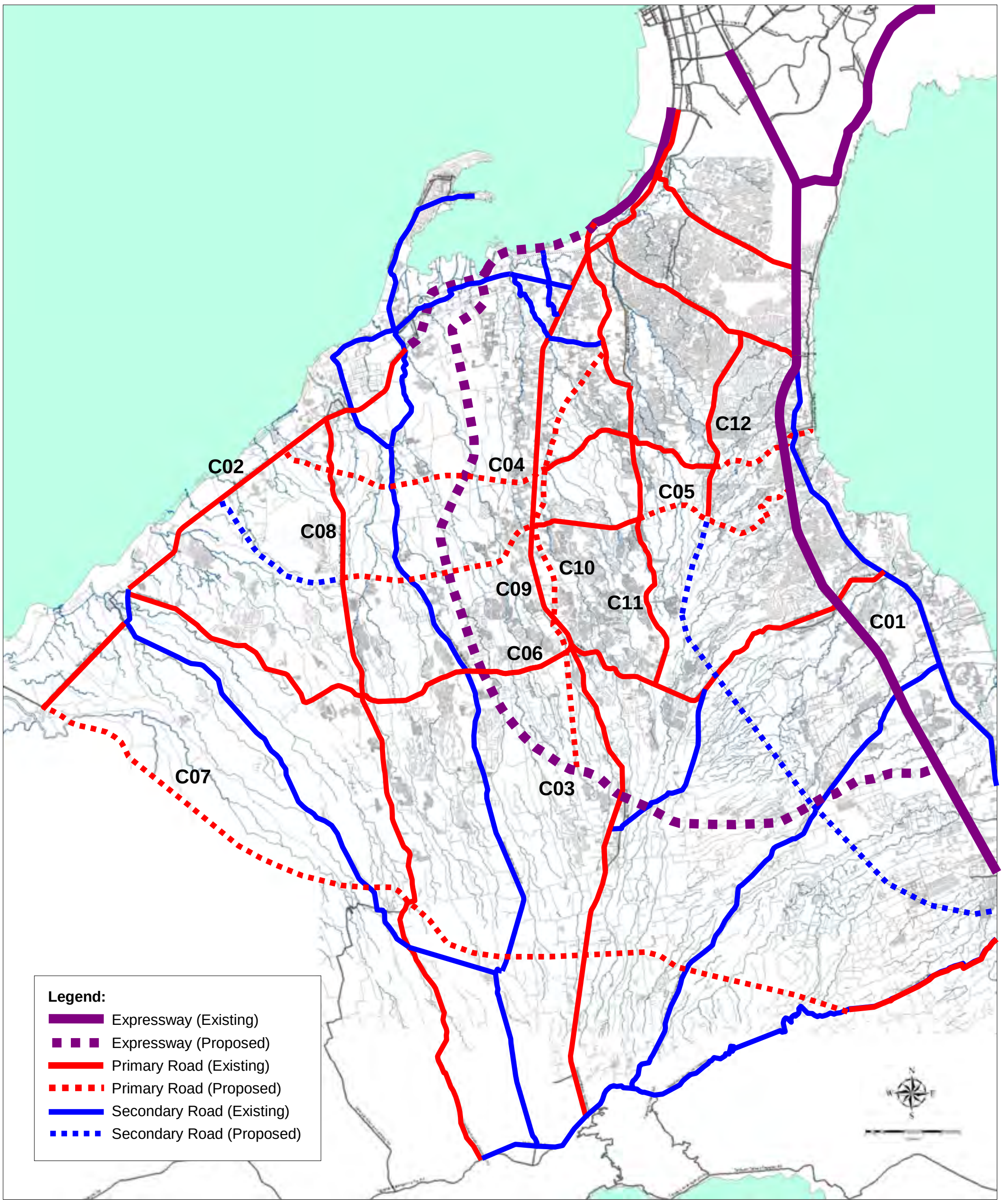


**Table 6.1.1 Project Components of Selected Road Network Alternative**

| | | Cost Estimates (Billion Pesos) | | |
|---|---|---|---|---|
| | | Const. | ROW | Total |
| C01 | South Luzon Expressway | 4.9 | 0.0 | 4.9 |
| C02 | West Coastal Road | 2.2 | 0.7 | 2.9 |
| C03 | CALA Expressway | 10.6 | 4.4 | 15.0 |
| C04 | E/W 1 (Daang Hari Ext.) | 2.5 | 2.1 | 4.6 |
| C05 | E/W 2 (Calibuyo Ext.) | 1.8 | 1.2 | 3.0 |
| C06 | E/W 3 (Governor's drive) | 1.2 | 1.8 | 3.0 |
| C07 | E/W 4 (Maragondon) | 3.8 | 1.9 | 5.7 |
| C08 | N/S 1 (Tanza-Tagaytay) | 0.7 | 0.5 | 1.2 |
| C09 | N/S 2 (Aguinaldo) | 0.5 | 0.3 | 0.8 |
| C10 | N/S 3 (Bacoor-Dasmariñas) | 3.4 | 2.1 | 5.5 |
| C11 | N/S 4 (Molino) | 0.9 | 0.7 | 1.6 |
| C12 | N/S 5 (Daang Hari ext.) | 1.1 | 0.7 | 1.8 |

Note: Estimated preliminarily using unit costs per km.

## 6.2 Selection of the Target Roads

### 6.2.1 Methodology

There are two steps to select the priority projects among the ones shown, to wit:

Step 1: The economic evaluation for each project is conducted and all projects are ranked by the result. The demand in 2020 is used for this evaluation and the same methodology of economic evaluation as explained in the previous chapter is applied (measuring the difference of transport cost between "with-project" case and "without-project" case).

Step 2: At step 1, there is no examination on the road network while each project is to be evaluated, and it is difficult to decide how many projects are to be selected only by the evaluation of individual projects and their rankings. Therefore, at step 2, a hypothetical examination is conducted as follows: the better project in terms of economic evaluation is selected one by one, and network performance is checked until the target level of performance is achieved. This time, the target is set to V/C ratio below 1.0 and 1.5 under the traffic demand in 2010 and 2020 respectively. Despite the service level not good enough to ensure high accessibility and comfort for road users, however, realization of the project is the priority consideration given the shortage of investment funds at present.

### 6.2.2 Result of Economic Evaluation

Table 6.2.1 shows the result of economic evaluation of each project. North-South 3 (C10) shows the highest value and East-West 1 (C04) shows the second highest in terms of EIRR. The third one is CALA expressway but this project shows the highest value on net present value (NPV).

**Table 6.2.1 Result of Economic Evaluation of Each Project**

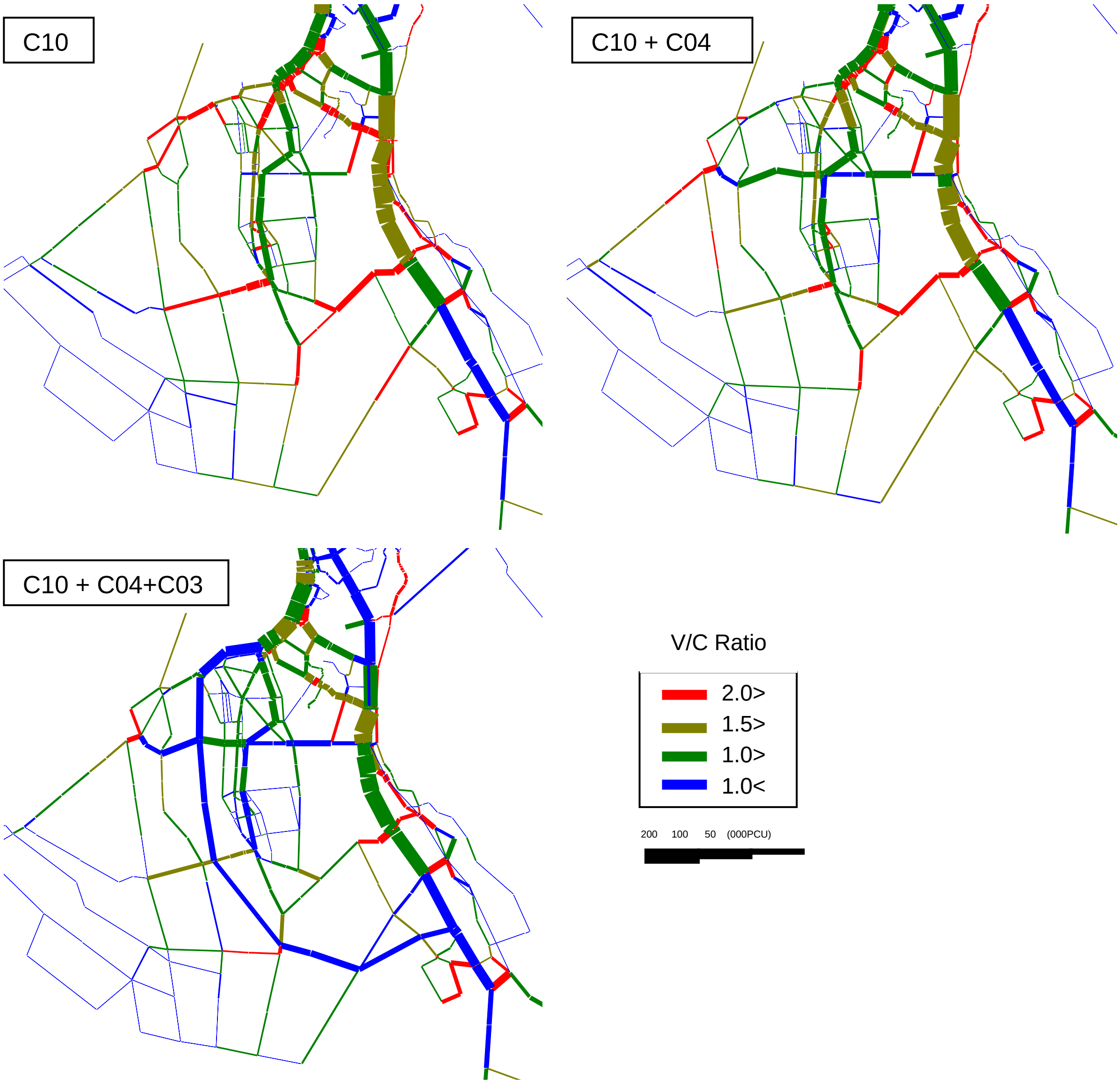
| | | Benefit (Billion Pesos/year) (2020) | Evaluation | | | Rank |
|---|---|---|---|---|---|---|
| | | | EIRR (%) | NPV (Billion Pesos) | B/C | |
| C01 | South Luzon Expressway | 5.2 | 19.7 | 1.9 | 1.6 | 12 |
| C02 | West Coastal Road | 5.5 | 25.1 | 3.4 | 2.6 | 8 |
| C03 | CALA Expressway | 51.6 | 33.0 | 41.0 | 4.5 | 3 |
| C04 | E/W 1 (Daang Hari Ext.) | 29.4 | 41.1 | 26.2 | 7.8 | 2 |
| C05 | E/W 2 (Calibuyo Ext.) | 10.4 | 32.1 | 8.2 | 4.4 | 4 |
| C06 | E/W 3 (Governor's drive) | 8.6 | 27.9 | 6.2 | 3.4 | 6 |
| C07 | E/W 4 (Maragondon) | 11.9 | 25.6 | 7.7 | 2.7 | 7 |
| C08 | N/S 1 (Tanza-Tagaytay) | 1.7 | 21.2 | 0.8 | 1.9 | 11 |
| C09 | N/S 2 (Aguinaldo) | 2.6 | 22.1 | 0.7 | 2.0 | 10 |
| C10 | N/S 3 (Bacoor-Dasmariñas) | 28.3 | 42.7 | 24.5 | 8.6 | 1 |
| C11 | N/S 4 (Molino) | 3.0 | 23.6 | 1.8 | 2.3 | 9 |
| C12 | N/S 5 (Daang Hari ext.) | 5.9 | 31.4 | 4.6 | 4.2 | 5 |

After determining the projects' economic rating, their performance in the network is conducted for the future years. Table 6.2.2 shows the result of the procedure for selecting the priority project(s) as "step 2" of the evaluation. The results show that the priority projects are C10, C04 and C03 based on the V/C ratio criteria (i.e., ratio should be below 1.0 and 1.5 under the traffic demand of 2010 and 2020, respectively). In addition, results show that there is no significant impact by adding the fourth best project (C05) to the network. Therefore, the three mentioned projects are chosen as the priority projects.

**Table 6.2.2 Priority Projects and Network Performance (2010, 2020)**

| Priority Project | | 2010 | | 2020 | |
|---|---|---|---|---|---|
| | | V/C Ratio | Ave. Speed | V/C Ratio | Ave. Speed |
| C10 | N/S 3 (Bacoor – Imus) (C10) | 1.30 | 19.9 | 1.93 | 14.5 |
| C04 | E/W 1 (Daang Hari Extension) (C10+C04) | 1.23 | 21.6 | 1.82 | 16.1 |
| C03 | Cavite Expressway (C10+C04+C03) | 0.91 | 27.2 | 1.36 | 21.4 |
| C05 | E/W 2 (Calibuyo Extension) (C10+C04+C03+C05) | 0.87 | 27.4 | 1.30 | 21.9 |

**Figure 6.2.1 Network Performance by Stage of Priority Project Selection, 2020**




### 6.2.3 The Target Roads

At present, the Government of the Philippines has been encountering serious shortage of capital, which at times results in the suspension of the process in ODA funding due to the unavailability of counterpart fund. As such, for the proper and smooth progression of the project, a strategic development scheme is necessary as well as the consideration for the minimum required investment(s).

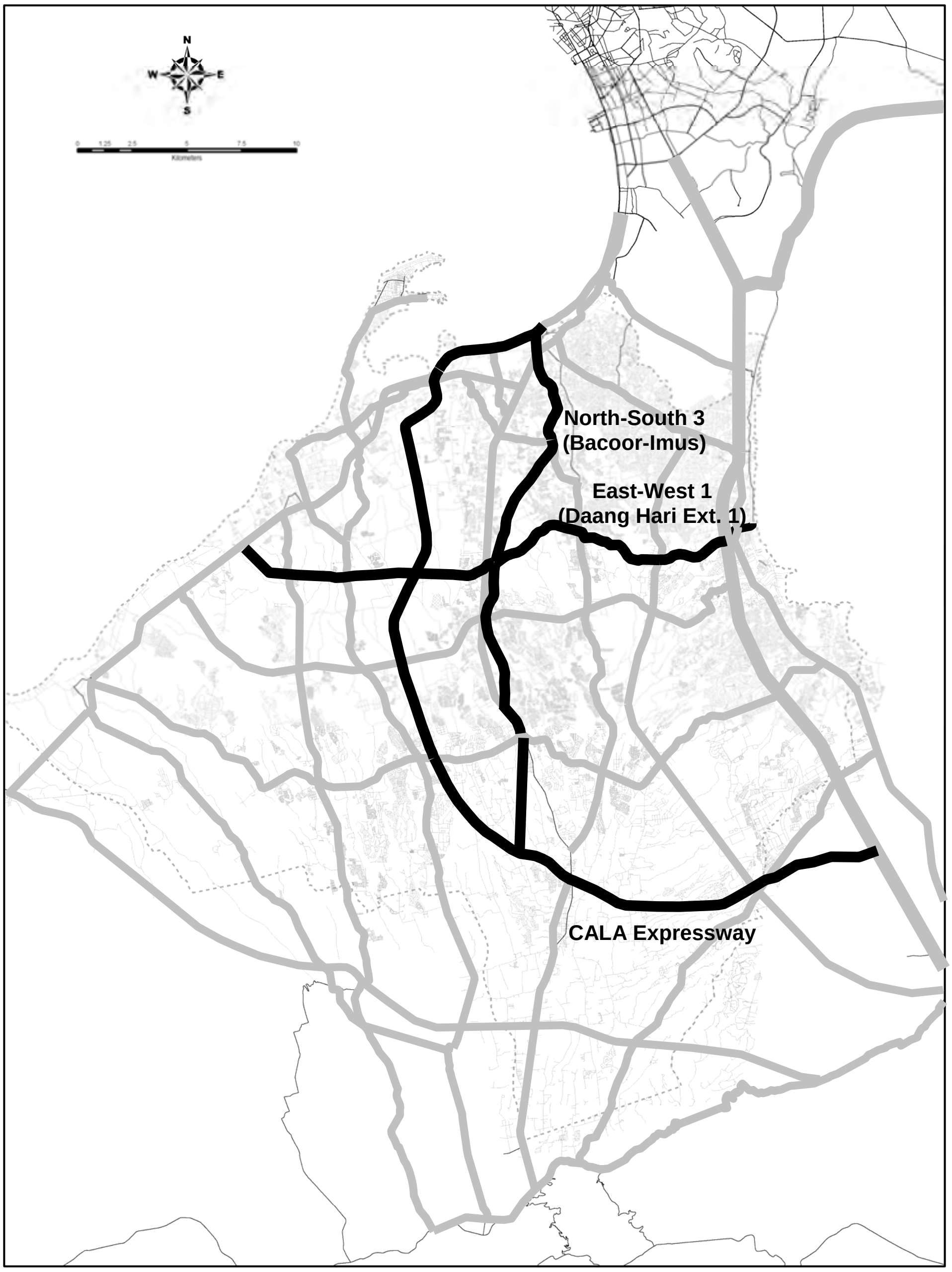
Moreover, adherence to environmental standards is essential for the projects. It is, therefore, required that the projects have mitigating measures to counter the negative impacts on the natural and social environment as much as possible.

As priority projects, there are three projects selected. The basic structures of each project are initially proposed in Table 6.2.3.

**Table 6.2.3 Proposed Structure of Priority Projects**

| | | Road Type | Length (km) | Designed Speed (km/h) | No. of Lanes | ROW (m) |
|---|---|---|---|---|---|---|
| C10 | North-South 3 (Bacoor – Imus) | Highway | 28 | 60 | 6 | 30 |
| C04 | East West 1 (Daang Hari) | Highway | 24 | 60 | 4 | 30 |
| C03 | CALA Expressway | Expressway | 50 | 100 | 6 | 50 |

**Figure 6.2.2 Proposed Priority Projects**



## 6.3 Alignment Considerations

### 6.3.1 Alignment Alternatives

For each of the North-South Road (North-South 3 of C10 in previous sections), Daang Hari Road (East-West 1 or CO4) and CALA Expressway (CO3), some alternative routes can be considered as shown in Figure 6.3.1 to Figure 6.3.3.

**Figure 6.3.1 Alternative Alignment of the North-South Road**

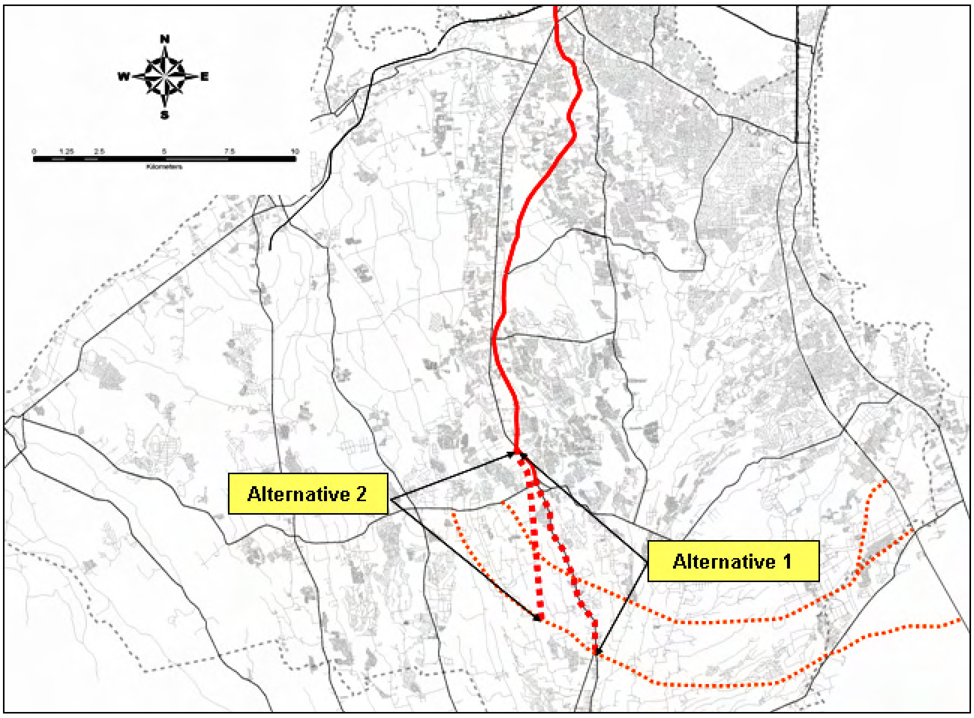



**Figure 6.3.2 Alternative Alignments of the Daang Hari Road**

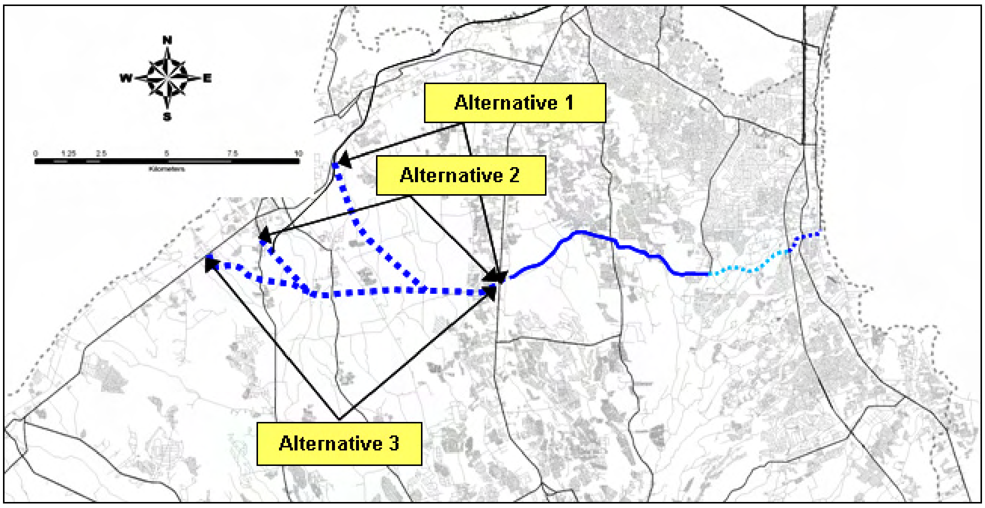
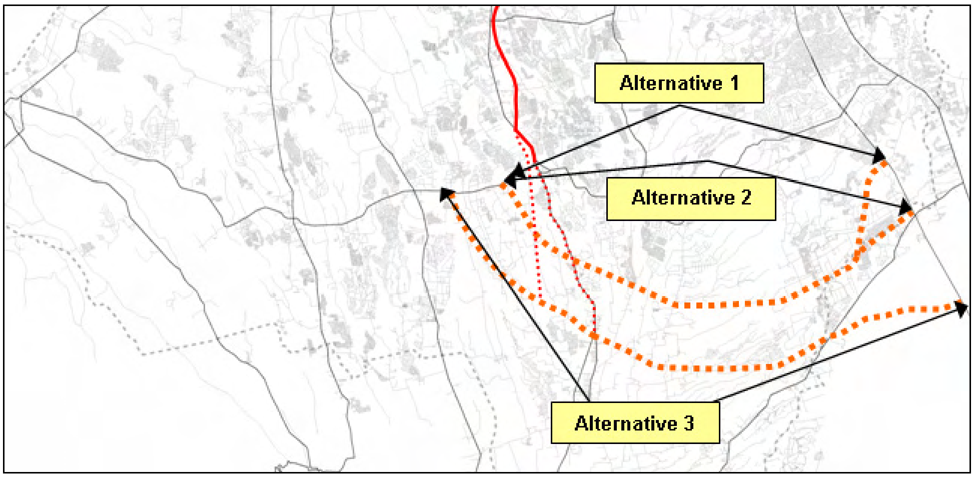


**Figure 6.3.3 Alternative Alignments of the CALA Expressway**




In order to select the best alternative alignment, it was decided that the stakeholders of the project should make the selection by themselves. The details of this procedure are described hereafter. Table 6.3.1 to Table 6.3.3 shows the basic features of the alternatives.

**Table 6.3.1 Projected Traffic Volume by Alternative**

| | (000 PCUs/day) | | |
|---|---|---|---|
| | Alternative | 2010 | 2020 |
| N/S Road | 1 | 80.4 | 96.9 |
| | 2 | 82.1 | 117.8 |
| Daang Hari Extension | 1 | 42.3 | 58.9 |
| | 2 | 44.2 | 77.3 |
| | 3 | 52.4 | 83.3 |
| CALA Expressway | 1 | 100.4 | 157.5 |
| | 2 | 98.7 | 155.2 |
| | 3 | 61.5 | 124.0 |

**Table 6.3.2 Economic Evaluation by Alternative**

| | Alternative | EIRR (%) | NPV (Million Pesos) | B/C |
|---|---|---|---|---|
| N/S road | 1 | 21.6 | 4,106 | 2.72 |
| | 2 | 41.6 | 6,783 | 5.52 |
| Daang Hari Extension | 1 | 39.9 | 3,950 | 4.96 |
| | 2 | 43.8 | 3,903 | 5.96 |
| | 3 | 43.4 | 4,052 | 5.78 |
| CALA Expressway | 1 | 30.2 | 8,065 | 2.65 |
| | 2 | 28.1 | 7,600 | 2.43 |
| | 3 | 27.3 | 7,164 | 2.24 |

**Table 6.3.3 Number of Structures Affected by Alternative**

| | Type of Structures | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Residential | | | Commercial | | | School | Church | Others | |
| | | | | | Concrete / Wood | | | | | | |
| | Alternative | Wooden | Concrete | Mix | Small | Medium | Large | | | | |
| N/S road | 1 | 218 | 570 | 39 | - | 126 / 18 | 1 / 0 | 7 | 2 | 6 | **987** |
| | 2 | 3 | 13 | - | - | 1 | - | - | - | - | **17** |
| Daang Hari Extension | 1 | 14 | 30 | - | 0 / 1 | - | - | - | - | - | **45** |
| | 2 | 12 | 16 | - | 0 / 1 | - | - | - | - | - | **29** |
| | 3 | 13 | 10 | - | 0 / 1 | - | - | - | - | - | **24** |
| CALA Expressway | 1 | - | 99 | - | 0 / 1 | - | - | - | - | Laguna Technopark | **100** |
| | 2 | - | 99 | - | - | - | - | - | - | Laguna Technopark | **100** |
| | 3 | - | 5 | - | - | - | - | - | - | - | **5** |

### 6.3.2 Establishment of Evaluation Criteria

Based on the discussion in the 4th Technical Working Group meeting held on 26 October 2005, the alternative alignments of the three target roads were evaluated based on three criteria; that is, in terms of (1) traffic and technical conditions, (2) regional development and (3) environmental and social consideration.

The Technical Working Group, after an intensive discussion on evaluation criteria and parameters that should be considered, recommended the evaluation weights assigned for each target road (Table 6.3.4) which signifies their developmental importance in the road network for the CALA subregion.

**Table 6.3.4 Evaluation Weights (Summary)**

| | (1) | (2) | (3) | Total |
|---|---|---|---|---|
| | Traffic/Technical | Regional Development | Environment | |
| North - South Road | 45% | 20% | 35% | 100% |
| Daang Hari Road | 25% | 40% | 35% | 100% |
| CALA Expressway | 30% | 40% | 30% | 100% |

- North-South Road is seen to strongly address the traffic congestion in the area. Hence a weight of 45% is assigned to the Traffic/Technical criteria. The environmental and social considerations come second with 35% weight.
- Daang Hari Road is perceived, first and foremost, to play a more important role in regional development above other evaluation criteria. Hence, a heavier weight of 40% is pegged to its role in regional development. This is followed by 35% for the environmental and social considerations due to its relatively lesser adverse impact on environment.
- CALA Expressway is also perceived to be more important for regional development with an assigned weight of 40%. The traffic and technical conditions and the environmental and social considerations are on equal footing of 30% each.

In turn, each evaluation criteria has three sub-criteria as explained in Table 6.3.5. Key sub-criteria were assigned higher weights to reflect their importance in implementing alternative alignments.

**Traffic/Technical:** Key consideration for all target roads has been singled out to be the magnitude of capital required for realizing the road (alternative alignment). The lesser the capital required, the higher its rating for implementation. Other considerations are the adequacy of alignment and easiness of construction.

**Table 6.3.5. Evaluation Weights (Traffic/Technical)**

| | (1) Traffic/Technical | | | |
|---|---|---|---|---|
| | (1-1)<br>Easiness of construction<br>- road design (eg. Radius, number of river crossing, etc.)<br>- topographic condition<br>- type of work (widening of existing or new construction) | (1-2)<br>Adequacy of alignment<br>- areas traversed (open or built-up)<br>- areas to be served and traffic demand | (1-3)<br>Magnitude (less) of capital requirement<br>- given cost estimate (preliminary calculation) | Total |
| North-South Road | 10% | 15% | 20% | 45% |
| Daang Hari Road | 5% | 5% | 15% | 25% |
| CALA Expressway | 5% | 10% | 15% | 30% |

**Regional Development:** Key consideration here is different by target road. In Daang Hari Road and CALA Expressway, key considerations are the alignment's support to the growth corridors/industrial areas (as defined in the Provincial Physical Framework Plan and the CLUPs of the LGUs concerned) as well as network efficiency. The more immediate concern for North-South Road is network efficiency to relieve congestion in the area.

**Table 6.3.6. Evaluation Weights (Regional Developments)**

| | (2) Regional Development | | | |
|---|---|---|---|---|
| | (2-1)<br>Network efficiency<br>- economic evaluation<br>- road network with /without project<br>- traffic assignment for congestion | (2-2)<br>Support growth corridors/industrial areas<br>- reference to CLUPs of LGUs and the Provincial Physical Framework Plan<br>- location of existing industrial estates and planned urban developments<br>- selected development scenario of stakeholders | (2-3)<br>Tourism development<br>- tourism areas to be served and new tourism areas to be developed<br>- location of protected areas and water basins | Total |
| North-South Road | 10% | 5% | 5% | 20% |
| Daang Hari Road | 15% | 15% | 10% | 40% |
| CALA Expressway | 15% | 15% | 10% | 40% |

**Environment:** For environment, heavier rating (consideration) is given to the easiness in right-of-way acquisition (ROWA) for all target roads. By DPWH's experience in implementation, delays in ROW acquisition could spell out undue burden on investment requirement and unrealized benefits for road users as well as residents and commercial establishments of nearby areas. In relation to this, magnitude of disturbance is the next important sub-criteria. Impact on the agricultural sector is also a consideration but with lesser rating weight.

**Table 6.3.7 Evaluation Weights (Environment)**

| | (3) Environment | | | |
|---|---|---|---|---|
| | (3-1)<br>Magnitude of disturbance<br>- quantity of structures<br>- social disturbance (as perceived by concerned LGUs) | (3-2)<br>Easiness of ROWA<br>- identification of resettlement needed (perceived by LGUs)<br>- property ownership profile (perceived by LGUs) | (3-3)<br>Low impact on agricultural sector<br>- project impact to agricultural areas<br>- areas reserved for agricultural self sufficiency (not open to conversion) | Total |
| North-South Road | 15% | 15% | 5% | 35% |
| Daang Hari Road | 10% | 20% | 5% | 35% |
| CALA Expressway | 10% | 15% | 5% | 30% |

On the whole, the higher the percentage weight given to a particular criteria item, the more positive the impact is perceived by the group. The alternative alignment with the highest aggregated rating would mean its higher preference for implementation and would, therefore, be the selected alignment for further study in the feasibility study stage of this undertaking.

### 6.3.3 Evaluation of Alternative Alignments during the 4th Stakeholders' Meeting

Based on the evaluation criteria, the alternative alignments for the three target roads were evaluated and optimum alignments were selected during the 4th Stakeholders' Meeting held on 7 December 2005 in Cavite and 9 December 2005 in Laguna. The selected alignments are as follows: Alternative 2 for North–South Road, Alternative 3 for Daang Hari Road and Alternative 3 for CALA Expressway, as shown in Table 6.3.8. In the beginning of the stakeholders' meeting, the evaluation criteria and evaluation weights assigned by the TWG as previously discussed were explained to and agreed by the participants of the stakeholders' meeting.

The participants were divided into discussion groups by concerned LGU. The objective of the exercise was to evaluate the alternative alignments in the jurisdiction of LGUs concerned (or neighboring LGUs in some cases). Output of the exercise was a weighted scoring of each road alternative based on the above parameters.

At the beginning of the session, a chairperson for the group was selected. The group facilitator clarified issues on the parameters as well as took down the highlights of the discussion. The breakout session for the evaluation exercise lasted for approximately 35 minutes. Upon closing of the group discussion, the chairperson summarized the consensus of the group and indicated the main points resulting from the discussions.

The facilitator prepared the evaluation sheet for the group and submitted this to the secretariat for consolidation. All discussion notes of the respective groups were requested to be given to the workshop facilitators. Afterwards, the project coordinator presented the different groups' evaluation. To facilitate the discussions, reference materials were prepared for each evaluation point.

## Table 6.3.8 Results of the Evaluation of Alternative Alignments

| Alternative Alignment - Concerned LGU | Traffic/Technical | | | Regional Development | | | Environment | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | Easiness during Construction | Adequacy of the Alignment | Magnitude of Capital Requirement | Network Efficiency | Support Growth Corridors / Industrial Areas | Tourism Devmt. | Magnitude of Disturbance | Easiness in ROWA | Less impact on Agriculture | |
| ***North-South Road*** | **45%** | | | **20%** | | | **35%** | | | 100% |
| | 10 | 15 | 20 | 10 | 5 | 5 | 15 | 15 | 5 | |
| **Alternative 1: Governors' Drive to Silang (on Aguinaldo Highway)** | | | | | | | | | | **56** |
| - Province of Cavite | 10 | 10 | 15 | 5 | 5 | 5 | 5 | 5 | 3 | 63 |
| - Bacoor | 10 | 10 | 11 | 7 | 5 | 5 | 1 | 1 | 5 | 55 |
| - Dasmariñas | 4 | 9 | 12 | 4 | 3 | 3 | 6 | 6 | 2 | 49 |
| **Alternative 2: Governors' Drive to Silang (new alignment)** | | | | | | | | | | **92** |
| - Province of Cavite | 8 | 15 | 20 | 10 | 5 | 5 | 15 | 15 | 5 | 98 |
| - Bacoor | 7 | 15 | 20 | 10 | 5 | 5 | 15 | 15 | 1 | 93 |
| - Dasmariñas | 8 | 12 | 16 | 8 | 4 | 4 | 15 | 12 | 5 | 84 |
| ***Daang Hari Road*** | **25%** | | | **40%** | | | **35%** | | | 100% |
| | 5 | 5 | 15 | 15 | 15 | 10 | 10 | 20 | 5 | |
| **Alternative 1: Imus to Gen. Trias (EPZA)** | | | | | | | | | | **75** |
| - Province of Cavite | 3 | 5 | 14 | 13 | 15 | 6 | 5 | 15 | 5 | 81 |
| - General Trias | 5 | 3 | 11 | 8 | 12 | 8 | 10 | 20 | 5 | 82 |
| - Imus | 5 | 2 | 14 | 10 | 10 | 5 | 2 | 20 | 3 | 71 |
| - Tanza | 5 | 4 | 14 | 8 | 9 | 5 | 4 | 12 | 3 | 64 |
| **Alternative 2: Imus to Tanza (Gen. Trias Road)** | | | | | | | | | | **80** |
| - Province of Cavite | 5 | 5 | 15 | 14 | 14 | 8 | 8 | 18 | 5 | 92 |
| - General Trias | 4 | 4 | 13 | 10 | 10 | 4 | 10 | 20 | 5 | 80 |
| - Imus | 5 | 4 | 15 | 10 | 10 | 5 | 3 | 20 | 3 | 75 |
| - Tanza | 5 | 4 | 15 | 10 | 12 | 5 | 5 | 13 | 3 | 72 |
| **Alternative 3: Imus to Tanza (Tanza-Naic Road)** | | | | | | | | | | **89** |
| - Province of Cavite | 4 | 5 | 13 | 12 | 12 | 10 | 10 | 20 | 5 | 91 |
| - General Trias | 3 | 5 | 9 | 12 | 8 | 6 | 10 | 20 | 5 | 78 |
| - Imus | 5 | 5 | 13 | 15 | 15 | 10 | 5 | 20 | 5 | 93 |
| - Tanza | 3 | 5 | 13 | 15 | 15 | 10 | 8 | 18 | 5 | 92 |

### Table 6.3.8 Results of the Evaluation of Alternative Alignments (con't)

| Alternative Alignment - Concerned LGU | Traffic/Technical | | | Regional Development | | | Environment | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Easiness during Construction | Adequacy of the Alignment | Magnitude of Capital Requirement | Network Efficiency | Support Growth Corridors / Industrial Areas | Tourism Devmt. | Magnitude of Disturbance | Easiness in ROWA | Less impact on Agriculture | Total |
| ***CALA Expressway*** | **30%** | | | **40%** | | | **30%** | | | 100% |
| | 5 | 10 | 15 | 15 | 15 | 10 | 10 | 15 | 5 | |
| **Alternative 1: Governor's Drive to SLEX via Mamplasan Interchange** | | | | | | | | | | **59** |
| - Province of Cavite | 3 | 6 | 13 | 15 | 10 | 6 | 8 | 12 | 3 | 76 |
| - Silang | 2 | 7 | 13 | 8 | 8 | 5 | 10 | 15 | 5 | 73 |
| **Cavite Average** | | | | | | | | | | **75** |
| - Province of Laguna | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 |
| - Biñan | 3 | 5 | 15 | 15 | 8 | 3 | 5 | 8 | 3 | 65 |
| - Sta Rosa | 3 | 3 | 12 | 12 | 12 | 8 | 8 | 10 | 4 | 72 |
| **Laguna Average** | | | | | | | | | | **49** |
| **Alternative 2: Governor's Drive to SLEX via Sta Rosa Interchange** | | | | | | | | | | **62** |
| - Province of Cavite | 4 | 8 | 15 | 15 | 12 | 8 | 8 | 10 | 3 | 83 |
| - Silang | 2 | 7 | 15 | 10 | 8 | 5 | 10 | 15 | 5 | 77 |
| **Cavite Average** | | | | | | | | | | **80** |
| - Province of Laguna | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 |
| - Biñan | 2 | 5 | 10 | 10 | 10 | 3 | 5 | 10 | 3 | 58 |
| - Sta Rosa | 4 | 6 | 14 | 13 | 13 | 9 | 9 | 10 | 4 | 82 |
| **Laguna Average** | | | | | | | | | | **50** |
| **Alternative 3: Governor's Drive to SLEX via ABB Interchange** | | | | | | | | | | **91** |
| - Province of Cavite | 5 | 10 | 10 | 15 | 15 | 10 | 10 | 15 | 5 | 95 |
| - Silang | 5 | 10 | 10 | 15 | 15 | 10 | 7 | 10 | 3 | 85 |
| **Cavite Average** | | | | | | | | | | **90** |
| - Province of Laguna | 5 | 10 | 15 | 15 | 15 | 10 | 10 | 15 | 5 | 100 |
| - Biñan | 5 | 10 | 8 | 8 | 15 | 10 | 10 | 15 | 5 | 86 |
| - Sta Rosa | 5 | 9 | 10 | 14 | 14 | 10 | 10 | 10 | 5 | 87 |
| **Laguna Average** | | | | | | | | | | **91** |

## 6.4 Selected Project Package

### 6.4.1 Project Package Alternatives

At present, the Government of the Philippines has been encountering serious shortage of capital, which at times results in the suspension of the process in ODA funding due to unavailability of counterpart funds. As such, for the proper and smooth progression of the project, a strategic development scheme is necessary as well as the consideration for the minimum required investment(s).

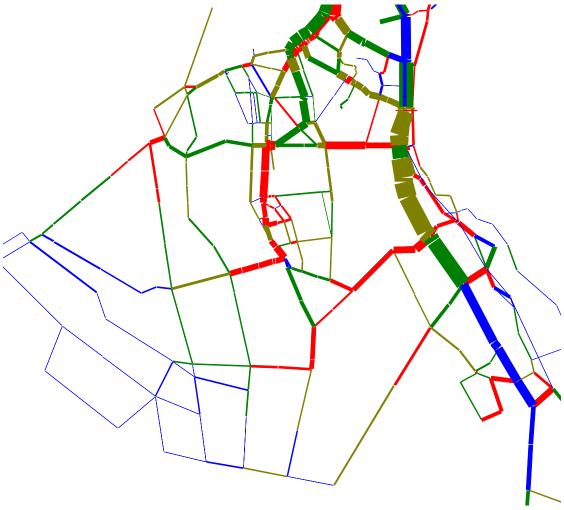
Three target roads have been selected as previously mentioned. Out of these three roads, priority sections should be determined for early implementation taking into account the current shortage of government budget and time/budget constraints of this study. Figure 6.4.1 shows the initially selected alternatives of priority sections (project package).

Figure 6.4.2 presents forecast traffic distribution of these alternatives for 2010. Judging from the distribution of congested road sections, Alternative 7 (APP 7) or Alternative 8 (APP 8) seems to be more reasonable than other alternatives.

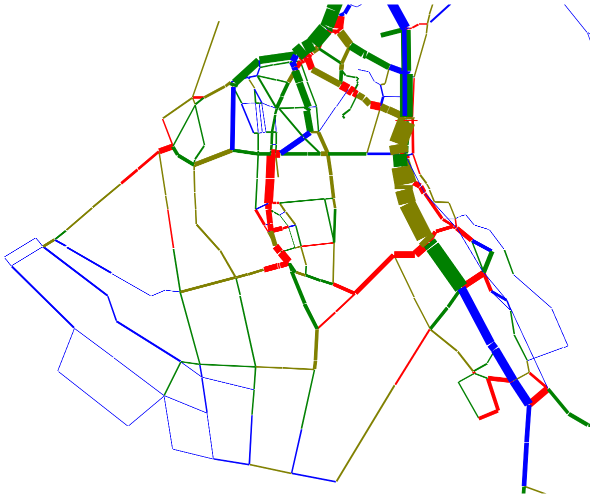
**Figure 6.4.1 Alternative Project Packages**

## Figure 6.4.2 Result of Traffic Assignment for Consideration of Packaging (2010 Demand)

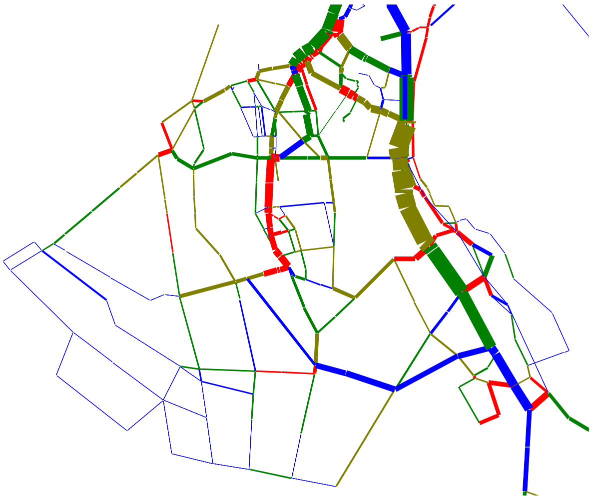
APP1



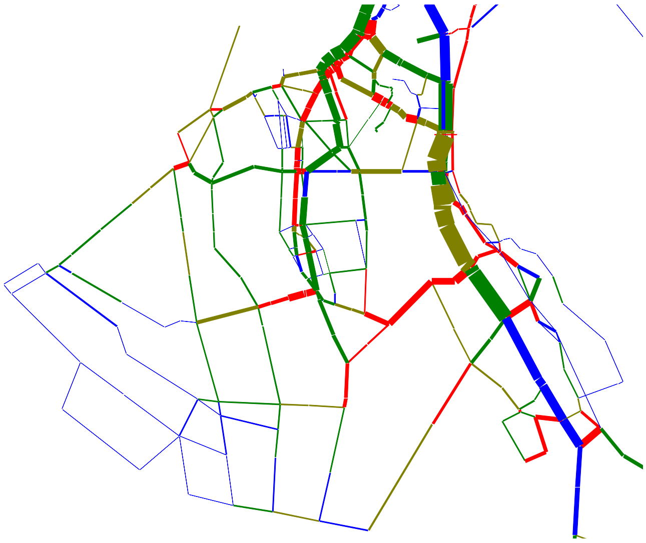
APP2

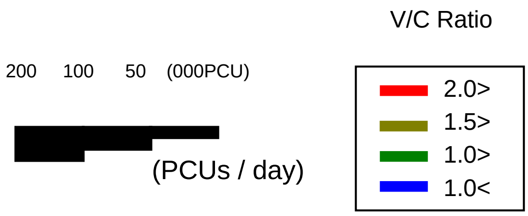


APP3



APP4

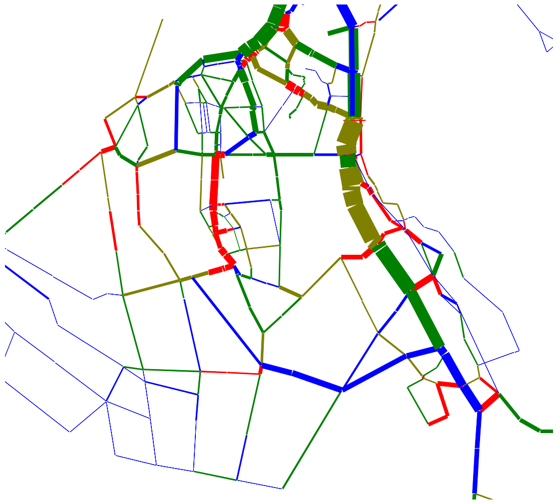




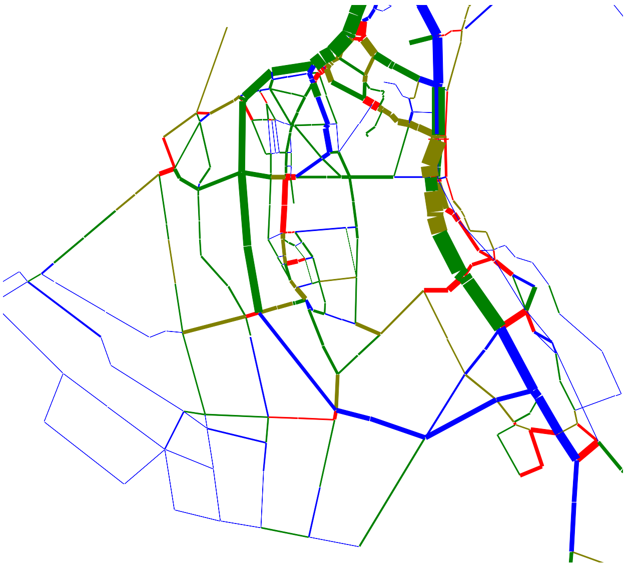
**Cont. Figure 6.4.2**

APP5

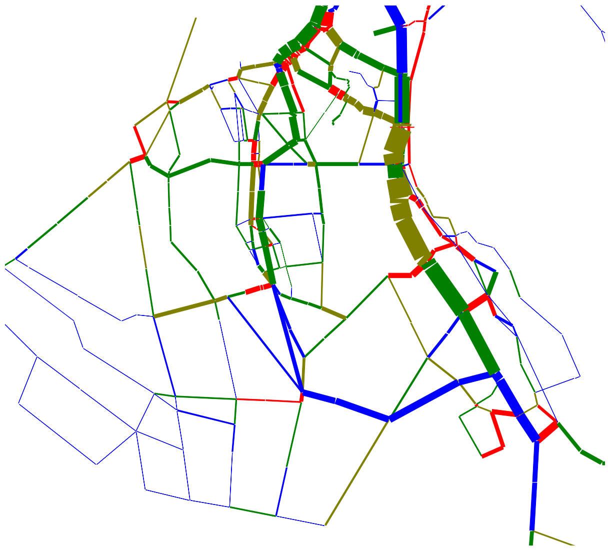
APP6

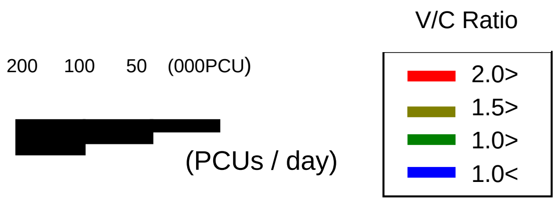


APP7



APP8





### 6.4.2 Do-ability of Selected Target Roads

#### 1) North-South Road

The DPWH, the provincial government of Cavite, the private sector, and potential lenders are of the consensus that the North-South road is of the highest priority – due to its high vehicular traffic and ease of construction. NDC as well as the World Bank are willing to finance this road section as a toll road project.

#### 2) Daang Hari Road

PNCC and NDC have given the linkage of Daang Hari to SLEX its highest priority since it would: i) enhance traffic to SLEX; ii) entail minimal ROW problems during execution (most of the road passes the National Bilibid Prison (NBP) land) and iii) enables future connection to a bay coastal road (C-6 alignment) towards San Pedro, Laguna. The two SOEs have already taken steps (assess feasibility, prepare preliminary designs, conduct of parcellary surveys and initial negotiations with property owners) leading to financing and construction. Obstacles to securing a supplemental toll operating agreement from TRB is not anticipated, since the road falls under the existing franchise of PNCC.

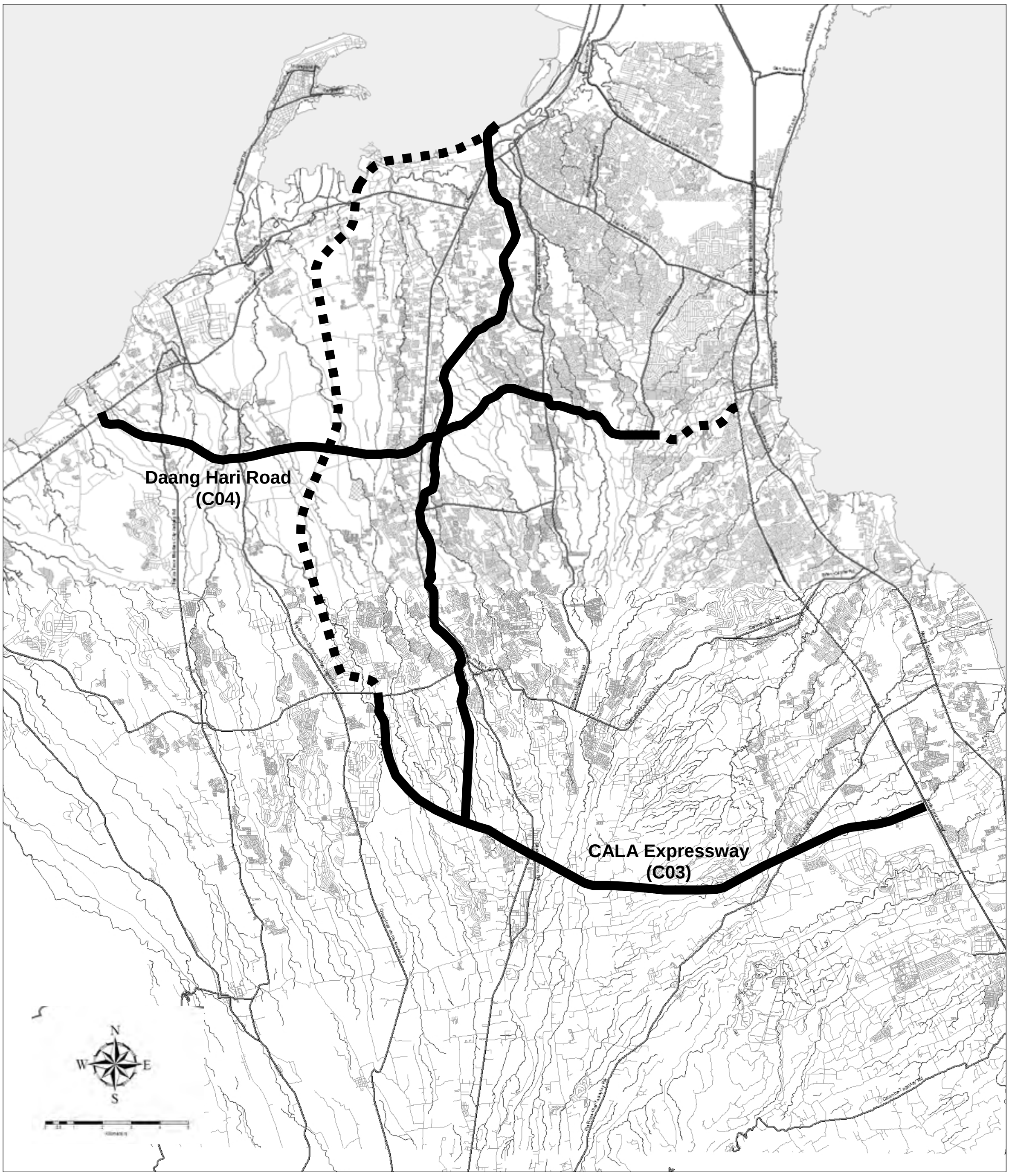
#### 3) CALA Expressway

The R-1 Extension from Zapote to Noveleta was supposed to start construction in 1998 and should have been operational by now. However, the project got stalled due to a number of factors: i) failure to complete ROW for phase 2 (link of R-1 to SLEX) which led to the latter's abandonment in 2004; ii) corporate squabbles among the project proponent which led to a change in ownership (from UEM-Mara to Coastal Road Corporation) and iii) failure to secure financing after more than three attempts. In October 2003, the IFC was reported to have approved a $70 million loan for the project but was withdrawn in March 2005. In August 2006, the proponent announced again that it has signed a P3.5 billion loan, this time from 5 local banks. The repeated delays in the realization of the R-1 Extension have undermined the early viability of the southern sections of CALA Expressway and made the North-South tollway even more urgent.

### 6.4.3 Selected Project Package for FS

As a result of technical, economic and environmental analyses, coupled with a series of stakeholder consultations, the target road package for detailed Feasibility Study was arrived at, as illustrated in Figure 6.4.3.

**Figure 6.4.3 Target Roads for JICA's Feasibility Study**



# 7 ENGINEERING STUDIES

## 7.1 Introduction

Three priority project roads, selected in the previous Chapter 6, were proposed to have the basic structures as shown in Table 7.1.1.

**Table 7.1.1 Proposed Structure of Priority Projects**

| Road Name | Road Type | Road Length (km/h) | Designed Speed (km/h) | No. of Lanes | ROW (m) |
|---|---|---|---|---|---|
| North-South Road | Highway | 27.8 | 60 | 6 | 30 |
| Daang Hari Road | Highway | 21.0 | 60 | 4 | 30 |
| CALA Expressway | Expressway | 22.7 | 100 | 6 | 50 |

## 7.2 Natural Condition Surveys

Geotechnical investigation, aerial photography survey, topographic survey, hydrologic and hydraulic studies were conducted along the selected three routes for the preliminary design.

### 7.2.1 Geotechnical Investigation

#### (1) Purpose of the Study

Geotechnical investigation for the study was subcontracted to Geotesting International. The investigation can be divided into three different types of components as described below.

(a) Boring Investigation

To provide the design engineers with geotechnical parameters for the determination of the foundation type and structure of the flyovers planned on the project roads, twenty one (21) 76 mm diameter boreholes to depth ranging from 11.0 to 21.0 meters deep and a series of laboratory tests are conducted. The boreholes were drilled with trailer mounted rotary wash drilling equipment employing the wash boring method supplemented by rock coring using NMX double tube core barrel. Standard Penetration Test (SPT) was also conducted in the soils at 1.0 m intervals for each borehole.

Locations of the tests are selected at the major bridge and overpass/underpass sites.

(b) Soil Investigation

Soil conditions and embankment materials along the project road alignment were investigated by fifty three (53) test-pits excavated to 1.0 meter deep each.

(c) Investigation for existing pavement structure

For the pavement structure of existing roads traversing the project roads for the design of the intersections, auger boring were conducted at major grade crossing locations of existing roads and project highways.

### (2) Outline of Geotechnical Investigation

The geotechnical investigation consists of core drilling, standard penetration test (SPT) and laboratory tests for soil along the project roads. Location of the boring survey and auger boring are shown in Figure 7.2.1. The quantity and standard of each test item are as follows:

(a) Mechanical boring for flyover and bridge foundation

| Item | Unit | Quantity | Standard | Remarks |
|---|---|---|---|---|
| Core Drilling (380m in total) | site | 21 | | Drilling on land at position of assumed flyover or bridge abutment site along the project road |
| Standard Penetration Test | test | Every 1.0 meter | ASTM D 1586 | |

(b) Laboratory test for flyover and bridge foundation

| Item | Unit | Quantity | Standard | Remarks |
|---|---|---|---|---|
| Atterberg Limit | sample | 32 | ASTM D 4318 | 2 samples from 16 boreholes |
| Unit Weight | sample | 32 | ASTM D 2937 | 2 samples from 16 boreholes |
| Natural Water Content | sample | 32 | ASTM D 2216 | 2 samples from 16 boreholes |
| Sieve Analysis | sample | 32 | ASTM D 422 | 2 samples from 16 boreholes |
| Soil Classification | borehole | 21 | ASTM D 2488 | |

(c) Test-pit and auger boring for road embankment and pavement

| Item | Unit | Quantity | Standard | Remarks |
|---|---|---|---|---|
| Test pit | location | 53 | | Approx. every 1 or 2 km along the project road alignment |
| Auger boring | location | 8 | AASHTO T 306 | At the intersection of existing road and the project road |

(d) Laboratory test for test-pit and auger boring

| Item | Unit | Quantity | Standard | Remarks |
|---|---|---|---|---|
| Specific Gravity of Soil | sample | 61 | ASTM D 854 | 1 sample from each test pit or auger boring |
| Atterberg Limit | sample | 61 | ASTM D 4318 | 1 sample from each test pit or auger boring |

| Item | Unit | Quantity | Standard | Remarks |
|---|---|---|---|---|
| Moisture-Density Relation Test | sample | 61 | AASHTO T 99 or T 180 | 1 sample from each test pit or auger boring |
| CBR Test | sample | 10 | ASTM D 1883 | samples from selected 10 test pits |
| Natural Water Content | sample | 61 | ASTM D 2216 | 1 sample from each test pit or auger boring |
| Sieve Analysis | sample | 61 | ASTM D 422 | 1 sample from each test pit or auger boring |
| Soil Classification | sample | 61 | ASTM D 2488 | 1 sample from each test pit or auger boring |

### (3) Available Data and Information

DPWH provided with the following geotechnical information, which can be utilized for preliminary design of the study:

(i) Geotechnical report on Daang Hari Bridge located on existing Daang Hari Road 400 east from Aguinaldo Highway

(ii) Geotechnical report on Pala-pala Interchange Project at Pala-pala Junction, Dasmariñas.

(iii) Boring log of Bucal Bridge on Governors' Drive near Pala-Pala Junction, Dasmariñas.

(iv) Geotechnical report on Bancal Bridge Widening Project located at boundary of Carmona and GMA on Governors' Drive

### (4) Results and Major Findings

(a) General Geology

Previous works conducted by the Philippine Mines and Geo-Sciences Bureau have yielded fairly limited geological data covering the provinces of Cavite and Laguna.

The provinces of Cavite and Laguna are within the Central Physiographic province being a part of the Southern Luzon Uplands. The area is basically a volcanic terrain where volcanic flows of andesite/basalt particularly of the Mt. Makiling area and pyroclastics rocks of bedded tuff and cinder in the western and southern parts of the Silang area.

The project site and immediate vicinities are underlain by three (3) geologic formations, namely the Quaternary Alluvium, the quaternary rocks of volcanic derivative which are the Quaternary Volcanics and the Taal Formation.

A more descriptive discussion of the different geologic formations from the youngest to the oldest is hereby presented:

- The Quaternary Alluvium (Qal) comprises the broad lowlands surrounding the Laguna Bay area. The Qal comprises extensive alluvial and river deposits, deltas, swamps, estuaries and talus deposits. The sickness of the alluvium ranges from one (1) to more than 20 meters.
- Underlying Qal is the Quaternary Volcanics (QV) composed mainly of basalt and andesite flows with associated pyroclastic deposits. This is localized around the vent of Mt. Makiling, which also occurs as plugs and dated as Late Pleistocene.
- The Taal Tuff (Qtt), which is composed mostly of pyroclastic rocks, interbedded agglomerate and consisting also of bedded to massive vitric tuffs, cinders, lapilli tuff and volcanic breccia. The fine-grained variety locally shows well-defined bedding, which suggests deposition in a fairly quiet environment. The conglomerate is composed of rounded pebbles to cobble sized andesitic and basaltic clants in sandy tuffaceous matrix. Tuffite is composed of a mixture of volcanic ash and sedimentary detritus. This rock unit is also dated as early to middle Pleistocene.

(b) Foundations for Flyovers and Bridges

Standard Penetration Test (SPT) has been conducted at each borehole. Locations of boreholes and the results including the depth of bearing strata are shown in Table 7.2.1.

**Table 7.2.1 Depth of Bearing Strata (Tuff Rock)**

| Borehole SN. | Route | Vicinal Station | Total borehole depth (m) | Depth of bearing strata (m) | Remarks |
|---|---|---|---|---|---|
| BH-1 | CE | Sta.0+000 | 21 | 20 | SLEX Junction |
| BH-2 | CE | Sta.5+150 | 20 | 16 | Sta.Rosa-Tagaytay Rd. |
| BH-3 | CE | Sta.5+820 | 14 | 11 | Wide Creek |
| BH-4 | CE | Sta.7+200 | 12 | 9 | Wide Creek |
| BH-5 | CE | Sta.8+500 | 11 | 7 | Wide Creek |
| BH-6 | CE | Sta.9+600 | 17 | 13 | Westgrove Heights |
| BH-7 | CE | Sta.10+840 | 15 | 11 | Near Poultry |
| BH-8 | CE | Sta.13+250 | 20 | 17 | River Confluence |
| BH-9 | CE | Sta.14+650 | 20 | 17 | Aguinaldo Highway Flyover |
| BH-10 | CE | Sta.15+320 | 18 | 14 | Wide Creek |
| BH-11 | CE | Sta.17+200 | 15 | 10 | End of NS (Junction) |
| BH-12 | CE | Sta.19+300 | 20 | 17 | Wide Creek |
| BH-13 | DH | Sta.15+220 | 20 | 5 | River |
| BH-14 | DH | Sta.17+400 | 20 | 17 | Near Suspension Pedestrian Bridge |
| BH-15 | NS | Sta.1+000 | 20 | 11 | Bacoor Flyover |
| BH-16 | NS | Sta.1+400 | 20 | 4 | Bacoor Flyover |
| BH-17 | NS | Sta.8+500 | 20 | 16 | Near Cita Italia |
| BH-18 | NS | Sta.14+340 | 18 | 15 | Near Suspension Pedestrian Bridge |
| BH-19 | NS | Sta.19+000 | 11 | 7 | Aguinaldo Highway Flyover |
| BH-20 | NS | Sta.0+500 | 20 | 10 | Bacoor Interchange |
| BH-21 | NS | Sta.0+000 | 20 | 8 | Bacoor Interchange |

It is suggested that all bridge foundations be embedded on the hard strata such as tuff rock with N value equal or greater than 50.

(c) Liquefaction Potential Analysis

Liquefaction potential along NS-1,2,3 has been evaluated using the Seed method (ref. Seed and Idriss, 1971) and the Iwasaki method (ref. Iwasaki and Tatsuoka, 1978). The method consists of evaluating the cyclic stress ratio (L) in an element of soil resulting from an earthquake acceleration and comparing it with the cyclic resistance ratio (R). The liquefaction resistance (FL) is defined as FL = R / L. If FL is less than 1.0, liquefaction may occur.

The liquefaction resistance (FL) is conventionally determined from the following equations:

$F_L = R / L$

$R = R_1 + R_2 + R_3$

$L = 0.65 \times \alpha_{max} \times \gamma_d \times \sigma_v / \sigma_v'$

$R_1 = 0.0882 \times \sqrt{\dfrac{N}{\sigma_v' + 0.7}}$

$R_2 = 0.19 \quad (0.02mm \le D_{50} \le 0.05mm)$

$0.225 \times \log_{10}(0.35 / D_{50}) \quad (0.05mm < D_{50} \le 0.6mm)$

$-0.05 \quad (0.6mm < D_{50} \le 2.0mm)$

$R3 = 0.0 \quad (0\% \le FC \le 40\%)$

$0.004 \times FC - 0.16 \quad (40\% < FC \le 100\%)$

$\gamma_d = 1.0 - 0.015x$

where,

$F_L$: liquefaction resistance
R: cyclic resistance ratio
L: cyclic stress ratio
$\alpha_{max}$: maximum horizontal acceleration coefficient
$\gamma_d$: stress reduction coefficient
$\sigma_v$: total vertical stress (tf/$m^2$)
$\sigma_v'$: effective vertical stress (tf/$m^2$)
N: N-value
$D_{50}$: diameter at which 50% of the soil is finer (mm)
FC: fine particle content (%)
x: depth (m)

The estimated maximum horizontal accelerations for the bridge design have been assessed at 0.4g under seismic zone 4. Therefore, the above maximum horizontal accelerations were adopted for the liquefaction potential analysis in this study.

The liquefaction potential analysis was carried out on five boreholes in Municipality of Bacoor that are BH-15, BH-16, BH-17, BH-20 and BH-21.

The result of the analysis shows that there is some potential of liquefaction at coastal area where Talaba Flyover crossing Aguinaldo Highway is planned. Therefore, due considerations shall be given to foundation design of the flyover and other structures.

(d) Tectonic Features of the Region

Several tectonic features and structures are reported based from the regional geologic study of the region.

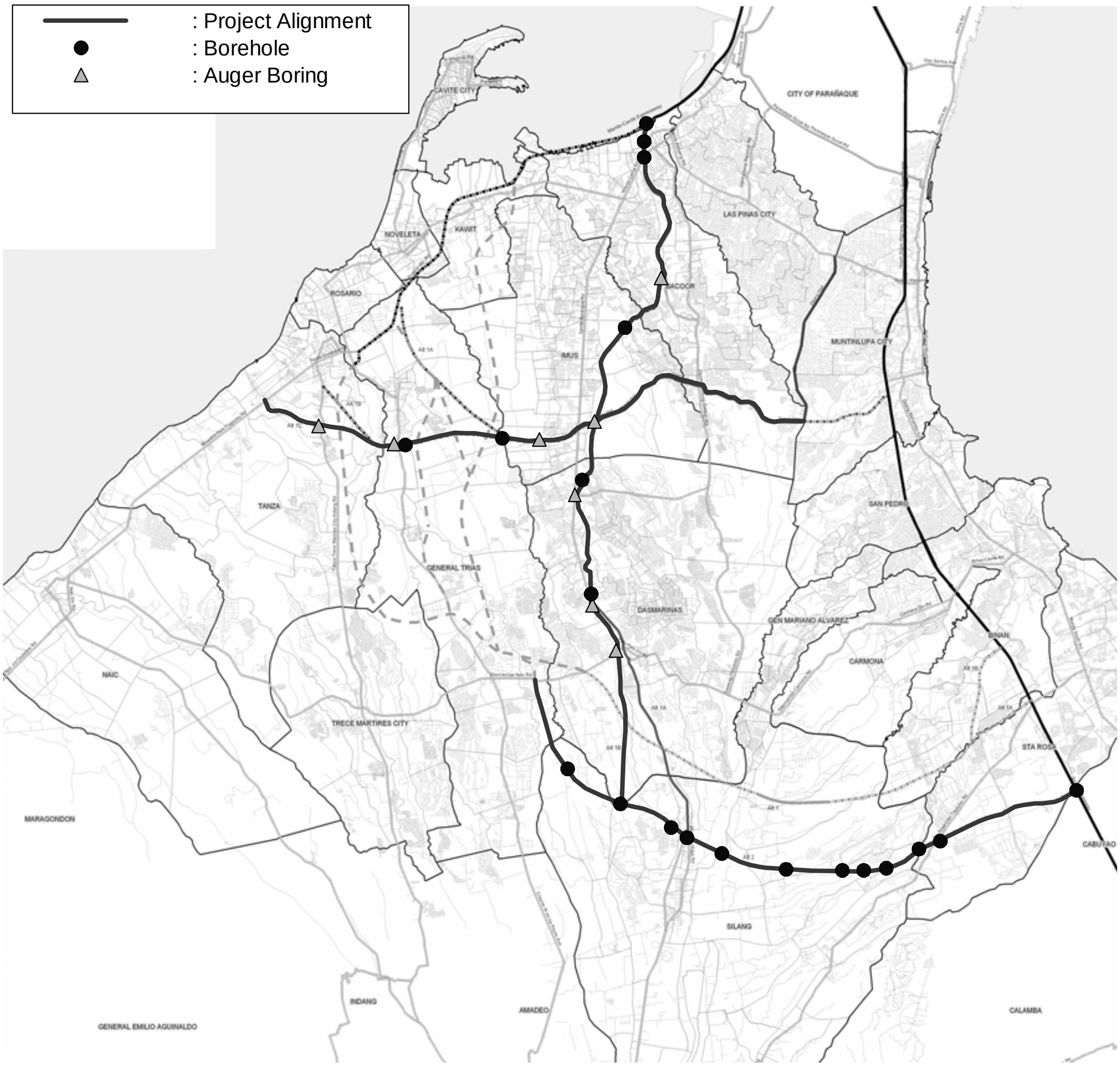
(i) The movement of the West Valley Fault of the Valley Fault Systems formerly known as the Marikina Valley Fault System. The Valley Fault System is essentially a gravity fault system consisting of two parallel northeast trending faults, the West Valley Fault and the East Valley Fault. Based from the previous movement of this structure, the sides towards Laguna Lake were downthrown relative to the other blocks i.e. the western side of the fault which are Cavite, Laguna and west of Metro Manila. The faults can also be recognized by the abrupt change in topography between coastal plains of Cavite and the northern slope of the Tagaytay Ridges. However, based on the information from the Mines and Geo-Science Bureau and PHILVOCS, no further study was conducted at the project site concerning the past, present and future activities of this Marikina Valley Fault.

(ii) The Philippine Fault is an active left lateral strike slip fault and traverses the archipelago from Northern Luzon to Southern Mindanao with a general trend of northwest-southeast. The movement along the Digdig Fault segment of the Philippine Fault triggered the July 16, 1990 earthquake that caused significant damages in Luzon.

(iii) Another significant structure is the Lubang-Verde Fault, which is a stripe slip west-northwest trending fault. It is mapped between Batangas and Mindoro.

(iv) The Philippine Trench, where the South China Sea subducts beneath the western Philippines. Numerous earthquakes have been attributed the movement along this trench.

**Figure 7.2.1 Location of the Borehole and Auger Boring**




### 7.2.2 Aerial Photography Survey

Aerial Photography survey was subcontracted to F. F. Cruz. The outline of the survey was as follows:

#### (1) Location of Work

| Proposed Road | Section | Aerial photography and Mosaiking Length (km) |
|---|---|---|
| NS: North-South Rd | Manila-Cavite Expressway to CALA Expressway | 29 |
| DH: Daang Hari Rd | Tanza-Naic Rd to Aguinaldo Hi-way | 14 |
| CE: CALA Expressway | Governor’s Drive to SLEX | 25 |
| Total | | 68 |

**(2) Scope of Work**

Following Works were conducted under the survey:

(i) 1:10,000 Scale Aerial Photography (Coverage area: 68 line-km in total) including Photo Scanning and Contact Printing.

(ii) Ground Control Survey (30 points in total) including Monumentations, GPS Survey and Differential Leveling.

(iii) 1:2,000 Scale Digital Orthophoto Mosaiking (Coverage area: 68 km x 1 km= 68 $km^2$ in total) including Aerial Triangulation and Orthophoto Mosaic Production.

### 7.2.3 Topographic Survey and Mapping

Topographic survey on the selected alignment was subcontracted to RASA Surveying. The survey consisted of the following components.

**(1) Location of Work**

| Proposed road | Section | Topographic Survey and Mapping Length (km) |
|---|---|---|
| DH: Daang Hari Rd | Tanza-Naic Rd to Aguinaldo Highway | 12 |
| NS: North-South Rd | Manila-Cavite Expressway to CALA Expressway | 27 |
| CE: CALA Expressway | Governor's Drive to SLEX | 23 |
| Total | | 62 |

**(2) Scope of the Works**

The Contractor shall carry out the following works:

(a) Road Survey

- Road Profile Survey (3 routes, interval = 50 m, length: 62 km in total)
- Road Cross Section Survey (3 routes, width = 200 m, 1,491 sections including additional structures sections)

(b) Topographic Mapping at Scale of 1:2,000

- Digital Plotting (Coverage area: length of 62 km x width of 200 m = 12.4 $km^2$ in total)
- Digital Editing (Coverage area: length of 63 km x width of 200 m = 12.4 $km^2$ in total)

(c) River Survey

- River Cross Section Survey (Width = 60 m, 22 bridge sections in total)
- Flood Damage Survey (Interview at 10 offices of DPWH and Municipality)