SECTION 8

PRELIMINARY EXAMINATION OF PROSPECTIVE NEW AIRPORT SITES

SECTION 8: PRELIMINARY EXAMINATION OF PROSPECTIVE NEW AIRPORT SITES

8.1 Prospective New Airport Sites

As a result of the initial screening discussed in Section 6, following five sites have been chosen as the prospective new airport sites for development of NMIA:

i) Sangley Point Option 1 located offshore Cavite Peninsular;
ii) Sangley Point Option 2 located parallel to the existing runway at Sangley Point;
iii) Central Portion of Manila Bay;
iv) San Nicholas Shoals located to the south of Sangley; and
v) Western Portion of Laguna de Bay.

Approximate location and layout of these prospective new airport sites are described below. It should be noted that the phased facility development concept and size of the platform of NMIA is to be examined in sufficient detail during the next Master Plan/Feasibility Study stage, and the locations and layout shown in this Report need to be further refined and adjusted.

1) Sangley Point Option 1

The Sangley Point Option 1 site is located almost parallel to the southern part of Cavite Peninsular. The runways are oriented to 02/20 in order to prevent the instrument flight procedures from protruding the prohibited airspace RP-P1: Malacanang. A possibility to utilize the existing Sangley as the supplemental relief airport for NAIA has been taken into account when tentatively positioning the runways. The runways were located to southern part of the Peninsular so that the construction equipment and airport facilities under construction should not infringe the obstacle limitation surfaces of the supplemental runway at Sangley. The average depth of reclamation at this site would be about 10 m.

There exists no significant obstruction for safe and efficient aircraft operations. However, there is an oil terminal in Rosario operated by PETRON located just under the aircraft approach and departure paths. Although the oil terminal does not infringe the airport obstacle limitation requirement, it could be regarded as a risk of significant hazard to surrounding area in case of an aircraft crash into the oil terminal. Figure 8.1-1 shows approximate location and airport general layout for Sangley Point Option 1.

2) Sangley Point Option 2

The Sangley Point Option 2 is located parallel to the existing runway at Sangley. The runways are oriented to 07/25. The average depth of reclamation at this site would be about 10 m. It has been intended that while NMIA is being constructed at this site, the existing Sangley could be utilized as the supplemental runway for NAIA. The supplemental runway could be developed in future as the third runway of NMIA. However, in case of this option, the airspaces necessary to establish the instrument flights procedures unavoidably overlap with RP-P1: Malacanang.

Figure 8.1-2 shows approximate location and airport general layout for Sangley Point Option 2.

3) Central Portion of Manila Bay

The approximate location and general layout for the Central Portion of Manila Bay has been prepared mainly considering the following:

- ✓ RP-P1: Malacanang should not be protruded by the instrument flight procedures of aircraft approaching/departing NMIA;
- ✓ Horizontal and vertical limitation on the surrounding cities should be minimized and adequate distances between NMIA and the coastal areas should be provided;
- ✓ Any tall structures located in the Port of Manila, other than those in the anchorage area, should not infringe the obstacle limitation surfaces.

As a result the runways are oriented to 16/34. The prospective new airport site thus located overlaps the Manila Port Zone and coordination with the Philippine Port Authority (PPA) would be required. The average depth of reclamation at this site would be about 10 m. As the construction equipment and airport facilities under construction would obstruct the aircraft operations at Sangley, utilization of the runway at Sangley as the supplemental runway for NAIA is not practicable. Figure 8.1-3 shows approximate location and airport general layout for the Central Portion of Manila Bay.

4) San Nicholas Shoals

The San Nicholas Shoals site is located almost parallel to the coastline of Rosario and Tanza. The runways are oriented to 04/22. The average depth of reclamation at this site would be about 7 m. Although this site was examined in DOTC study as an alternative to Sangley to avoid overlapping RP-P1: Malacanang, the airspaces for the instrument flight procedures for this site would overlap the RP-P1. In case of this option, the runway at Sangley could be utilized at the supplemental runway for NAIA during the construction of NMIA. Figure 8.1-4 shows approximate location and airport general layout for San Nicholas Shoals.

5) Western Portion of Laguna de Bay

The approximate location and general layout for the Western Portion of Laguna de Bay has been prepared so that the mountain ranges on Morong Peninsular to the east and the proposed reclamation areas along the Laguna Lakeshore Expressway Dike Project (see Figure 6.2-12) would not constitute obstructions for RWY 18/36. The average depth of reclamation at this site would be about 2.5 m. Figure 8.1-5 shows approximate location and airport general layout for Western Portion of Laguna de Bay.

6) Alternative Sangley Point Option 1

The location of Sangley Point Option 1 discussed above was prepared taking into account of utilizing the existing Sangley as NAIA's supplemental runway. In case the existing Sangley runway is not utilized as NAIA's supplemental runway, the location of Sangley Point Option 1 might move forward to north. Figure 8.1-6 shows approximate location of and airport general layout for alternative Sangley point option 1. During the next feasibility study stage, advantage and disadvantage of these two alternatives should be examined in detail.

Figure 8.1-1 Approximate Location and Airport General Layout of Sangley Point Option 1

Figure 8.1-2 Approximate Location and Airport General Layout of Sangley Point Option 2

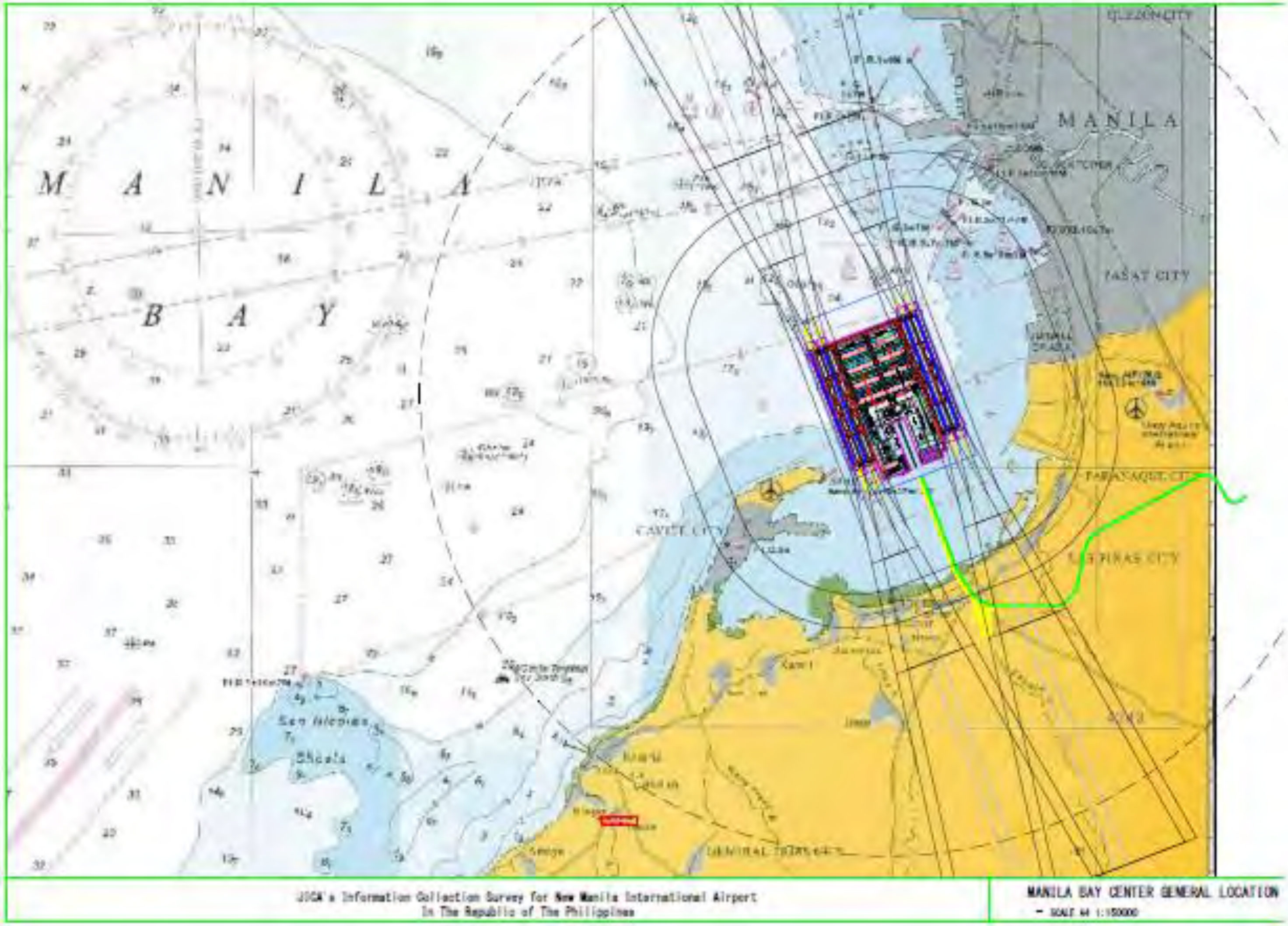


Figure 8.1-3 Approximate Location and Airport General Layout of Central Portion of Manila Bay

Figure 8.1-4 Approximate Location and Airport General Layout of San Nicholas Shoals

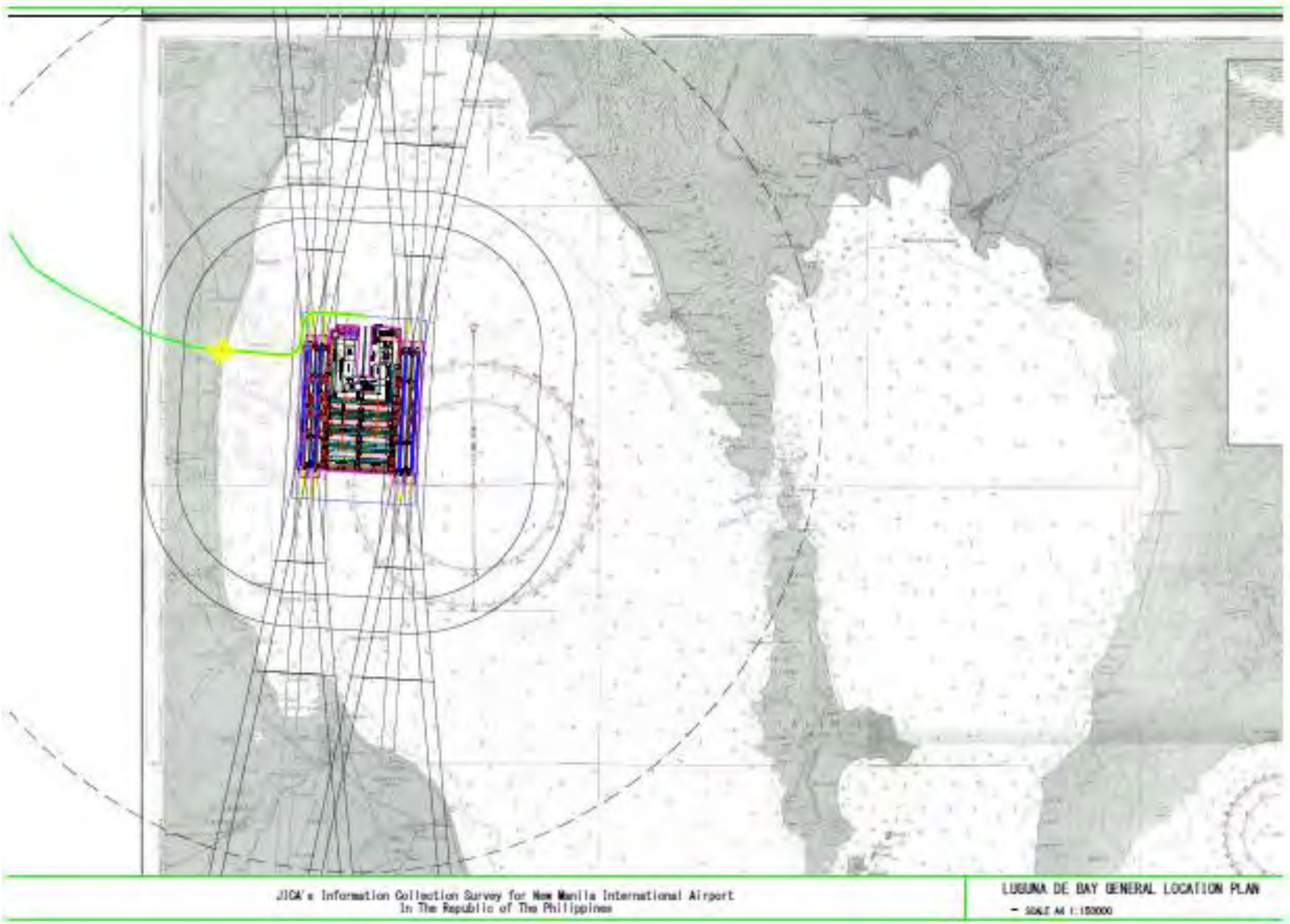


Figure 8.1-5 Approximate Location and Airport General Layout of Western Portion of Laguna de Bay

Figure 8.1-6 Approximate Location and Airport General Layout of Alternative Sangley Point Option 1

8.2 Items for Examination of Prospective New Airport Sites

8.2.1 General

Detail examination of the prospective new airport sites has been carried out based on the data and information including results of the surveys such as the boring test at Sangley Options 1 and 2, the bathymetric surveys as well as the water quality measurements, etc. at five sites.

8.2.2 Items for Detail Examination

Detail examination of the prospective new airport sites are to be conducted with respect to the following items:

a) Airspace Utilization and Aircraft Operations
   - i) Wide area airspace utilization; whether any vertical separation or lateral separation between the instrument flight procedures and the restrictions of the existing prohibited/restricted airspaces could be ensured or not.
   - ii) Physical obstruction for aircraft operations; whether instrument approach and take-off procedures could be established without infringement of physical obstructions.
   - iii) Possibility to coexist with the existing NAIA.
   - iv) Usability factor (wind coverage).

b) Environmental and Social Consideration

c) Risk of Natural Hazard

d) Reclamation for Airport Platform Development
   - i) Examination of applicable method for revetment, stabilization of subsoils and prevention of liquefaction.
   - ii) Estimate of work volumes for airport platform development.
   - iii) Preliminary cost estimate.

e) Airport Access Network

f) Surrounding Land Use and Urban Planning

g) Preliminary Cost Estimate for NMIA Development

8.3 Examination on Airspace Utilization and Aircraft Operations

8.3.1 Airspaces and Instrument Flight Procedures for Ultimate Phase Option 1: Two Sets of Widely Spaced Close Parallel Runways

This section deals with an aeronautical feasibility study focused on the fundamental question of whether the prospective sites could meet basic airport planning requirements in terms of airspace/air traffic and obstacle/terrain feasibility for the intended airport role. Subsection 8.3.1 examines the Ultimate Phase Option 1: Two Sets of Widely Spaced Close Parallel Runways, followed by Subsection 8.3.2 for the Ultimate Phase Option 2: Three Open Parallel Runways.

Possibility for the new airport to coexist with the existing NAIA has also been examined for the Ultimate Phase Option 1.

8.3.1.1 Methodology

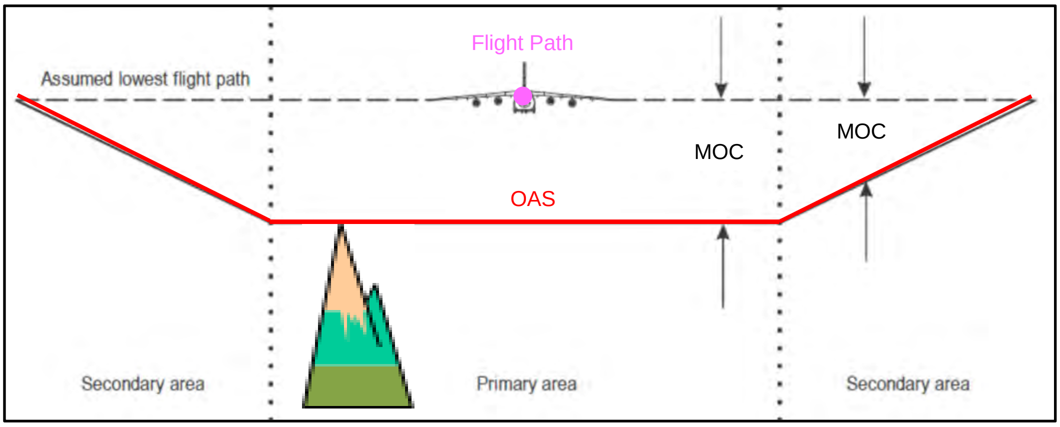
A series of analyses were performed on each prospective site location for the new airport to evaluate feasibility to establish Instrument Flight Procedures (IFPs) within Manila Terminal Control Area (TMA). IFPs, such as Instrument Approach Procedures (IAPs) and Standard Instrument Departures (SIDs) for each prospective site were developed to confirm whether the appropriate IFPs could be accommodated within Manila TMA and to identify relative challenges that each of the prospective site would face. This qualitative analysis included evaluation of terrain elevations as well as man-made artificial obstacles around the site by using flight procedure design software.

Since the objective of this analysis was preliminary examination and main concerning is the lower part within entire flight profiles to/from enroute segments, IAPs up to the intermediate phase of missed approach procedures and the lower part of SIDs were only established respectively for the feasibility evaluation purpose. It is obvious that there is no case that any prospective site results in unfeasible due to arrival routes, the upper part of SIDs, or the final phase of missed approach procedures, since those procedures will have various options to establish a flight procedure route in both vertically and laterally to solve any conflict on the route. Preliminary evaluations for the airspace route, however, were carried out to form holding stacks and departure/arrival paths enabling traffic to leave from or enter to neighboring airspace at known points and levels safely and efficiently.

1) Instrument Flight Procedure Design Overview

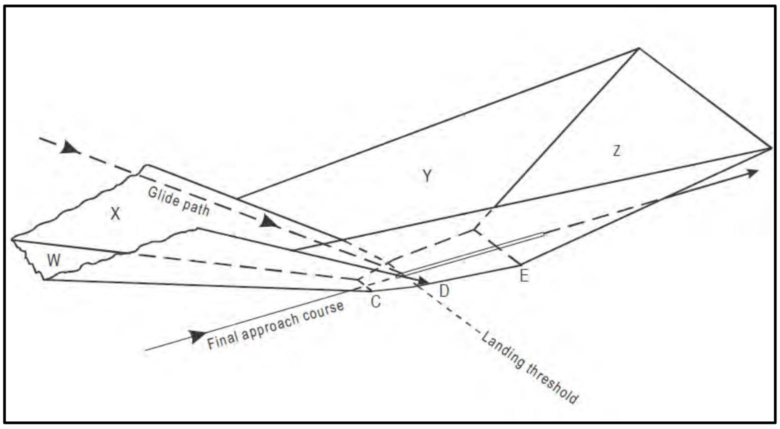
   IFPs are developed in order to provide aircraft a means of navigating along an obstacle-free track without visual reference to the ground or surrounding obstacles. In order to design IFPs ensuring an obstacle-free track, a protected area, also called obstacle assessment area (OAA), is defined along the designed lateral track of each procedural segment. This OAA is an area whose dimensions and shape are defined within flight procedure design criteria, and based, in part, on the navigation technology that is being used to define the path. All obstacles that fall within the

OAA must be cleared vertically by a specified minimum obstacle clearance (MOC) value, which defines an obstacle assessment surface (OAS). Published minimum altitudes of each segment are derived by evaluating the obstacles that lie within the OAA at each segment and adding the MOC value to heights of the obstacles. The minimum altitude that aircraft must climb to or descend with adequate gradient on an IFP is generally defined by the highest obstacle within the segment. Higher altitudes may be specified for a number of reasons, including airspace integration requirements or for noise mitigation purposes. Figure 8.3.1-1 shows the concepts of OAS and MOC. Figure 8.3.1-1 depicts a notional example of the OAS for ILS approach procedure.



Source: ICAO Doc 8168 Vol.2

Figure 8.3.1-1 Cross-section of Obstacle Assessment Area showing Obstacle Clearance



Source: ICAO Doc 8168 Vol.2

Figure 8.3.1-2 Illustrations of ILS Obstacle Assessment Surfaces - Perspective View

2) Procedure Design Criteria

In the Philippines, the majority of IFP design criteria are promulgated by the CAAP under provisions of the Procedures for Air Navigation Services - Aircraft Operations (PANS-OPS) Volume II: Construction of Visual and Instrument Flight Procedures [ICAO Doc 8168] published by ICAO. The IFP design criteria describe details of geometric constructs, such as OAA, OAS, and MOC, that must be complied when designing an IFP.

3) Operating Requirements and Constraints

a) Simultaneous Operations on Parallel Runways

An advantage of four runways at new NAIA will be a potential for several alternative operating modes, enabling flexibility and tailoring of the airport to (for instance) arrival or departure peaks. The runway utilization issues associated with different modes of operation are covered elsewhere in this report. However, some assumptions associated with the airspace evaluation are outlined here.

It is the obvious choice of simultaneous operations on two pairs of close-parallel runways in mixed mode (landing/departure) for each runway to maximize the runway capacity. ICAO provides guidance material on parallel runway operations in the Manual on Simultaneous Operations on Parallel or Near-Parallel Instrument Runways (SOIR) [ICAO Doc 9643]. The Manual lay down requirements for SOIR operation as below:

For independent parallel approaches:

i) ILS and/or MLS approaches are conducted on both runways;

ii) Missed approach track for one approach diverges by at least 30° from the adjacent approach;

iii) Radar vectoring is used to intercept the ILS localizer course or the MLS final approach track;

iv) A No Transgression Zone (NTZ) at least 610m wide is to be established equidistant between extended runway center lines;

v) A 1000 FT in vertical separation or 3.0 NM radar separation shall be provided at least until 10 NM from the threshold and maintained up to inbound on the ILS localizer course;

vi) The final vector shall enable the aircraft to intercept the ILS localizer course at an angle not greater than 30° and to provide at least 1.0 NM straight and level flight prior to ILS localizer course. The vector shall also enable the aircraft to be established on the ILS localizer course in level flight for at least 2.0 NM prior to intercepting the ILS glide path (GP).

For Independent parallel departures:

i) Departure tracks diverge by at least 15° immediately after take-off;

ii) Suitable surveillance radar capable of identifying the aircraft within 1.0 NM from the departure end of the runway (DER) is available.

b) Lateral Separation Minima

In addition to the requirement in ICAO Doc 9643 criteria, the Procedures for Air Navigation Services - Air Traffic Management [ICAO Doc 4444] prescribes lateral procedural separation minima for use in the separation of aircraft during arrival and departure phases of a flight. According to the ICAO Doc 4444, the following separation minima of departing and/or arriving aircraft on IFP tacks were adopted for the feasibility evaluation in this report:

i) Not less than 5 NM between any combination of RNP 1, or RNP APCH tracks, or
ii) The protected areas of tracks designed using obstacle clearance criteria do not overlap and provided operational error is considered.

4) Designing Flight Paths for the Assessment

JICA Survey Team designed IFPs in accordance with applicable PANS-OPS design criteria to enable simultaneous approaches and departures. Since the PANS-OPS design criteria have been established based on a wide range of navigation and flight guidance technologies, some IFP design parameters are to be assumed. Those parameters define the geometry of OAA and OAS. Key operational parameters assumed for IFPs design included, but were not limited to, the following:

a) Navigation System

According to the PBN Implementation Plan (Ver.2) issued by CAAP, mandating RNP1 for terminal application in busy airports such as NAIA is among the long term (beyond year 2016) goals. For approach application, CAAP will maintain ILS approaches and monitor the development of approach technology that use satellite based navigation such as SBAS and GBAS. Thus, RNP1 was adopted as the navigation system of both SIDs and IAPs, and ILS was adopted in where after the final approach point of IAPs for the evaluation purpose.

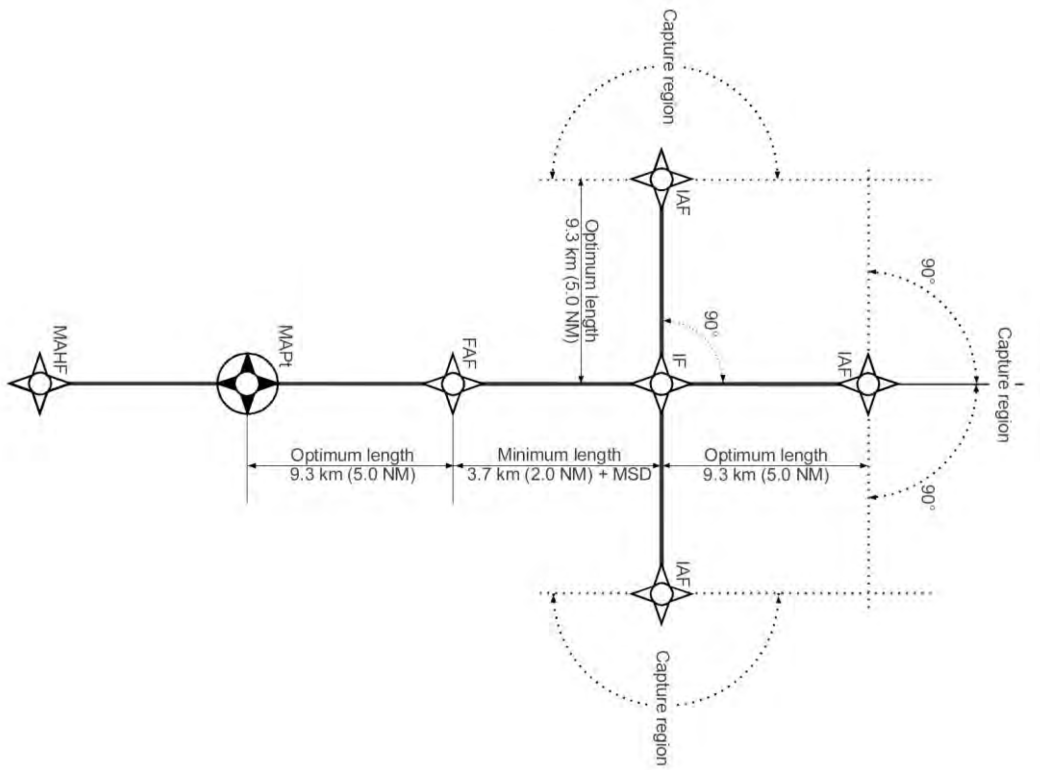
b) Aircraft Speed

Maximum of 210KIAS for IAP were assumed in accordance with the Section AD 2.20 of the Aeronautical Information Publication (AIP) Philippines.

c) Procedure Layout

There will be different options to connect to/from an enroute segment to the runway via IFPs depending on the airspace design concept that will be introduced to new Manila TMA based on prospective detailed airspace study. For feasibility evaluation purpose, the Survey Team developed protected area templates for each prospective site representing typical IFP layout for airport operation with four parallel runways configuration. IAPs were designed on a standard "T" bar for each Initial Approach Fix (IAF) permitting straight-in, left base, and right base joins. The T-bar will normally have a layout as shown in Figure 8.3.1-3. Location of the Final Approach Point (FAP) was defined by an intersection of a Glide Path (3° angle) beam and GP intercept altitude of 2500ft that was set as the same as that of current precision IAP at NAIA. The Intermediate Fix (IF) was placed at optimum distance of 5.0NM from FAP.

The nominal track of the initial phase of missed approach procedure diverged 15° from extended runway centerline (30° to adjacent missed approach procedure) to allow for simultaneous ILS/APV SBAS approaches to parallel instrument runways. The missed approach procedure was continued until a 2.5% climb surface reaches 2000ft that was a termination altitude of Parallel Approach Obstacle Assessment Surfaces (PAOAS). Although an approach procedural layout for the feasibility evaluation was symmetrical of adjacent approach layout, FAP location of each of IAPs in actual design should be segregated with 3.2NM distance to fulfill with the 1000ft vertical separation criterion. Adjustment of FAP location to meet with that criterion, however, will be able to be made without any problems when the symmetrical layout adopted for this study is feasible in terms of obstacle clearance and airspace availability.



Source: ICAO Doc.8168 Vol.2

Figure 8.3.1-3 T-Bar General Arrangement

For SID design, a straight segment that originates at the DER is to be oriented on 15° offset from the extended runway centerline to fulfill the independent parallel departures requirement under suitable surveillance radar environment. The design path terminates at a point where 3.3% of a procedure design gradient profile crosses 3000ft, which is the same procedure altitude for the first turn initiation on existing conventional (DVOR) SIDs at NAIA. The required geometry shape of protected area for RNP SIDs would be consequently the same as that of conventional SID on this evaluation.

8.3.1.2 Airspace / Air Traffic Feasibility

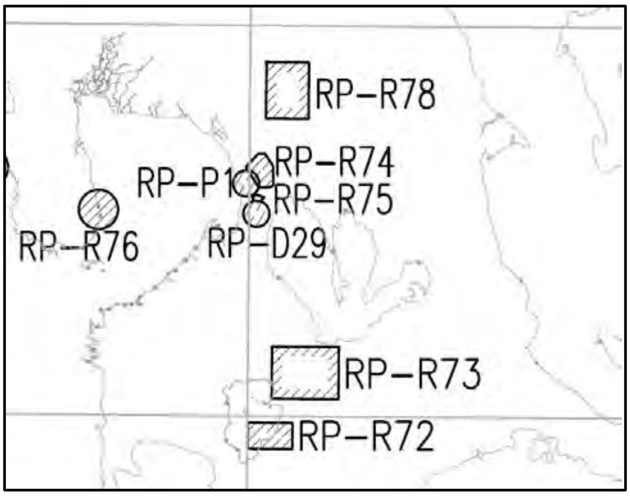
1) Airspace Constraint

All of the prospective sites will inevitably require major airspace redesign of Manila TMA in order for them to work effectively from an airspace / air traffic control standpoint. Since existing Intensive Military Training Areas, Corridors, and Flight Training Areas would be reallocated within the extent of new TMA by succeeding development phase of airspace redesign, those airspaces were ignored in the evaluation. Meanwhile, existing Prohibited, Restricted and Danger Areas that have been established for security or other reasons associated with the nature or activities at the ground surface of those specific areas were considered in the evaluation. Airspaces affecting the IFPs of the prospective sites appear in Table 8.3.1-1 and Figure 8.3.1-4.

As the result of an interview with DOTC and CAAP, JICA Study Team realized that it would be impracticable to change the extent of RP-P1 airspace. The finding was reflected for the feasibility evaluation on each prospective site.

Table 8.3.1-1 Airspaces Affecting the IFPs of the Prospective Sites

Identification	Name	Upper limit / Lower limit	Remarks
RP-P1	MALACAÑANG	5500FT ALT / SFC	Official residence of the President of the Philippines.
RP-R72	LIPA	10000FT ALT / SFC	Acrobatic operations Philippine Air Force
RP-R73	BARRADAS AIRSTRIP	5000FT ALT / SFC	Skydiving, aerobatic flying, ultra-light and aero-model operation.
RP-R74	(Nil)	2000FT ALT / SFC	Antenna farm.
RP-R75	MAKATI	1600FT ALT / SFC	Tall structure.
RP-R76	LIMAY	UNL / SFC	Philippine National Oil Corporation.



Source: AIP Philippines

Figure 8.3.1-4 Airspaces Affecting the IFPs of the Prospective Sites

2) Comparative Criteria

The Survey Team developed the following three criteria to evaluate airspace/air traffic feasibility of the prospective sites.

Table 8.3.1-2 Comparative Criteria for Airspace / Air Traffic Evaluation

Comparative Criterion	Metric
A-1 Preservation of existing airspace	Vertical separation or lateral separation between IFPs and existing airspace are certainly preserved or not.
A-2 Airspace availability for arrival routes	Sufficient extent of airspace is available to accommodate with omni-directional arrival routes to all IAFs or not.
A-3 Airspace availability for holding stacks	Sufficient extent of airspace is available to accommodate with holding procedures on all IAFs or not.

8.3.1.3 Obstacle / Terrain Feasibility

1) Obstacle and Terrain Data

In order to determine all potential airspace hazards in terms of obstacles and terrain, the Survey Team utilized data sets of digital obstacles and terrain files. The data sets consist of:

a) ASTER GDEM (Ver. 2)

ASTER GDEM is Digital Elevation Model (DEM) data of 30m posting interval and 7m to 14m accuracy over the entire Manila TMA. It was developed by using the satellite-borne sensor "ASTER" under a joint project by the Ministry of Economy, Trade and Industry of Japan (METI) and the National Aeronautics and Space Administration (NASA). The data have been acquired from March 2000 to August 2010.

b) ALOS 5m DEM

ALOS DEM is digital 3D topographic data which shows undulations of terrain (including ground covers, such as buildings and vegetation) in 5m resolution. It was developed by using Panchromatic Remote-sensing Instrument for Stereo Mapping (PRISM), and acquired by Advanced Land Observing Satellite (ALOS) of the Japan Aerospace Exploration Agency (JAXA). ALOS have been operated from January 2006 to May 2011. The data coverage area for this evaluation and a perspective image of the data appear in the figures below.

Figure 8.3.1-5 ALOS 5m DEM Coverage Area

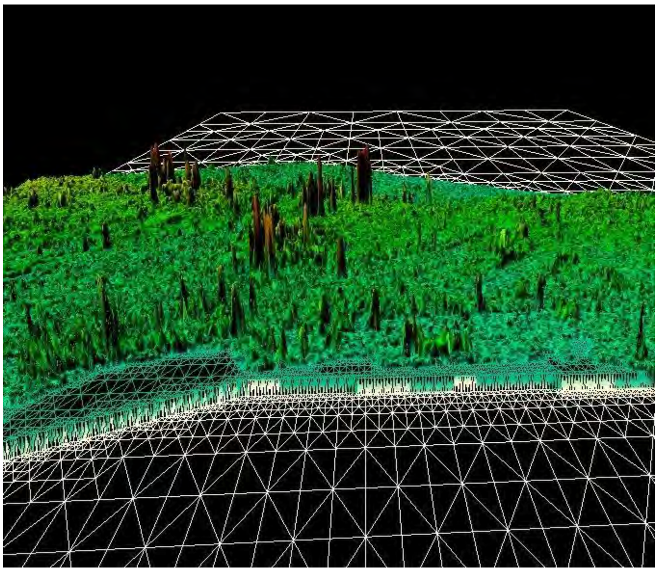


Figure 8.3.1-6 Perspective of ALOS 5m DEM

c) Artificial Obstacle Data

All aerodrome obstacles that shown in the Aeronautical Information Publication (AIP) of NAIA were taken into account for the assessment of obstacles under the protected area. Additional data were surveyed via the internet to include high-rise building structures that were under construction and/or planned in the future as many as possible. Table 8.3.1-3 shows a list of high-rese buildings taken into account for the assessment. Elevation of each building was estimated for assessment purpose from the sum of building height and ground elevation acquired from ASTER GDEM data.

Table 8.3.1-3 List of High-rise Buildings for the Obstacle Assessment

Building Name	Location	Height	Floor	Year	Building Name	Location	Height	Floor	Year
Philippine Diamond Tower	Triangle Park	612	200	2016	Alphaland Makati Place [2]	Makati	200	50	2015
Skycity	Mandaluyong	335	80	NA	Summit One Tower	Mandaluyong	200	49	1998
The Stratford Residences	Makati Poblacion	312	76	2015	AIC Empire Tower	Ortigas Center	200	52	NA
Trump Tower at Century City	Kalayaan Avenue	280.1112	58	2016	One Central	Makati CBD	195	50	2013
PBCom Tower	Makati CBD	259	52	2000	RCBC Plaza Yuchengco Tower	Makati CBD	192	46	2001
PBCom Tower	6795 Ayala Avenue	258.4704	52	2000	Park Terraces Tower 1 and 2	Makati CBD	187	51	2015
Grand Hyatt Manila	Taguig	258.4704	66	2015	One San Miguel Avenue	Ortigas Center	183	54	2001
Shangri-La at the Fort, Manila	Bonifacio Global City	250	61	2014	LKG Tower	Makati CBD	180	38	2000
Discovery Primea	Makati CBD	250	68	2014	The Shang Grand Tower	Makati CBD	180	46	2006
Gramercy Residences	Makati Poblacion	250	68	2013	Pacific Plaza Tower 2	Bonifacio Global City	179	52	2001
Hyundai National Headquarters	Taguig	249.936	56	NA	Pacific Plaza Tower 1	Bonifacio Global City	179	52	2001
Grand Riviera Suites	Roxas Boulevard	230.124	55	2014	Atlanta Centre	San Juan	179	37	1998
One Shangri-La Place South Tower	Ortigas Center	227	64	2014	Admiral Baysuites	Malate	178.6	53	NA
Shang Salcedo Place	Makati CBD	220	67	2016	Aspire at Nuvo City	Eastwood	178.0032	55	2012
The Knightsbridge Residences	Makati Poblacion	220	60	2014	Birch Tower	Malate	178	52	2012
Alphaland Makati Place [1]	Makati	220	55	2015	Robinsons Equitable Tower	Ortigas Center	175	45	1997
G.T. International Tower	Makati CBD	217	47	2001	One Roxas Triangle	Makati CBD	174	40	2000
Garden Towers 1	Makati	215	60	2016	Robinsons Summit Center	Makati CBD	174	38	2001
BSA Twin Tower 1	Ortigas Center	215	55	2000	Enterprise Center Tower One	Makati CBD	172	45	1999
BSA Twin Tower 2	Ortigas Center	215	55	2000	The Residences at Greenbelt Laguna Tower	Makati CBD	171	48	2008
St. Francis Tower 1	Ortigas Center	213	60	2009	The Residences at Greenbelt Manila Tower	Makati CBD	171	48	2010
St. Francis Tower 2	Ortigas Center	213	60	2009	The Beacon Arnaiz Tower	Makati CBD	170	50	2012
Park Terraces Point Tower	Makati CBD	210	59	2015	RCBC Plaza Tower 2	Makati CBD	170	41	2001
Petron Megaplaza	Makati CBD	210	45	1998	Pearl of the Orient Tower	Ermita	168	42	2004
UnionBank Plaza	Ortigas Center	206	49	2004	Rufino Pacific Tower	Makati CBD	161	41	1994
Greenbelt Lorenzo Tower	Makati CBD	205	57	2009	Ayala Tower One	Makati CBD	160	35	1996
Golden Empire Tower	Ermita	203	57	2002	The Beacon Roces Tower	Makati CBD	158	44	2011
One Corporate Centre	Ortigas Center	202	45	2009	Exportbank Plaza	Makati CBD	155	36	1998
Philamlife Tower	Makati CBD	200	48	2000	The World Centre	Makati CBD	152	30	1995
Milano Residences	Makati Poblacion	200	53	2015	One McKinley Place	Bonifacio Global City	150	43	2004

2) Comparative Criteria

The Survey Team developed the following four criteria to evaluate obstacle/terrain feasibility of the prospective sites. 5.0% of climb gradient on SIDs was set out as an acceptable maximum value for evaluation purpose based on Japanese IFP design practice, since there is no explicit description on such value in PANS-OPS criteria.

Table 8.3.1-4 Comparative Criteria for Obstacle / Terrain Evaluation

Comparative Criterion	Metric
O-1 ILS Approach Design	Minimum Decision Height (DH=200ft) can be obtained or not.
O-2 Initial/Intermediate Approach Design	Adequate descent gradient of approach segments; i.e., 5.241% on the final, 5.2% on the intermediate, and less than 8.0% on the initial, can be maintained or not.
O-3 Missed Approach Design	Adequate climb gradient; ideally 2.5% but acceptable up to 5.0% can be maintained or not.
O-4 Departure Design	Adequate climb gradient; ideally 3.3% but acceptable up to 5.0% can be maintained or not.

8.3.1.4 Assessment Result

Using the comparative criteria described above and IFP protected areas depicted in accordance with PANS-OPS criteria, the Survey Team conducted the site evaluation to determine the feasibility of the sites for development of NMIA in terms of airspace and obstacle restrictions. Results of the study revealed that all of the five prospective sites would require resolving conflicts between assumed IFP routes and existing airspaces more and less, although none of the five prospective sites would be fatally flawed because of the obstacle/terrain constraints.

The Survey Team came up with three favorable prospective sites for new NAIA; Central Portion of Manila Bay, Western Side of Laguna de Bay and Sangley Point Option 1 as these sites would not require significant conflict with the existing prohibited/restricted airspaces.
Other two sites; Sangley Point Option 2 and San Nicholas Shoals would require removal or significant relaxing of the height restriction of RP-P1: MALACANANG; the prohibited airspace established around the official residence of the President of the Republic of the Philippines. Successful negotiation/coordination with relevant authorities to remove/relax the restriction of RP-P1 in a timely manner is considered very much unlikely.

The results of evaluation on each prospective site are outlined in Table 8.3.1-5.

Depicted protected area templates of IFPs and criteria evaluation matrixes for each prospective site are shown in Figure 8.3.1-7 through Figure 8.3.1-16 and Table 8.3.1-6 through Table 8.3.1-10 respectively.

Table 8.3.1-5 Summary of Assessment Results for Six Prospective Sites (Ultimate Phase Option 1)

Sites Name	Brief Assessment Result Description
Central Portion of Manila Bay	This site location exhibits the most favorable assessment result to accommodate all IFPs in Manila TMA without major conflict with the existing airspaces. The airport has a good runway orientation and certain distance from adjacent TMAs that helps make flexible air traffic flows. The arrival routes from south, however, require a careful IFP design to resolve conflicts with an existing restricted airspace (RP-R73).
Western side of Laguna de Bay	This site location also exhibits favorable assessment result to accommodate all IFPs in Manila TMA without major conflicts with the existing airspaces. Its north/south runway orientation, however, will make a slight conflict between initial approach segments and an existing airspace (RP-R72).
Sangley Point Option 1	While this site location exhibits favorable assessment result in terms of conflict with the existing airspaces, existence of an oil terminal facility near RWY02R threshold could be a potential hazard for neighboring area in case of aircraft crash into the terminal. Coordination with authorities concerned would be required.
San Nicholas Shoals	While this site will be a good distance from Metro Manila region, its northeast/southwest runway orientation will cause some significant challenges on modifying vertical limit of some prohibited areas including RP-P1. This site will also require careful IFP design to work out terrain penetrations.
Sangley Point Option 2	This site will be the most challenging one due to proximate location to Metro Manila and its runway orientation. IAPs for this site will conflict with some prohibited/restricted airspaces including RP-P1. Limited extent of airspace to the west side of the airport will be only available due to a restricted airspace and an adjacent TMA, and it will make air traffic flow inefficient.

Less Challenging ↑ / More Challenging ↓

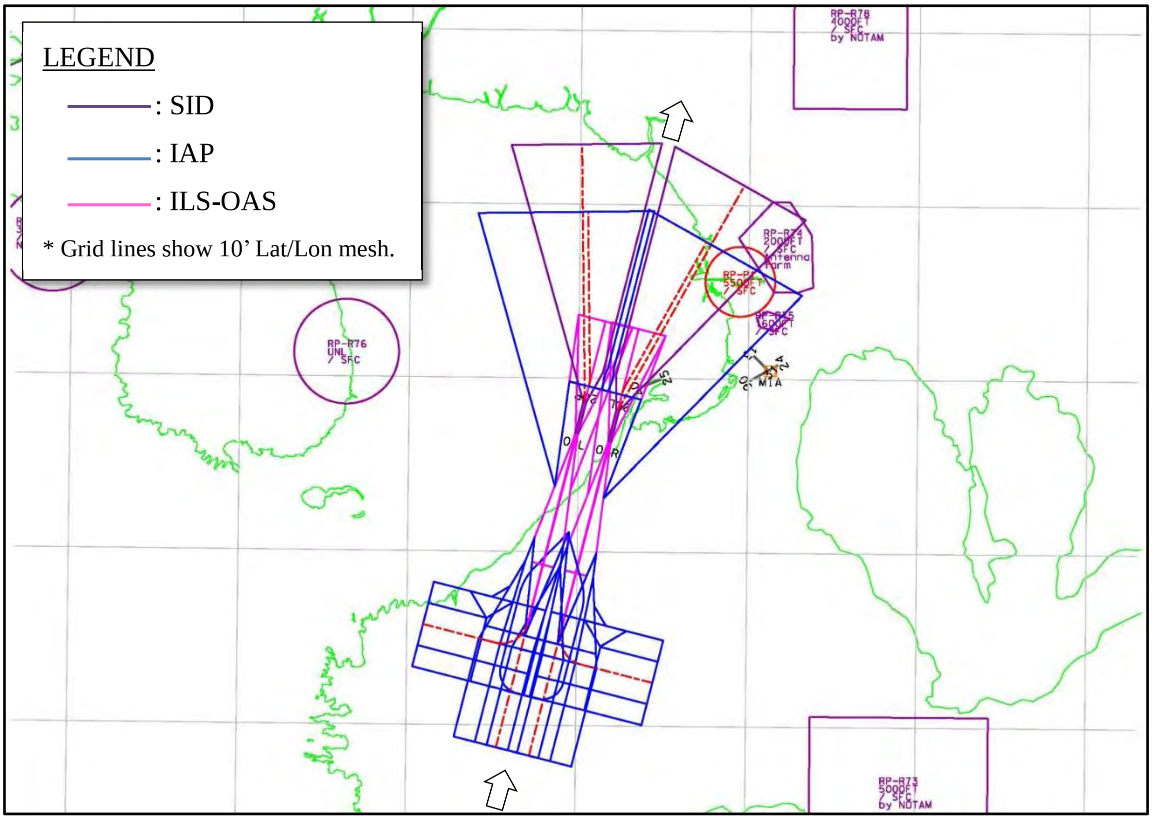


Figure 8.3.1-7 Protected Area Template of IFPs - Sangley Point Option 1 (RWY02L/02R)

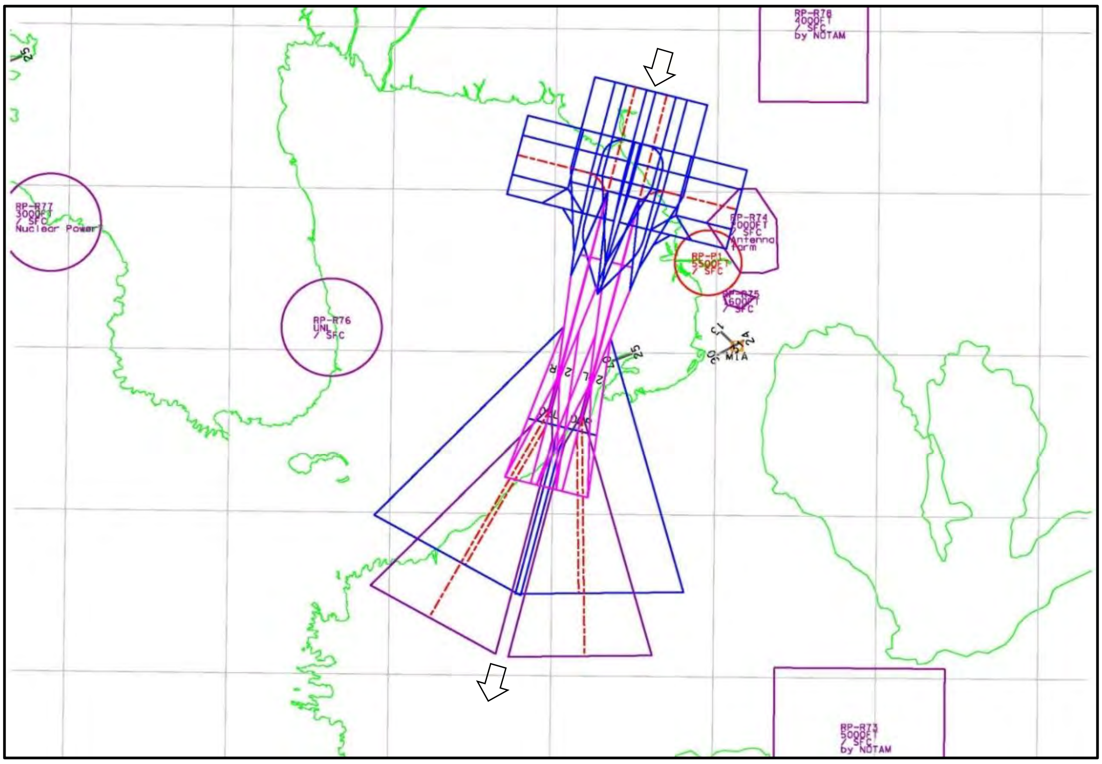


Figure 8.3.1-8 Protected Area Template of IFPs - Sangley Point Option 1 (RWY20L/20R)

Table 8.3.1-6 Criteria Evaluation Matrix – Sangley Point Option 1

Comparative Criteria		Operational Runway			
		RWY02L	RWY02R	RWY20L	RWY20R
A-1	Preservation of existing airspace	YES	YES RP-P1 and RP-R74 conflict with SID & Missed APCH OASs, but can be preserved by altered (straightened) flight track.	YES RP-P1 conflict with Initial Approach Segment, but can be preserved by altered route.	YES
A-2	Airspace availability for arrival routes	YES	YES	YES	YES
A-3	Airspace availability for holding stacks	YES	YES	YES	YES
O-1	ILS Approach Design	YES	YES But as Petron's oil terminal exists just under the final approach track, coordination could be required with authorities concerned.	YES	YES
O-2	Initial/ Intermediate Approach Design	YES	YES	YES	YES
O-3	Missed Approach Design	YES	YES	YES	YES
O-4	Departure Design	YES	YES More than 3.3% climb gradient is required due to a high-rise building.	YES But as Petron's oil terminal exists just under the departure track, coordination could be required with authorities concerned. More than 3.3% climb gradient is required due to an antenna.	YES

Note

RP-P1: MALACANANG RP-P72: LIPA (Acrobatic operations by PAF)
RP-P73: Barbados (Skydiving, etc.) RP-R74: Antenna Farm
RP-R75: MAKATI (High structure) RP-R76: LIMAY (Oil Corporation)

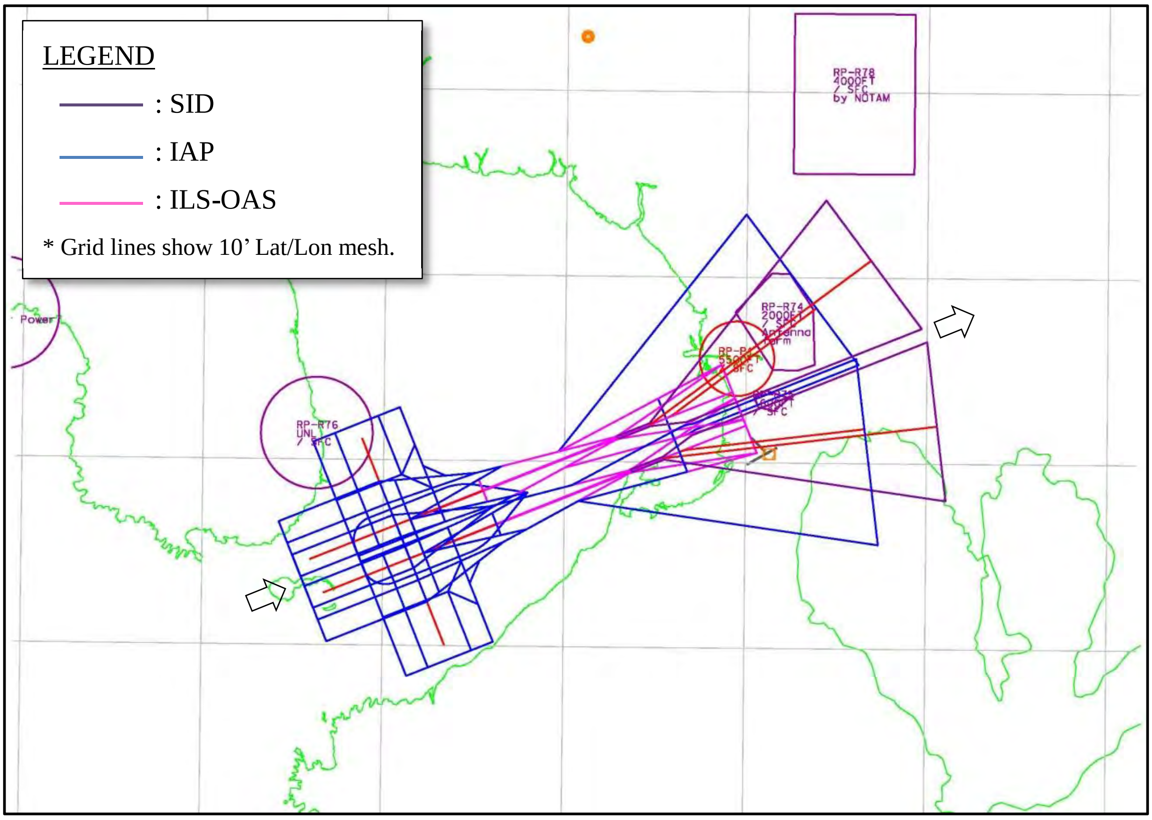


Figure 8.3.1-9 Protected Area Template of IFPs - Sangley Point Option 2 (RWY07L/07R)

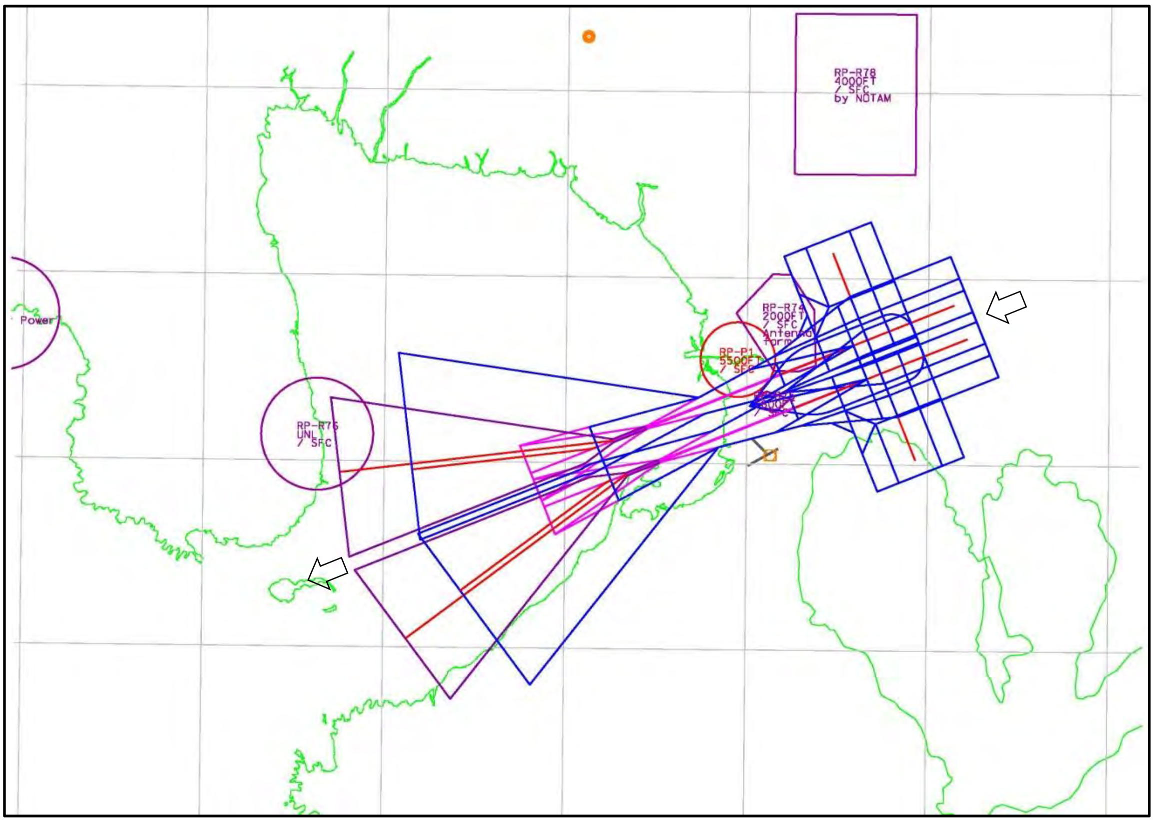


Figure 8.3.1-10 Protected Area Template of IFPs - Sangley Point Option 2 (RWY25L/25R)

Table 8.3.1-7 Criteria Evaluation Matrix – Sangley Point Option 2

Comparative Criteria		Operational Runway			
		RWY07L	RWY07R	RWY25L	RWY25R
A-1	Preservation of existing airspace	**NO** RP-P1 conflict with Missed APCH and SID OASs. RP-R74 and RP-R75 conflict with SID OAS. Successful coordination could not be expected.	**YES** RP-R75 conflict with SID OAS, but can be preserved by altered (curved) route.	**NO** RP-R75 conflicts with ILS-OAS. Successful coordination could not be expected.	**NO** RP-P1 and RP-R74 conflict with ILS-OAS. Successful coordination could not be expected. RP-R76 conflict with SID OAS, but can be preserved by altered (curved) route.
A-2	Airspace availability for arrival routes	**YES** Arrival routes from the north should be detoured due to PR-R76.	**YES**	**YES**	**YES**
A-3	Airspace availability for holding stacks	**NO** Difficult to establish a holding procedure for air traffic from the north due to Subic Bay TMA and RP-R76. Successful coordination could not be expected.	**YES**	**YES**	**YES**
O-1	ILS Approach Design	**YES**	**YES**	**YES**	**YES**
O-2	Initial/ Intermediate Approach Design	**YES**	**YES**	**YES**	**YES**
O-3	Missed Approach Design	**YES** More than 2.5% climb gradient is required due to a high-rise building.	**YES**	**YES**	**YES**
O-4	Departure Design	**YES** More than 3.3% climb gradient is required due to two high-rise buildings.	**YES**	**YES**	**YES**

Note
RP-P1: MALACANANG RP-P72: LIPA (Acrobatic operations by PAF)
RP-P73: Barbados (Skydiving, etc.) RP-R74: Antenna Farm
RP-R75: MAKATI (High structure) RP-R76: LIMAY (Oil Corporation)

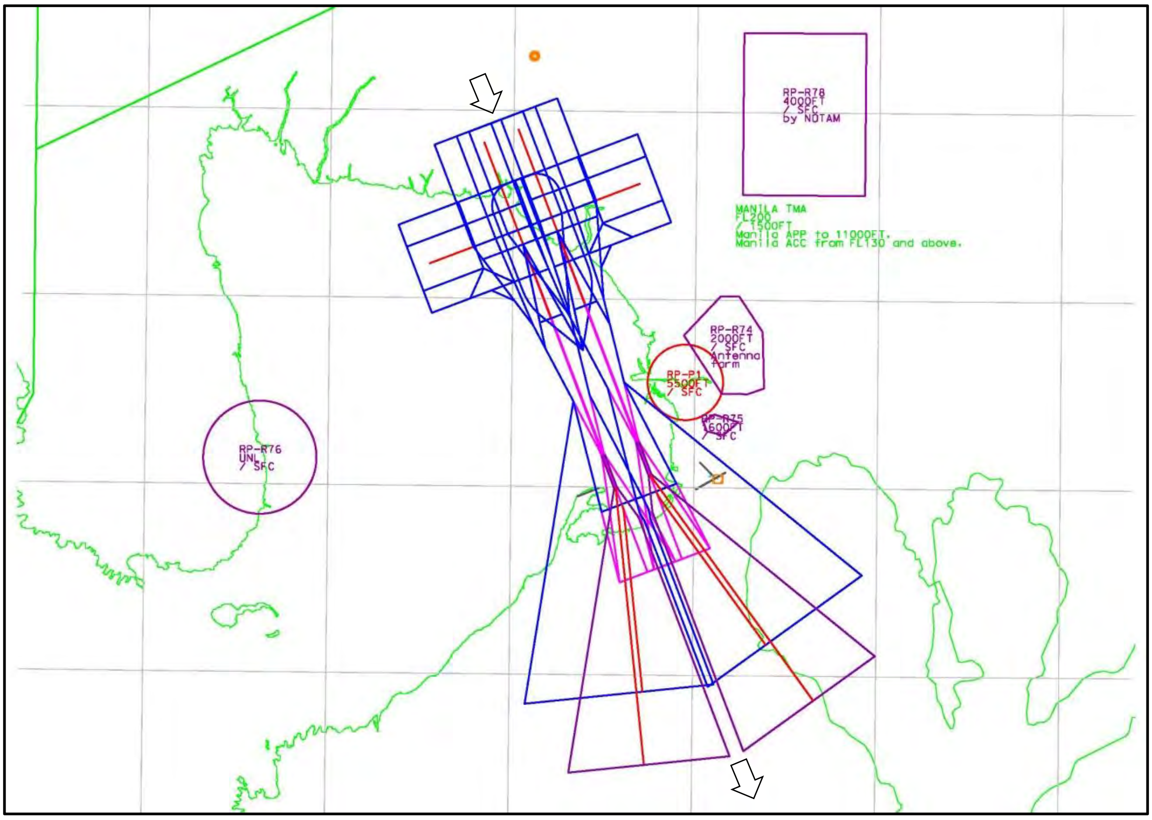


Figure 8.3.1-11 Protected Area Template of IFPs (Central Manila Bay: RWY16L/16R)

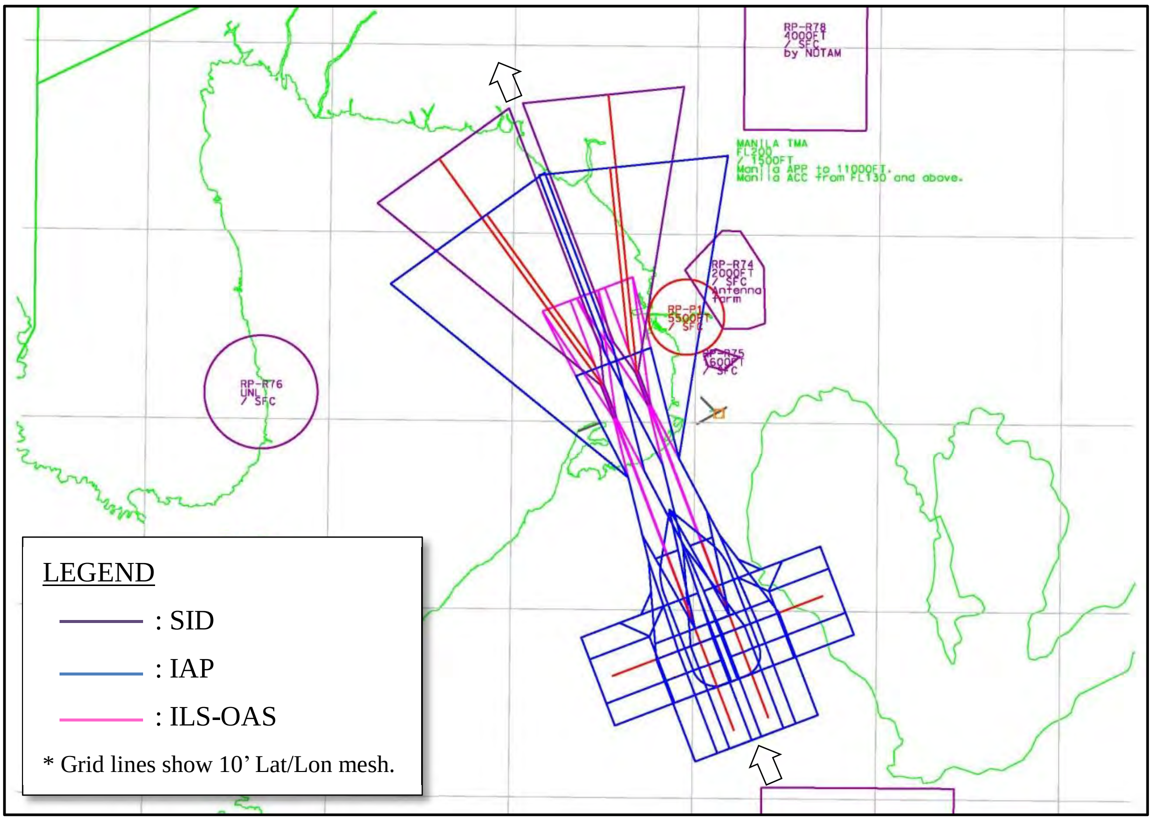


Figure 8.3.1-12 Protected Area Template of IFPs (Central Manila Bay: RWY34L/34R)

Table 8.3.1-8 Criteria Evaluation Matrix – Central Portion of Manila Bay

Comparative Criteria		Operational Runway			
		RWY16L	RWY16R	RWY34L	RWY34R
A-1	Preservation of existing airspace	**YES** SID require more than 3.3% climb gradient to overfly RP-R73.	**YES** SID require more than 3.3% climb gradient to overfly RP-R73.	**YES**	**YES** RP-P1 conflict with Missed APCH OASs, but can be preserved by altered (straightened) flight track.
A-2	Airspace availability for arrival routes	**YES** Arrival routes overflying Clark TMA should be detoured to maintain moderate descent gradient.	**YES** Arrival routes overflying Clark TMA should be detoured to maintain moderate descent gradient.	**YES** Arrival route overflying RP-R73 require 7% steep decent, but can be detoured.	**YES** Arrival route overflying RP-R73 require 7% steep decent, but can be detoured.
A-3	Airspace availability for holding stacks	**YES**	**YES**	**YES** Holding location may be limited due to PR-R73.	**YES** Holding location may be limited due to RP-R73.
O-1	ILS Approach Design	**YES**	**YES**	**YES**	**YES**
O-2	Initial/ Intermediate Approach Design	**YES**	**YES**	**YES**	**YES**
O-3	Missed Approach Design	**YES**	**YES**	**YES**	**YES** More than 5% climb gradient is required due to a high-rise building, but can be avoided by altered (straightened) flight track.
O-4	Departure Design	**YES**	**YES**	**YES**	**YES**

Note
RP-P1: MALACANANG RP-P72: LIPA (Acrobatic operations by PAF)
RP-P73: Barbados (Skydiving, etc.) RP-R74: Antenna Farm
RP-R75: MAKATI (High structure) RP-R76: LIMAY (Oil Corporation)

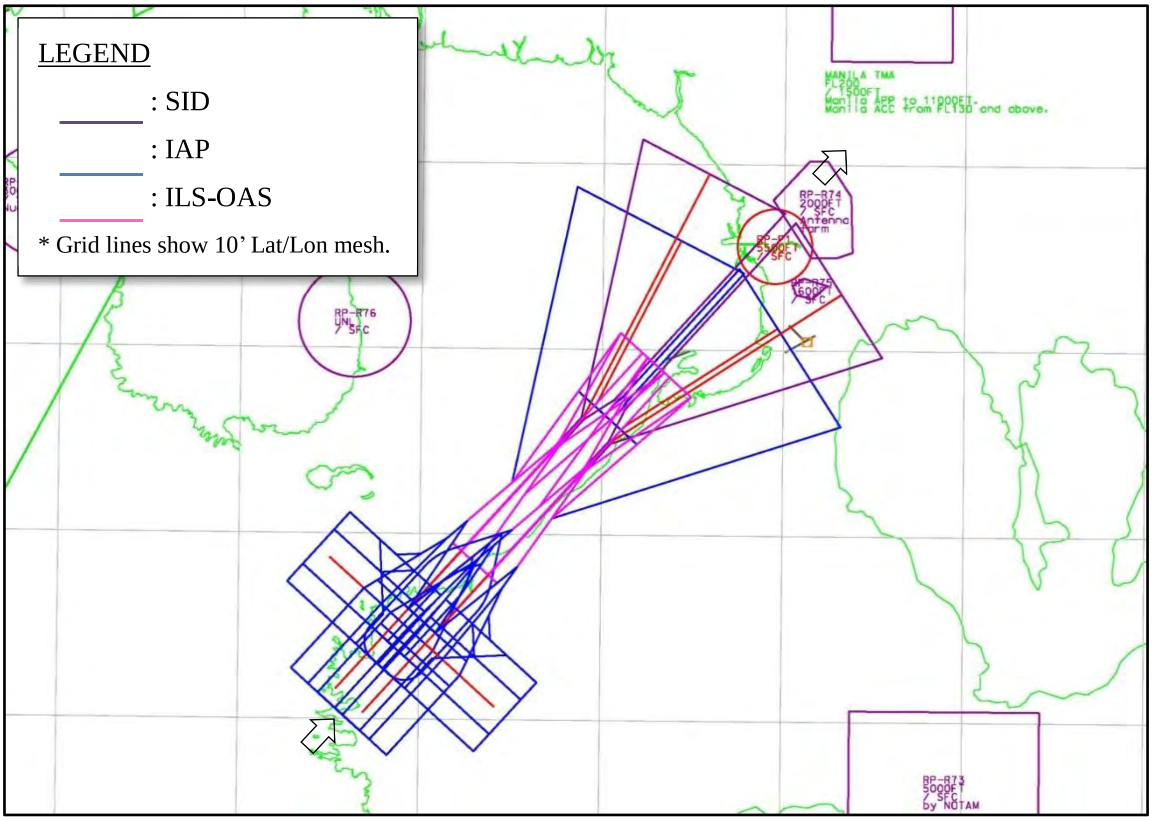


Figure 8.3.1-13 Protected Area Template of IFPs - San Nicholas Shoals (RWY04L/04R)

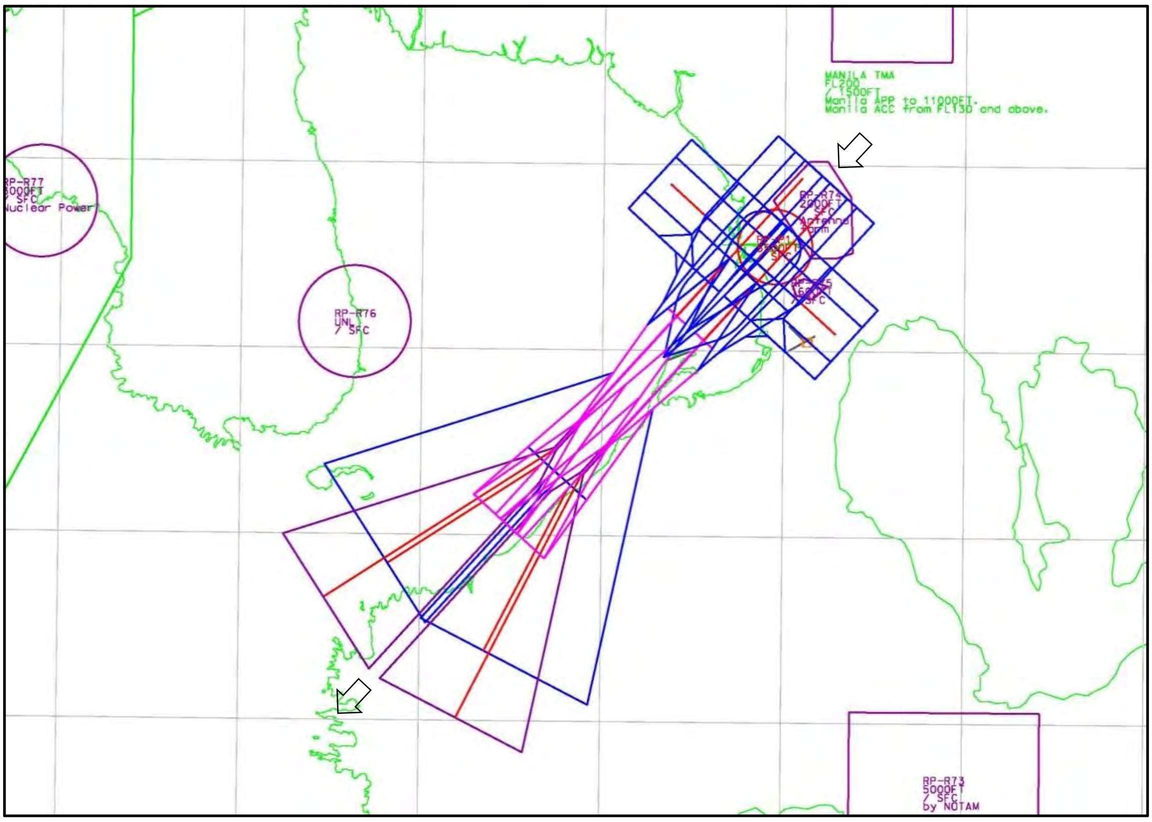


Figure 8.3.1-14 Protected Area Template of IFPs - San Nicholas Shoals (RWY22L/22R)

Table 8.3.1-9 Criteria Evaluation Matrix – San Nicholas Shoals

Comparative Criteria		Operational Runway			
		RWY04L	RWY04R	RWY22L	RWY22R
A-1	Preservation of existing airspace	**YES** RP-P1 conflict with SID & Missed APCH OASs, but can be preserved by altered (curved) route.	**YES** RP-P1 conflict with SID & Missed APCH OASs, but can be preserved by altered (curved) route.	**NO** IAP overflying RP-P1 require more than 5.2% descent gradient. Successful coordination could not be expected.	**NO** IAP overflying RP-P1 require more than 5.2% descent gradient. Successful coordination could not be expected.
A-2	Airspace availability for arrival routes	**YES**	**YES**	**YES**	**YES**
A-3	Airspace availability for holding stacks	**YES**	**YES**	**YES**	**YES**
O-1	ILS Approach Design	**YES**	**YES**	**YES**	**YES**
O-2	Initial/ Intermediate Approach Design	**YES** An step down fix is required for decent due to terrain.	**YES** An step down fix is required for decent due to terrain.	**YES**	**YES**
O-3	Missed Approach Design	**YES**	**YES**	**YES**	**YES**
O-4	Departure Design	**YES**	**YES** More than 3.3% climb gradient is required due to an antenna.	**YES** More than 3.3% climb gradient is required due to terrain.	**YES**

Note
RP-P1: MALACANANG
RP-P72: LIPA (Acrobatic operations by PAF)
RP-P73: Barbados (Skydiving, etc.)
RP-R74: Antenna Farm
RP-R75: MAKATI (High structure)
RP-R76: LIMAY (Oil Corporation)

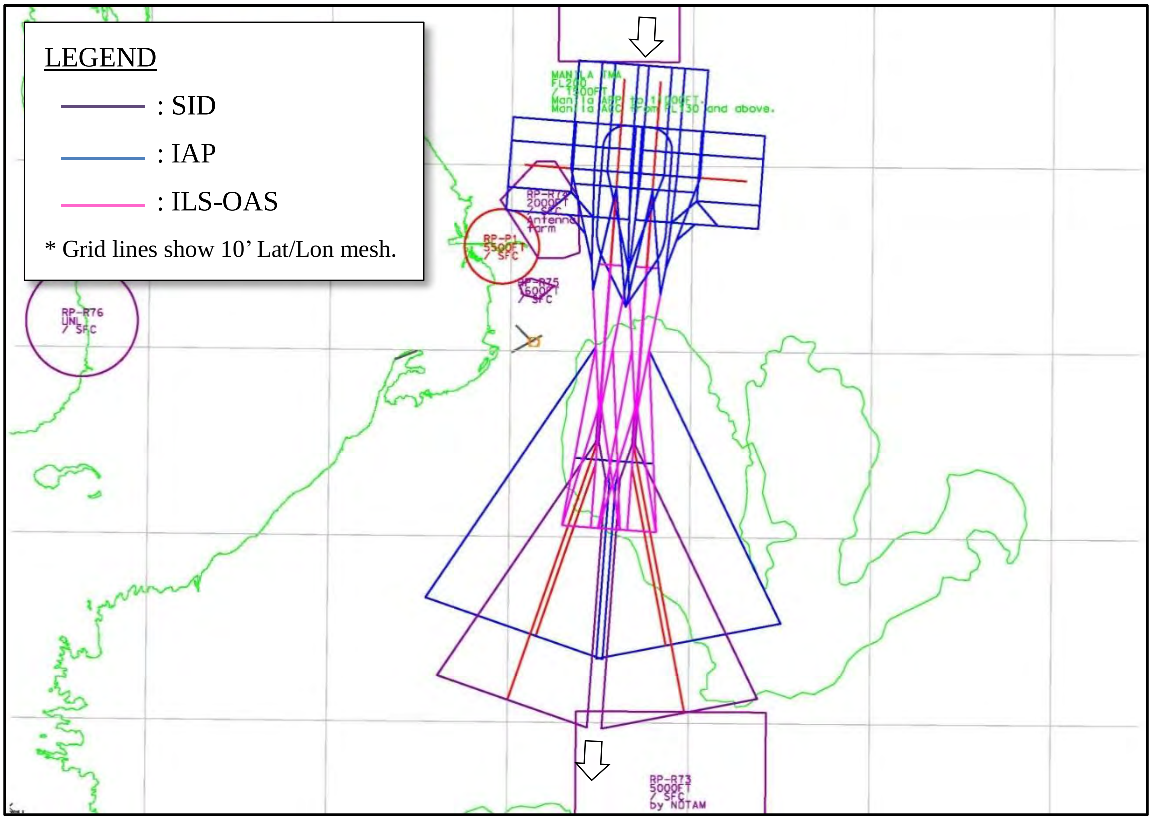


Figure 8.3.1-15 Protected Area Template of IFPs – West Laguna de Bay (RWY18L/18R)

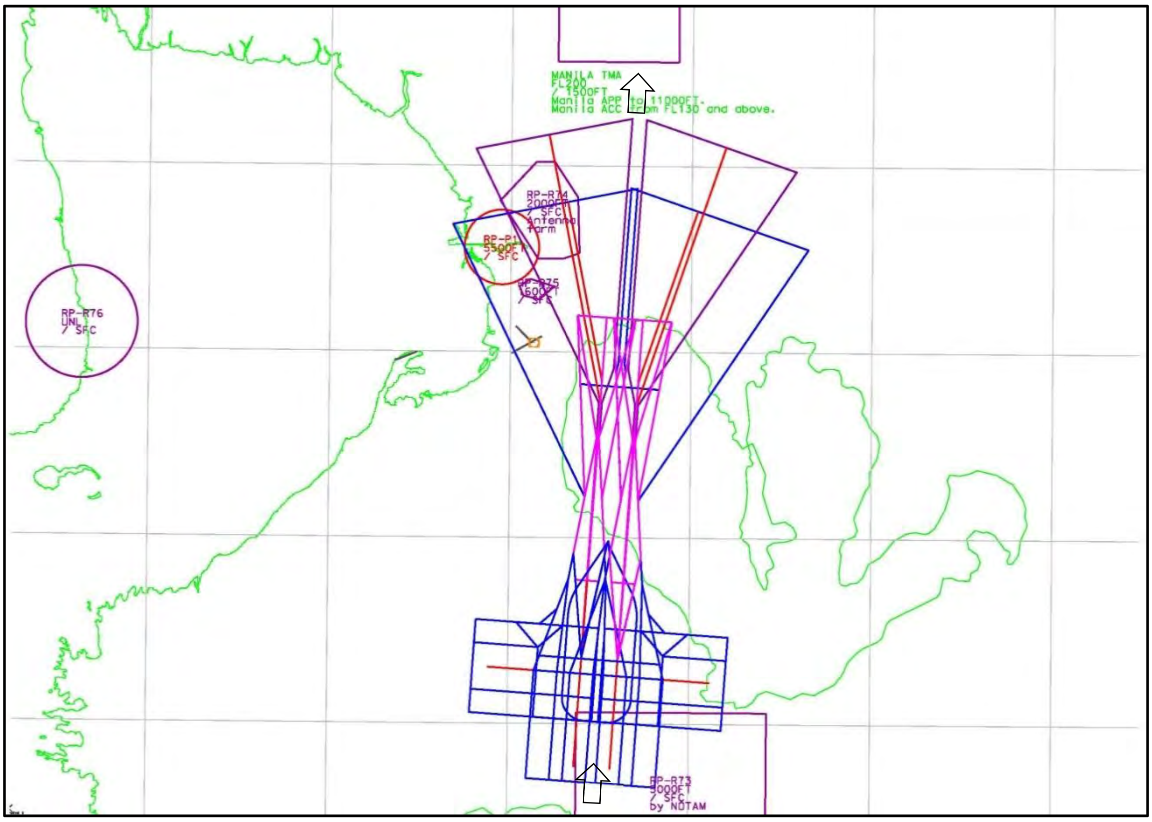


Figure 8.3.1-16 Protected Area Template of IFPs – West Laguna de Bay (RWY36L/36R)

Table 8.3.1-10 Criteria Evaluation Matrix – Western Side of Laguna de Bay

Comparative Criteria		Operational Runway			
		RWY18L	RWY18R	RWY36L	RWY36R
A-1	Preservation of existing airspace	YES RP-R73 conflict with SID OAS, but can be preserved by altered (curved) route.	YES RP-R73 conflict with SID OAS, but can be preserved by altered (curved) route.	YES IAP overflying RP-R73 require more than 5.2% descent gradient, however successful coordination to remove/relax the height limitation could be expected. SID & Missed APCH OASs conflict with RP-P1, but can be preserved by altered (straightened) route. SID required more than 3.3% climb gradient to overfly RP-R74 & RP-R75.	YES
A-2	Airspace availability for arrival routes	YES	YES	YES Arrival routes from the south should be detoured due to PR-R72.	YES Arrival routes from the south should be detoured due to PR-R72.
A-3	Airspace availability for holding stacks	YES	YES	YES Holding location may be limited due to RP-R72.	YES Holding location may be limited due to RP-R72.
O-1	ILS Approach Design	YES	YES	YES	YES
O-2	Initial/ Intermediate Approach Design	YES	YES	YES	YES
O-3	Missed Approach Design	YES	YES	YES	YES
O-4	Departure Design	YES	YES	YES More than 3.3% climb gradient is required due to a high-rise building.	YES

Note

RP-P1: MALACANANG RP-P72: LIPA (Acrobatic operations by PAF)
RP-P73: Barbados (Skydiving, etc.) RP-R74: Antenna Farm
RP-R75: MAKATI (High structure) RP-R76: LIMAY (Oil Corporation)

8.3.1.5 Interference with Prohibited/Restricted Airspaces

As a result of the examination on the airspace feasibility, it has been found out that the aircraft flight paths and their obstacle assessment surfaces (OAS) of the sites except for Sangley Point Option 1 and Central Portion of Manila Bay would penetrate some of the existing restricted/prohibited airspaces as summarized in Table 8.3.1-11. The penetration has been calculated based on the IFPs with acceptable maximum climb/descent gradient.

The most stringent restriction would be RP-P1: MALACANNG; the official residence of the President of the Republic of the Philippines. Presidential Security Group (PSG), the lead agency tasked in providing security to the President of the Philippines, has not yet responded to a query from DOTC and the Survey Team as to whether removal and/or relaxing of the restriction of RP-P1 would be possible or not. However it is considered practicable to assume that such removal and/or relaxing would not be easily accepted, requiring time-consuming study, discussion and coordination involving not only the current administration but also future ones, while decision-making for development of NMIA and its site should be made as soon as possible to address the significant airport capacity constraint issue. Therefore, it could be concluded that the sites of Sangley Point Option 1 and San Nicholas Shoals, of which the aircraft paths and their OAS would penetrate RP-P1, are not preferred options for development of NMIA.

Table 8.3.1-11 Summary of Prohibited/Restricted Airspaces Penetration
(Ultimate Phase Option 1: Two Sets of Widely Spaced Close Parallel Runways)

Site Name	Procedure Name	RP-P1		RP-R74		RP-R75		RP-R73	
		Penet. (FT)	New Upper Limit (FT)	Penet. (FT)	New Upper Limit (FT)	Penet. (FT)	New Upper Limit (FT)	Penet. (FT)	New Upper Limit (FT)
1. Sangley Point Option 1		0	-	0	-	0	-	0	-
2. Sangley Point Option 2		4800	700	700	1300	400	1200	0	-
	IAP RWY07L	4600	900	0	-	0	-	0	-
	SID RWY07L	4400	1100	200	1800	100	1500	0	-
	IAP RWY25L	0	-	0	-	400	1200	0	-
	IAP RWY25R	4800	700	700	1300	0	-	0	-
3. Central Portion of Manila Bay		0	-	0	-	0	-	0	-
4. San Nicholas Shoals		2900	2600		-	0	-	0	-
	IAP RWY22L	2900	2600	0	-	0	-	0	-
	IAP RWY22R	2900	2600	0	-	0	-	0	-
5. Western Portion of Laguna de Bay		0	-	0	-	0	-	1900	3100
	IAP RWY36L	0	-	0	-	0	-	1900	3100

Note. Alternative Sangley Point Option 1 site would not involve penetration of IFP to any of the prohibited/restricted airspaces.

8.3.1.6 Alternative Site Location in Central Portion of Manila Bay for Reference

Corresponding to a request from the Counterpart Team (CAAP), the Survey Team developed an additional site location in Manila Bay, i.e., at the south of Manila Bay, as an alternative site location of the Central Portion of Manila Bay. This alternative site would not overlap the Manila Port Zone and would not impose severe height limitation on the anchorages therein (see Subsection 8.8). The Survey Team evaluated the site's feasibility from an airspace/air traffic perspective as shown in Table 8.3.1-12. Depicted protected area templates of IFPs and a criteria evaluation matrix for the alternative site are shown in Figure 8.3.1-17 and Figure 8.3.1-18 and Table 8.3.1-13 respectively. This location will be ranked at the next position to the prospective site of Sangley Point Option 1 according to the amount of required challenges.

Table 8.3.1-12 Assessment Results for Alternative Site Location for Manila Bay

Sites Name	Brief Assessment Result Description
South of Manila Bay	While the east/west runway will have optimum orientation for avoiding the restricted and prohibited areas over Metro Manila region, departure aircraft will require more than 5% climb gradient due to electric transmission lines along the Manila-Cavite Expressway. The location will also require a challenge on modifying vertical limit of a prohibited area to establish instrument approach, arrival and holding procedures. In particular, the initial and intermittent segments of RWY 09 would protrude RP-R76: LIMAY; Philippine National Oil Corporation of which from the surface to unlimited upper airspace is restricted.

Table 8.3.1-13 Criteria Evaluation Matrix – South of Manila Bay

Comparative Criteria		Operational Runway			
		RWY09L	RWY09R	RWY27L	RWY27R
A-1	Preservation of existing airspace	**NO** RP-R76 conflict with Initial/Intermediate Approach Segments. RP-P1 conflict with Missed APCH OASs, but can be preserved by altered (straightened) flight track.	**NO** RP-R76 conflict with Initial/Intermediate Approach Segments.	**YES** RP-R76 conflict with SID OAS, but can be preserved by altered (curved) route.	**YES** RP-R76 conflict with SID OAS, but can be preserved by altered (curved) route.
A-2	Airspace availability for arrival routes	**YES** Arrival routes from the west should be detoured due to PR-R76.	**YES** Arrival routes from the west should be detoured due to PR-R76.	**YES**	**YES**
A-3	Airspace availability for holding stacks	**YES** Holding location may be limited due to PR-R76.	**YES** Holding location may be limited due to PR-R76.	**YES**	**YES**
O-1	ILS Approach Design	**YES**	**YES**	**YES**	**YES**
O-2	Initial/ Intermediate Approach Design	**YES**	**YES**	**YES**	**YES**
O-3	Missed Approach Design	**YES** More than 2.5% climb gradient is required due to two high-rise buildings.	**YES**	**YES**	**YES**
O-4	Departure Design	**YES** More than 3.3% climb gradient is required due to two high-rise buildings.	**NO** More than 5% climb gradient is required due to power transmission lines.	**YES**	**YES**

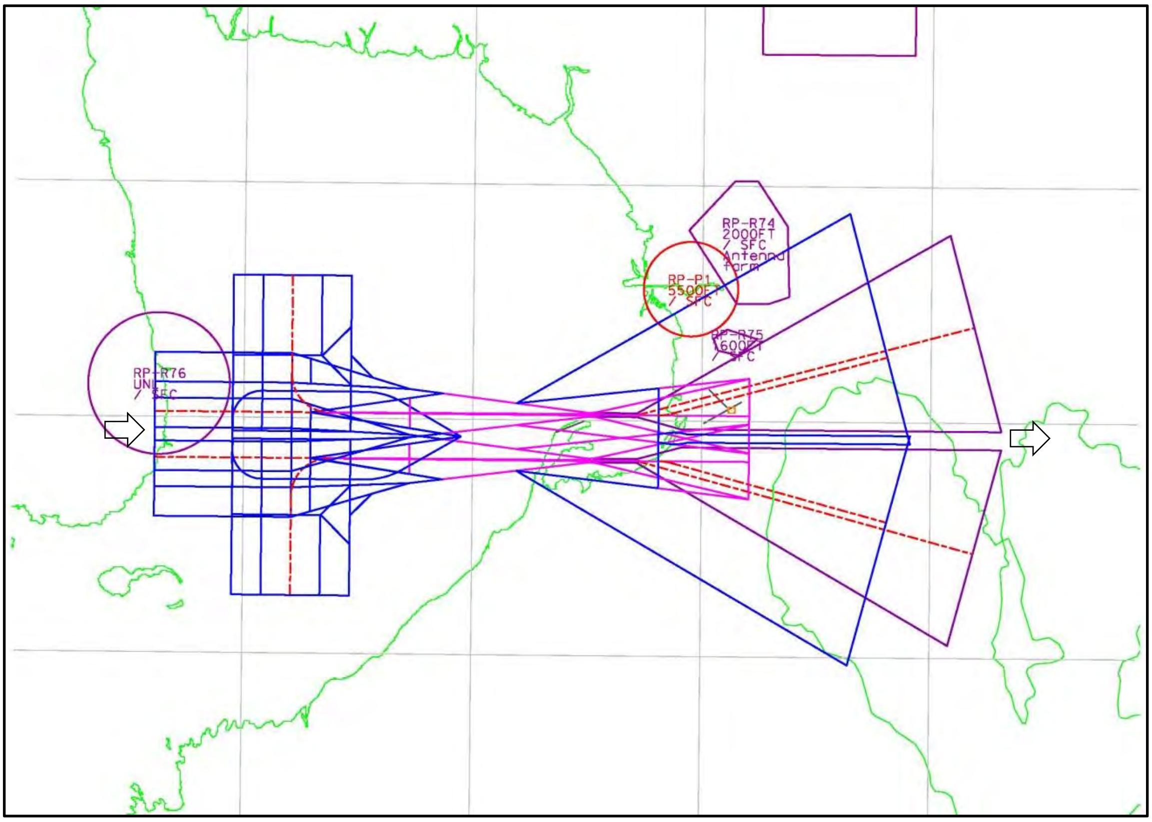


Figure 8.3.1-17 Protected Area Template of IFPs - South of Manila Bay (RWY09L/09R)

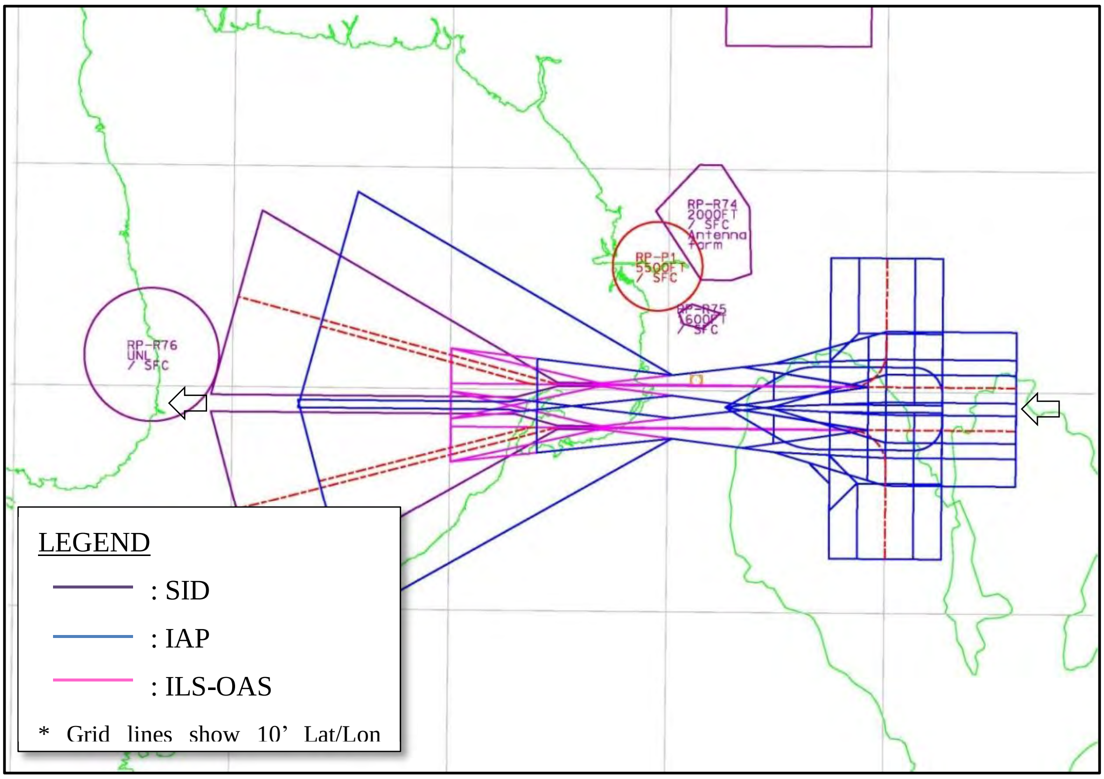


Figure 8.3.1-18 Protected Area Template of IFPs - South of Manila Bay (RWY27L/27R)

8.3.1.7 Feasibility of Independent Operation with existing NAIA

JICA Study Team assessed feasibility of independent runway operation between the new airport and existing NAIA. NAIA has primary runway 06/24 and secondary runway 13/31. RWY 13/31 does not meet relevant ICAO requirements in terms of the strip width, separation distance between runway and parallel taxiway centerlines for instrument runway. Operability of RWY 31 is very much limited as approach is allowed only during daytime under VMC.

Unless independent operations between NAIA RWY 06/24 and NMIA is achievable, NAIA is considered to be closed down for redevelopment and fund raising for NMIA development.

As the preliminary evaluation, JICA Survey Team assessed whether required lateral and vertical separations would exist between IFPs of the two airports. The protected area template of each prospective site and the ILS-OAS of existing NAIA, which would be the most essential flight procedure for aircraft operation, were used for the assessment. If the required separation did not exist, the ILS-OAS was altered so as to achieve the required separation. In case the required separation exists between the template and the ILS-OAS, a SID of existing NAIA was depicted for further evaluation.

The results of the preliminary evaluation showed that no prospective site would be feasible for the independent runway operation due to close distance between each prospective site and existing NAIA. A summary table of the assessment results appears in Table 8.3.1-12. Depicted drawings for the evaluations appear in Figures 8.3.1-19 through 8.3.1-28.

Table 8.3.1-14 Assessment Results of Independent Runway Operation

Site Name / Operation	Sangley Point Option 1	Sangley Point Option 2	Central Portion of Manila Bay	San Nicholas Shoals	Western side of Laguna de Bay
East Wind Operation	**Infeasible**	**Infeasible**	**Infeasible**	**Infeasible**	**Infeasible**
West Wind Operation	**Feasible**	**Infeasible**	**Infeasible**	**Feasible**	**Infeasible**
Overall Result	**Infeasible**	**Infeasible**	**Infeasible**	**Infeasible**	**Infeasible**

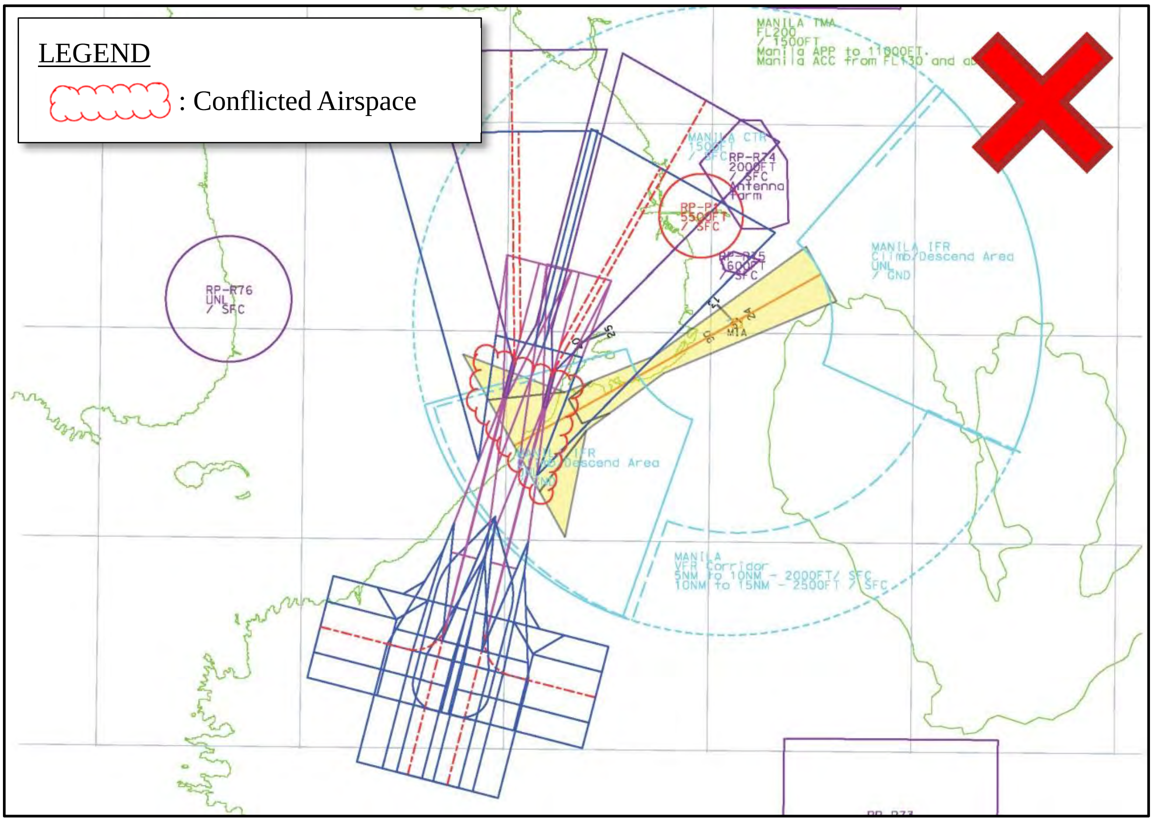


Figure 8.3.1-19 Protected Area Template of the Prospective Site and ILS-OAS of existing NAIA (Sangley Point Option 1, East Wind Condition)

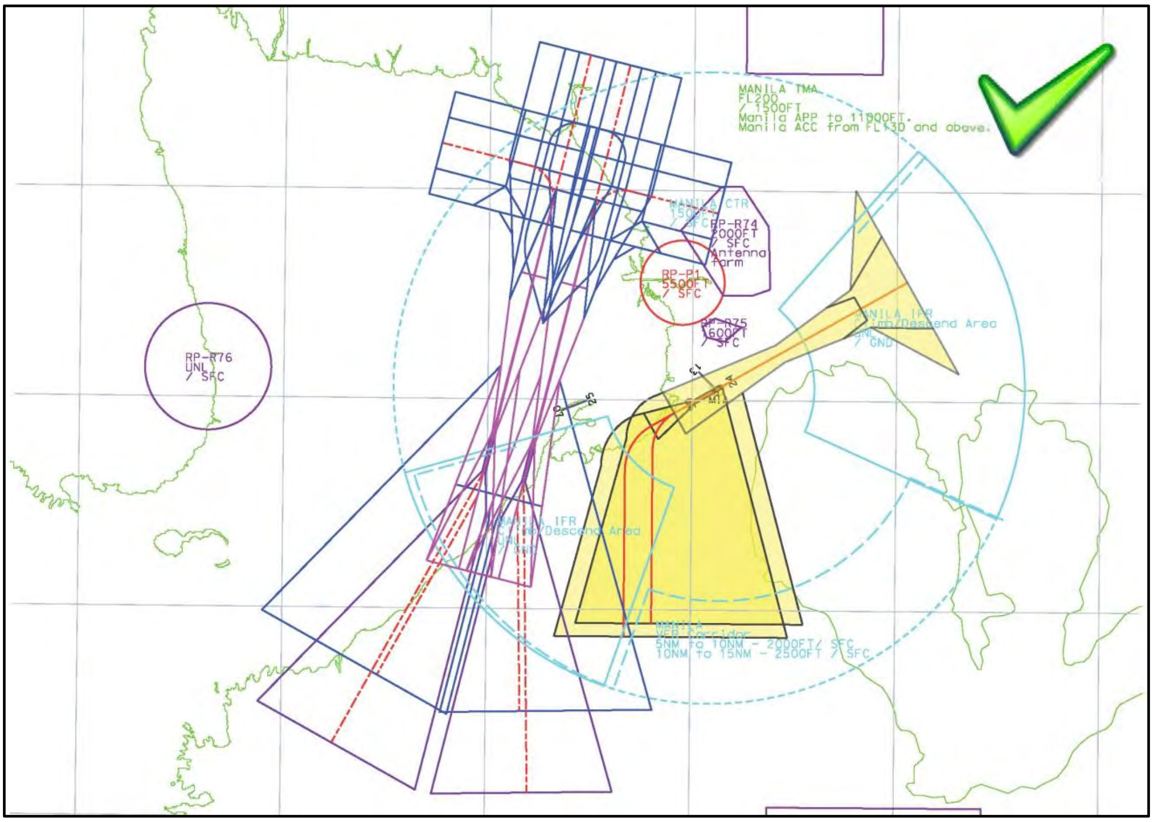


Figure 8.3.1-20 Protected Area Template of the Prospective Site and ILS-OAS of existing NAIA (Sangley Point Option 1, West Wind Condition)

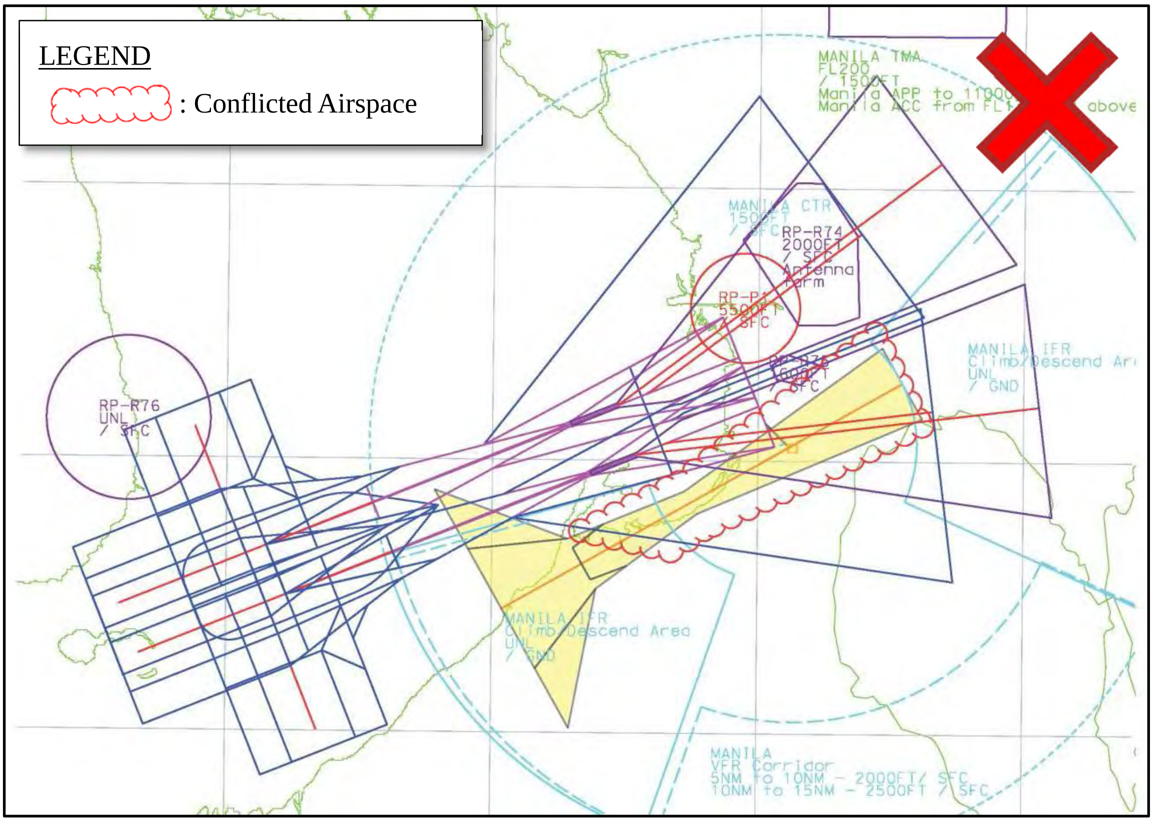


Figure 8.3.1-21 Protected Area Template of the Prospective Site and ILS-OAS of existing NAIA (Sangley Point Option 2, East Wind Condition)

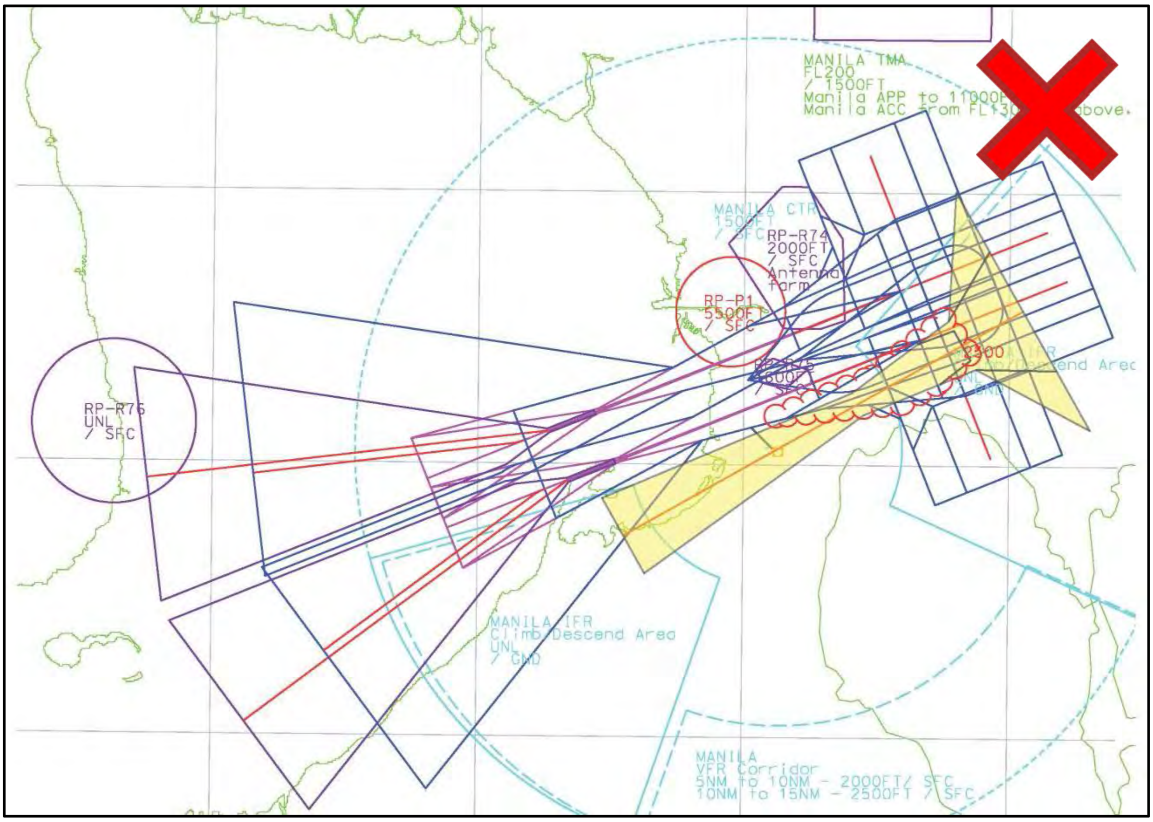


Figure 8.3.1-22 Protected Area Template of the Prospective Site and ILS-OAS of existing NAIA (Sangley Point Option 2, West Wind Condition)

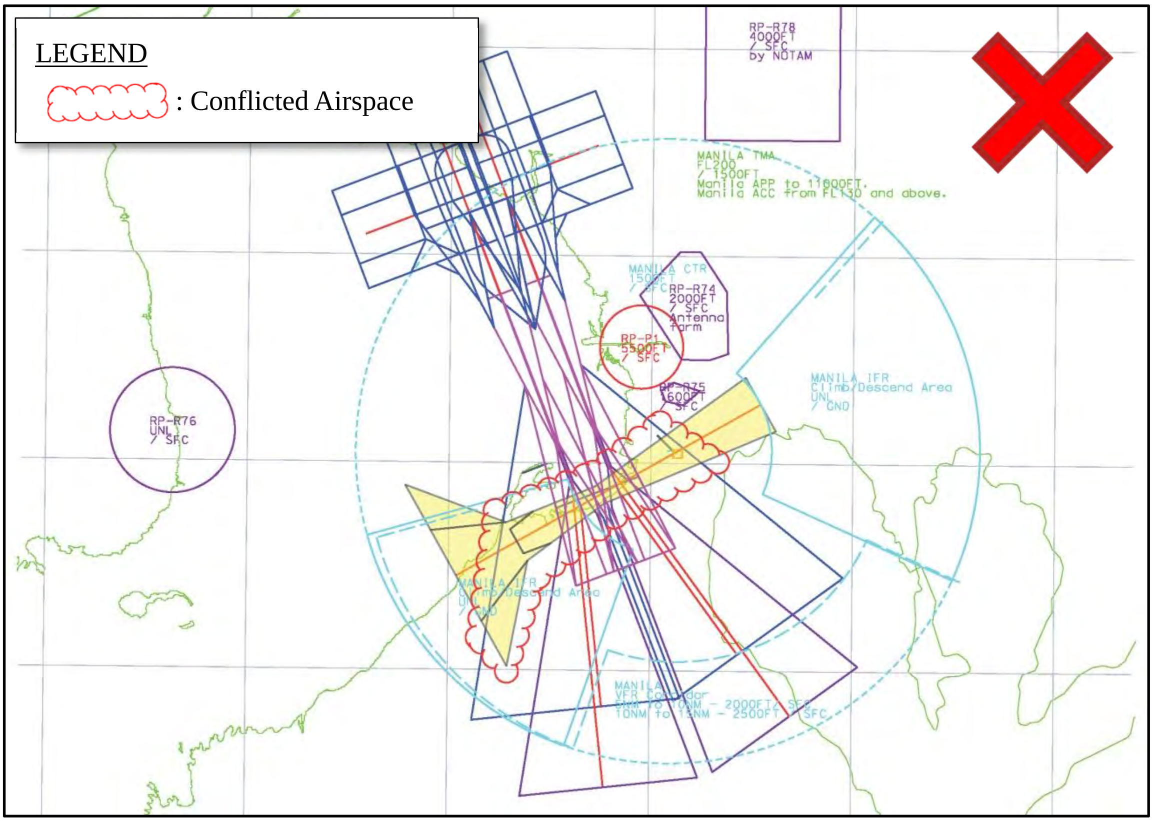


Figure 8.3.1-23 Protected Area Template of the Prospective Site and ILS-OAS of existing NAIA (Central Portion of Manila Bay, East Wind Condition)

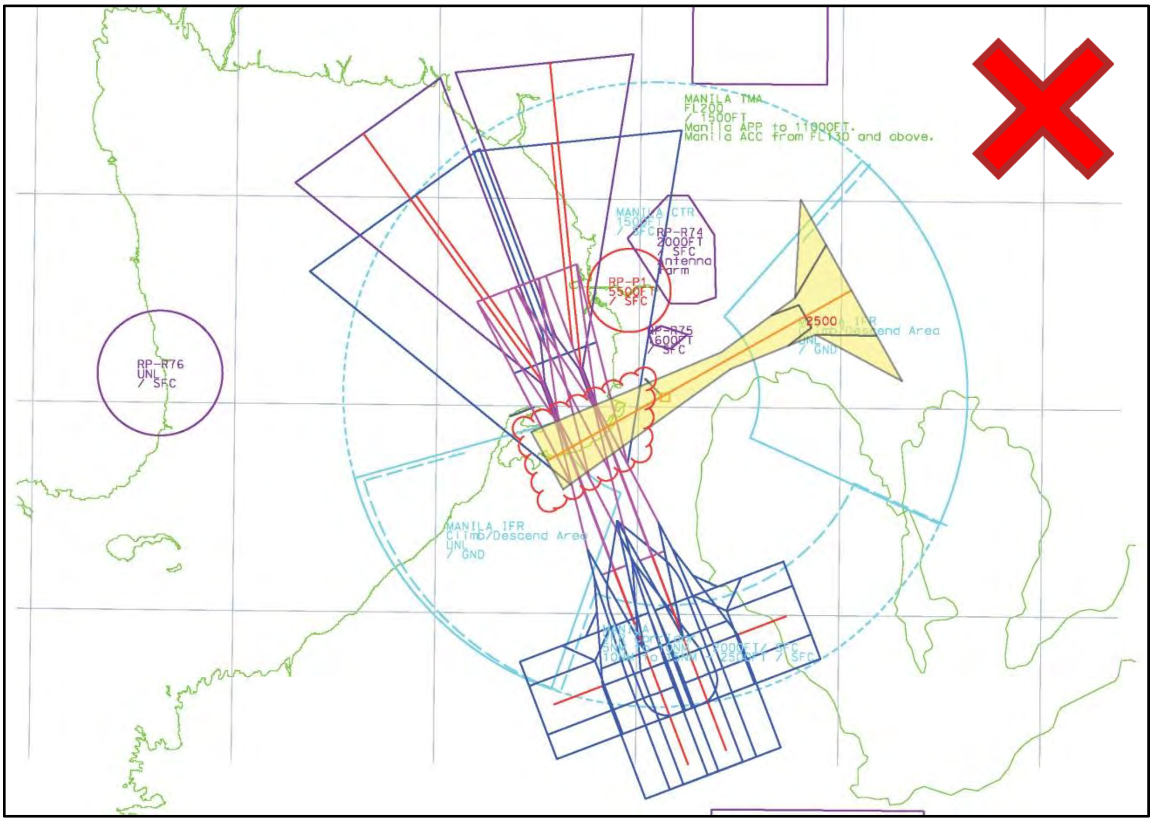


Figure 8.3.1-24 Protected Area Template of the Prospective Site and ILS-OAS of existing NAIA (Central Portion of Manila Bay, West Wind Condition)

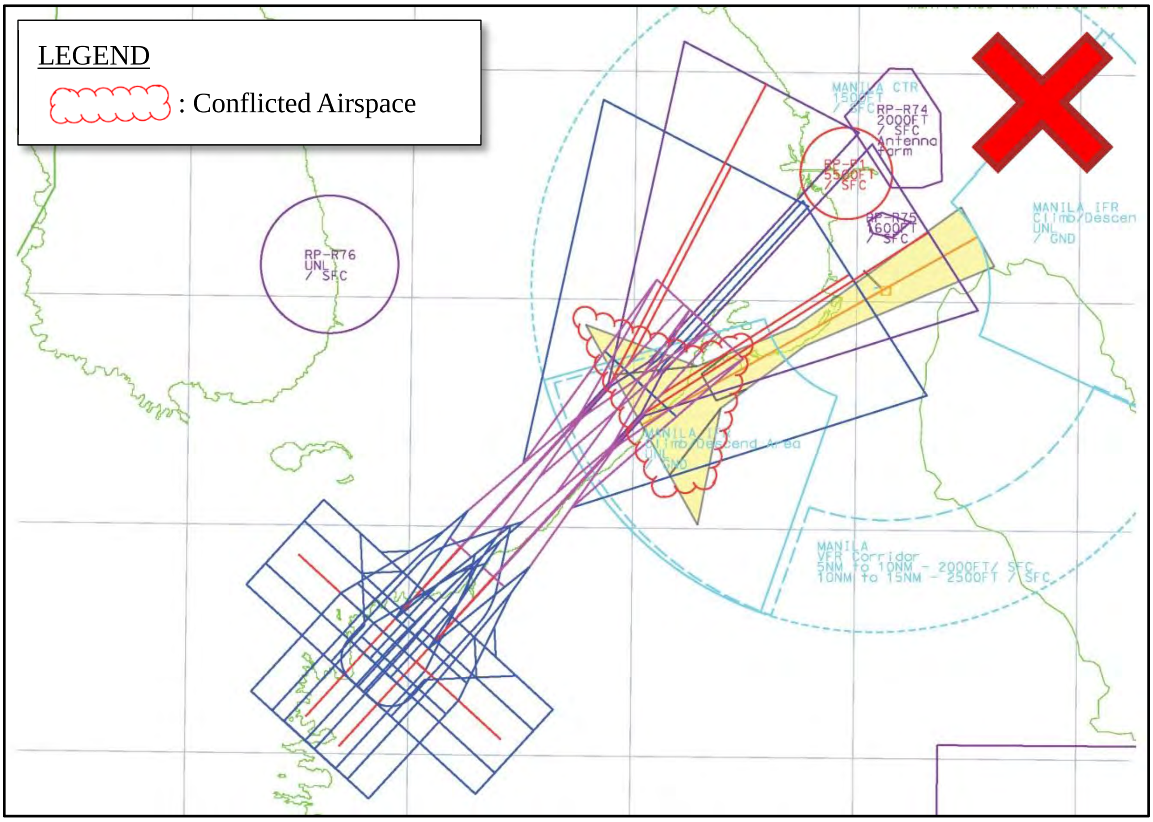


Figure 8.3.1-25 Protected Area Template of the Prospective Site and ILS-OAS of existing NAIA (San Nicholas Shoals, East Wind Condition)

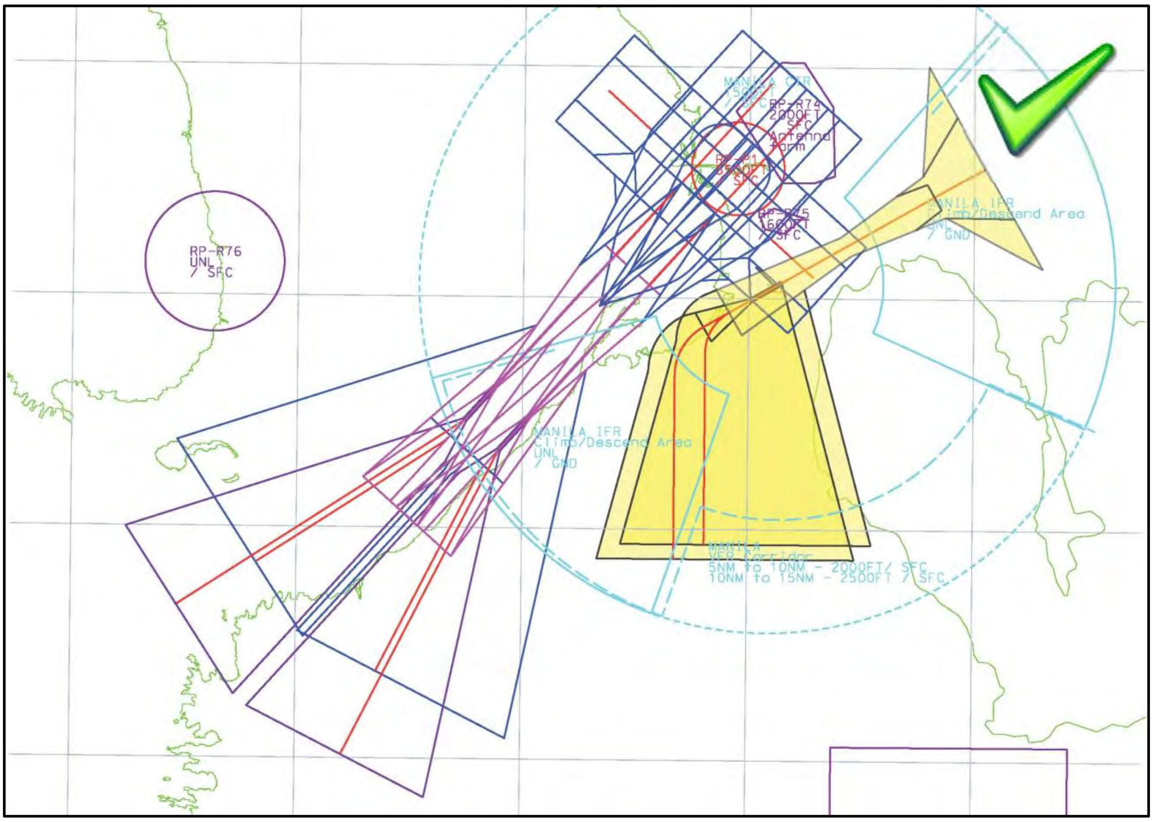


Figure 8.3.1-26 Protected Area Template of the Prospective Site and ILS-OAS of existing NAIA (San Nicholas Shoals, West Wind Condition)

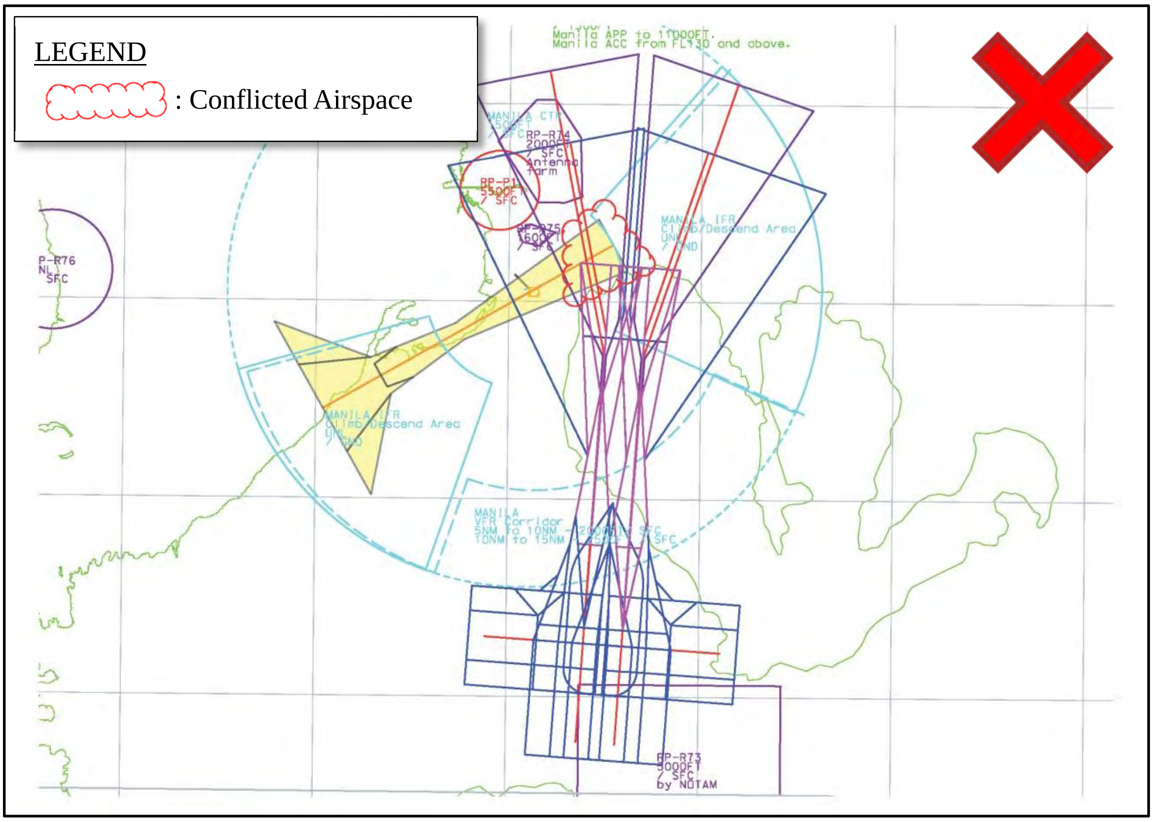


Figure 8.3.1-27 Protected Area Template of the Prospective Site and ILS-OAS of existing NAIA (Western side of Laguna de Bay, East Wind Condition)

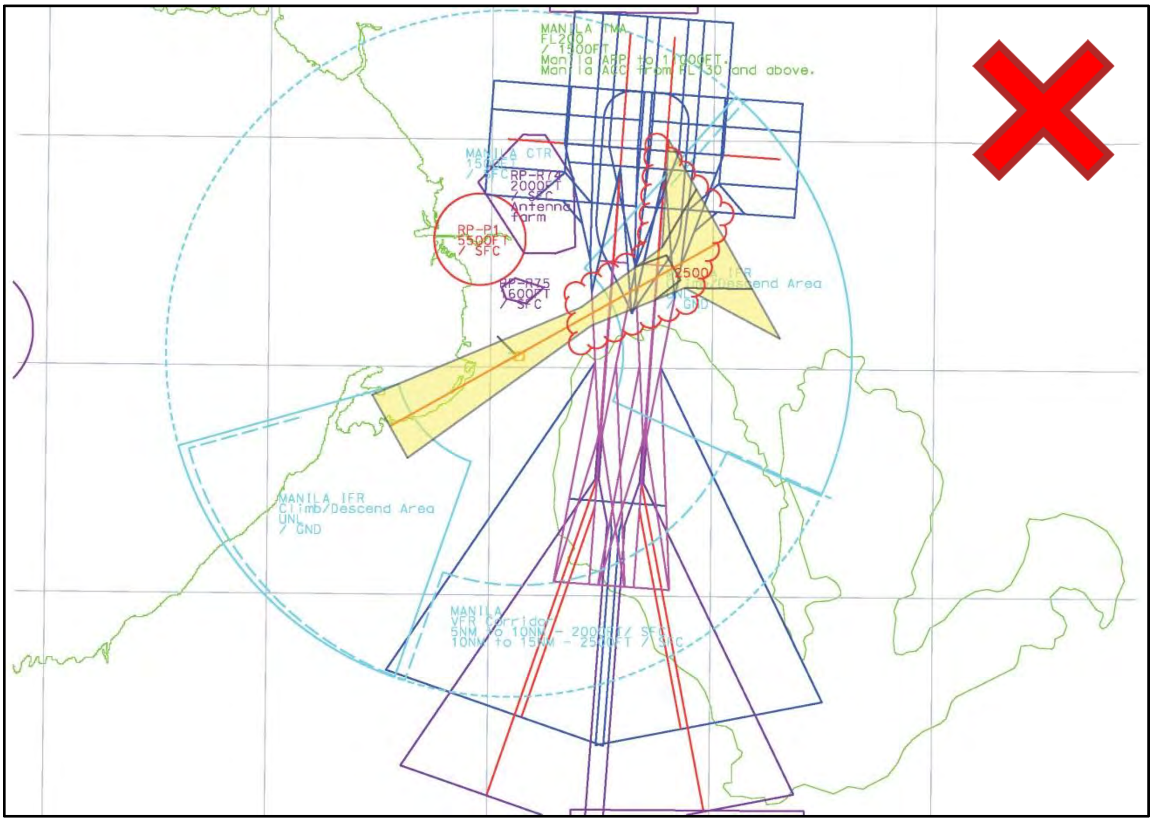


Figure 8.3.1-28 Protected Area Template of the Prospective Site and ILS-OAS of existing NAIA (Western side of Laguna de Bay, West Wind Condition)

8.3.2 Airspaces and Instrument Flight Procedures for Ultimate Phase Option 2: Three Open Parallel Runways

This section deals with an aeronautical feasibility study of the prospective sites for NMIA with three open parallel runways configuration (Ultimate Phase Option 2). It should be noted that the three open parallel runway configuration would enable independent operations of three runways requiring much wider obstacle free airspaces than the widely spaced two sets of close parallel runway configuration. As the possibility of independent operation of the two sets of close parallel runway configuration with the existing NAIA was not recognized as the result of the examination in Subsection 8.3.1.7, similar examination for the three-runway configuration was not conducted.

8.3.2.1 Methodology

The same methodology appeared in Section 8.2.5.2 or modified by the methodology in this Subsection was adopted to evaluate feasibility of IFPs on each prospective site.

1) Operating Requirements and Constraints

a) Simultaneous Operations on Three Independent Parallel Runways

It will be mandate requirement of simultaneous operations on three independent parallel runways in mixed mode (landing/departure) for each runway to accommodate anticipated air traffic volume of NMIA. Although the ICAO SOIR Manual (Doc 9643) describes certain standard procedures for operating parallel runways, the manual only covers two runway operations, not three runways. Meanwhile, simultaneous independent operation on three parallel runways is currently in place at some large airports in the Unite State. For examples;

1. CHICAGO-O'HARE INTL (ORD):
RWY09L/RWY09R/RWY10L or 10C and RWY27L/RWY27R/RWY28R or 28C

2. DENVER INTL (DEN):
RWY34L/RWY34R/RWY35R/RWY35L

3. GEORGE BUSH INTERCONTINENTAL/HOUSTON (IAH):
RWY08L/RWY08R/RWY09 and RWY26L/RWY26R/RWY27

4. ORLANDO INTL (MCO):
RWY17L/RWY17R/RWY18L or 18R and RWY35L/RWY35R/RWY36L or 36R

5. WASHINGTON DULLES INTL (IAD):
RWY19L/RWY19C/RWY19R and RWY01L/RWY01C/RWY01R

The air traffic control at those airports is being implemented in accordance with FAA ORDER 7110.65R. The Order lay down requirements for SOIR with three runways as below:

For independent parallel approaches:

i) Provide a minimum of 1,000ft vertical or a minimum of 3NM radar separation between aircraft during turn-on to parallel final approach.

ii) During triple parallel approaches, no two aircraft will be assigned the same altitude during turn-on. All three aircraft will be assigned altitudes which differ by a minimum of 1,000ft.
Example: 3,000/4,000/5,000; 7,000/8,000/9,000.

iii) Communications transfer to the tower controller's frequency shall be completed prior to losing vertical separation between aircraft.

iv) Triple parallel runway centerlines are at least 5,000ft apart and the airport field elevation is less than 1,000ft MSL.

v) A high-resolution color monitor with alert algorithms, such as the final monitor aid or that required in the PRM program shall be used to monitor approaches where triple parallel runway centerlines are at least 4,300ft but less than 5,000ft apart and the airport field elevation is less than 1,000ft MSL.

vi) An NTZ at least 2,000ft wide is established an equal distance between extended runway final approach courses and shall be depicted on the monitor display.

vii) Monitor all approaches regardless of weather. Monitor local control frequency to receive any aircraft transmission.

For Independent parallel departures:

i) Authorize simultaneous operations between an aircraft departing on a runway and an aircraft on final approach to another parallel runway if the departure course diverges immediately by at least 30 degrees from the missed approach course until separation is applied.

b) Procedure Layout

For feasibility evaluation purpose, the Survey Team developed protected area templates for each prospective site representing typical IFP layout for airport operation with the three open-parallel runways configuration. IAPs were designed on a standard "T" bar for each Initial Approach Fix (IAF) permitting arrivals from omni-directions. According to the PANS-OPS criteria, the Final Approach Point (FAP) should not normally be located more than 10.0NM before threshold unless adequate glide path guidance beyond the minimum specified in Annex 10 is provided. Thus the FAP altitude should be 1,500/2,500/3,500ft for each runway so that the FAP location is located within 10.0NM from threshold. The FAP altitude of 2,000/3,000/4,000ft were, however, adopted for this feasibility study based on operational preference for pilot/ATC and successful operational experiences in many airports in the world.

For SID design, a straight segment originated at each outer sides of DER was oriented on 30° offset from the extended runway centerline to fulfill the independent parallel departures requirement. A straight segment originated at middle of DER should be oriented with the extended runway centerline.

2) Required Airspace

Attention should be drawn to the fact that remarkable differences exist between two and three runways configurations in terms of airspace requirement. Suppose obstacles affecting to an IFP are located diagonally forward to the direction of departure runways. In case of two runways configuration, the departure route can be altered by straightened flight path, but not in case of three runways configuration (refer to figure below). The three runways configuration will require relatively larger obstacle free airspaces than those for two runways configuration.

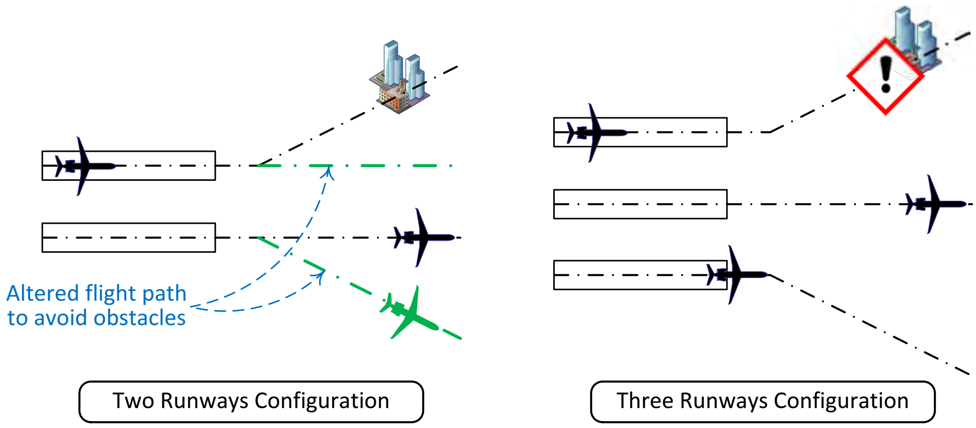


Figure 8.3.2-1 Differences between Two and Three Runway Configurations

8.3.2.2 Airspace/Air Traffic Feasibility

The same constraints and comparative criteria appeared in Section 8.2.5.3 were adopted to evaluate feasibility of IFPs on each prospective site.

8.3.2.3 Obstacle/Terrain Feasibility

The same constraints and comparative criteria appeared in Section 8.2.5.4 were adopted to evaluate feasibility of IFPs on each prospective site.

8.3.2.4 Assessment Result

Using both the comparative criteria and IFP protected areas, the Survey Team evaluated five prospective sites, i.e., Sangley Point Option 1, Sangley Option 2, Central Portion of Manila Bay, San Nicholas Shoals and Western Portion of Laguna de Bay, for development of NMIA from the perspective of airspace and obstacle restrictions.

The Survey Team came up with two potential prospective sites for NMIAs: Western Portion of Laguna de Bay and Sangley Point Option 1 in terms of the airspace and air traffic preference. The other three sites would require challenges to resolve conflicts with IFP routes, in particular RP-P1, i.e., to redesign existing airspaces and/or to remove existing limitations. The Survey Team also found out that no prospective sites would be fatally flawed because of physical obstacle constraints such as building structures.

The results of evaluation on each prospective site are outlined in the Table 8.3.2-1 below.
Depicted protected area templates of IFPs and criteria evaluation matrixes for each prospective site are shown in Figure 8.3.2-2 through 8.3.2-11 and Tables 8.3.2-2 through 8.3.2-6 respectively.

Table 8.3.2-1 Summary of Assessment Results for Six Prospective Sites (Ultimate Phase Option 2)

Sites Name	Brief Assessment Result Description
Western side of Laguna de Bay Less Challenging	This site location exhibits the most favorable assessment result to accommodate all IFPs in Manila TMA without major conflicts with the existing airspace. Although an existing restricted airspace will conflict with the IAPs from the south, the relevant authority seems optimistic about changing of this airspace.
Sangley Point Option 1	While this site location exhibits most favorable assessment result in terms of conflict with the existing airspaces, existence of an oil terminal facility near RWY02R threshold could be a potential hazard for neighboring area in case of aircraft crash into the terminal. Coordination with authorities concerned would be required. In addition, this site location will require removal of an antenna that penetrates the ILS-OAS. This issue could be resolved through further examination on the runway location.
San Nicholas Shoals	While this site will be a good distance from Metro Manila region, its northeast/southwest runway orientation will provide some challenges on modifying vertical limit of RP-P1. This site will also require careful IFP design to work out terrain penetrations.
Central Portion of Manila Bay	The airport has a good runway orientation and certain distance from adjacent TMAs that will help make flexible air traffic flows. This site, however, will require challenges to resolve conflict with two existing airspace including RP-P1 due to proximate location to Metro Manila region.
Sangley Point Option 2 More Challenging	This site will be the most challenging one due to neighboring location to Metro Manila. IAPs for this site will conflict with a prohibited airspace and two restricted airspace including RP-P1. Limited extent of airspace at the west side of the airport will be only available due to a restricted airspace and an adjacent TMA, and it will make air traffic flow inefficient.

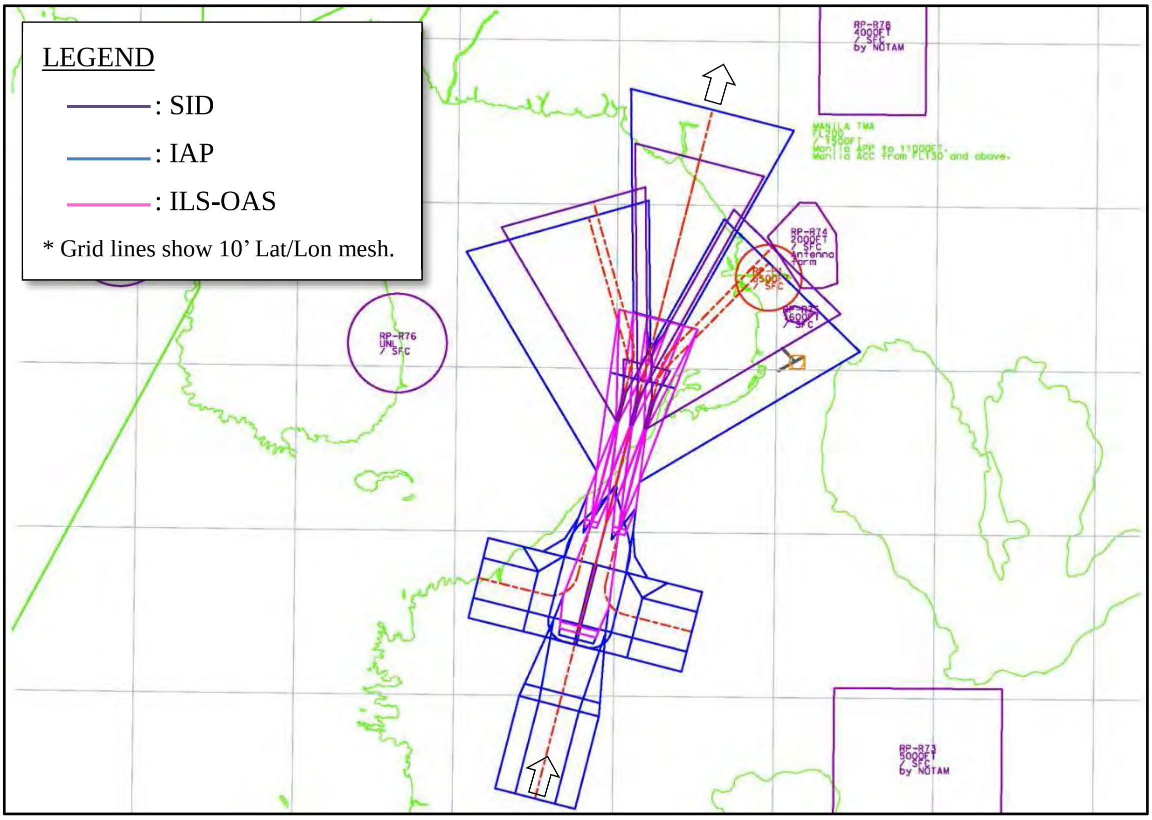


Figure 8.3.2-2 Protected Area Template of IFPs - Sangley Point Option 1 (RWY02)

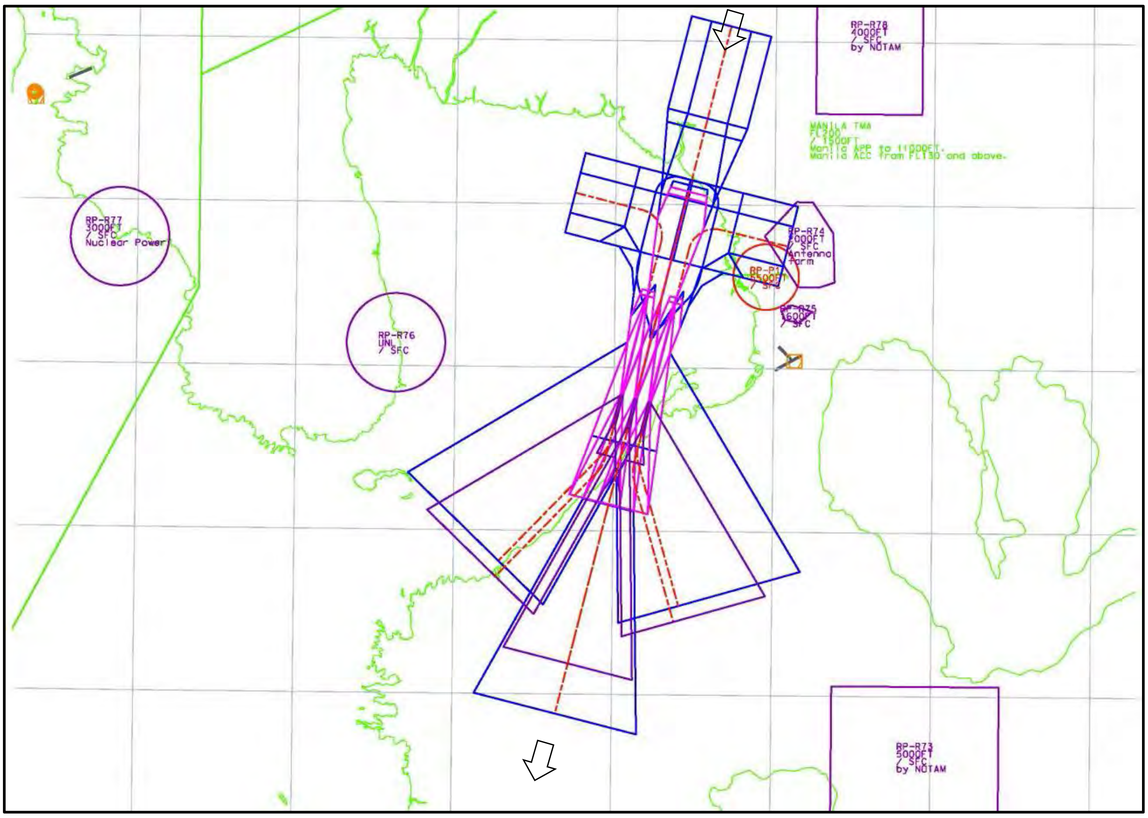


Figure 8.3.2-3 Protected Area Template of IFPs - Sangley Point Option 1 (RWY20)

Table 8.3.2-2 Criteria Evaluation Matrix – Sangley Point Option 1

Comparative Criteria		Operational Runway					
		RWY02L	RWY02C	RWY02R	RWY20L	RWY20C	RWY20R
A-1	Preservation of existing airspace	YES	YES	YES RP-P1, RP-R74 and RP-R75 conflict with SID & Missed APCH OASs, but can be preserved by altered (curved) flight track.	YES RP-P1 conflicts with Initial Approach Segment, but can be preserved by altered route.	YES	YES
A-2	Airspace availability for arrival routes	YES	YES	YES	YES	YES	YES
A-3	Airspace availability for holding stacks	YES	YES	YES	YES	YES	YES
O-1	ILS Approach Design	YES	YES	YES But as Petron's oil terminal exists just under the final approach track, coordination could be required with authorities concerned.	YES	YES	YES
O-2	Initial/ Intermediate Approach Design	YES	YES	YES	YES	YES	YES
O-3	Missed Approach Design	YES	YES	YES	YES	YES	YES
O-4	Departure Design	YES	YES	YES	YES But as Petron's oil terminal exists just under the departure track, coordination could be required with authorities concerned. More than 3.3% climb gradient is required due to an antenna.	YES	YES

Note
RP-P1: MALACANANG RP-P72: LIPA (Acrobatic operations by PAF)
RP-P73: Barbados (Skydiving, etc.) RP-R74: Antenna Farm
RP-R75: MAKATI (High structure) RP-R76: LIMAY (Oil Corporation)

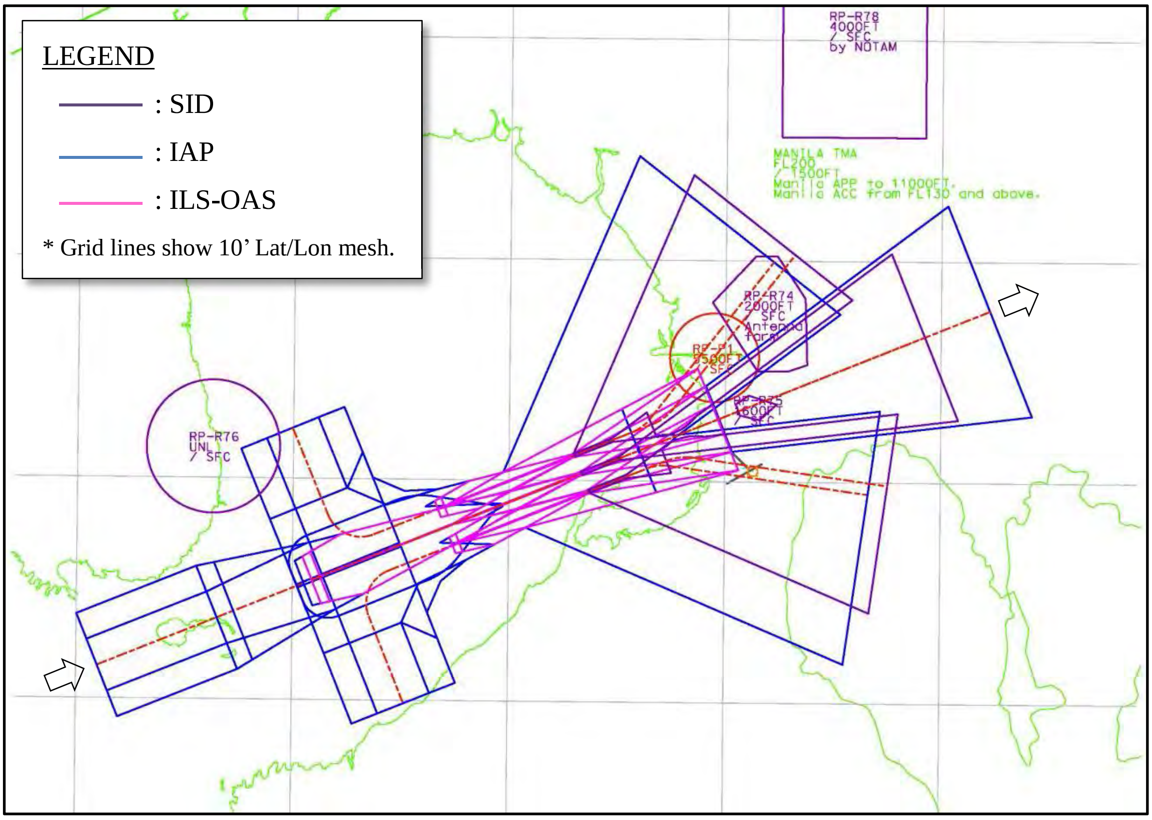


Figure 8.3.2-4 Protected Area Template of IFPs - Sangley Point Option 2 (RWY07)

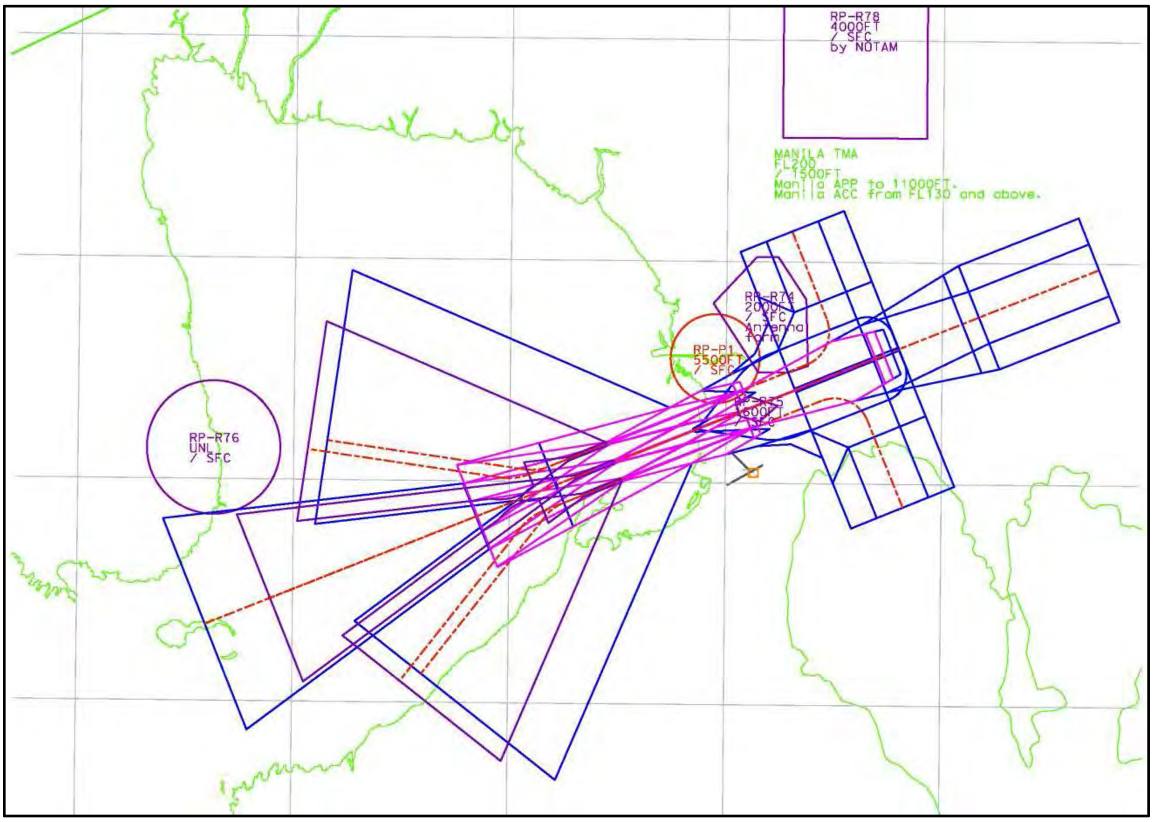


Figure 8.3.2-5 Protected Area Template of IFPs - Sangley Point Option 2 (RWY25)

Table 8.3.2-3 Criteria Evaluation Matrix – Sangley Point Option 2

Comparative Criteria		Operational Runway					
		RWY07L	RWY07C	RWY07R	RWY25L	RWY25C	RWY25R
A-1	Preservation of existing airspace	NO RP-P1 conflict with Missed APCH and SID OASs. RP-R74 conflict with SID OAS (More than 5% climb is required). Successful coordination could not be expected.	NO RP-P1 conflict with Missed APCH and SID OASs. RP-R74 and RP-R75 conflict with SID OAS (More than 5% climb is required). Successful coordination could not be expected.	YES	NO RP-R75 conflict with ILS-OAS. Successful coordination could not be expected.	NO RP-P1 and RP-R75 conflict with ILS-OAS. Successful coordination could not be expected.	NO RP-P1 and RP-R74 conflict with ILS-OAS. Successful coordination could not be expected. RP-R76 conflict with SID & Missed APCH OAS, but can be preserved by altered (curved) route.
A-2	Airspace availability for arrival routes	YES Arrival routes from the north should be detoured due to PR-R76.	YES	YES	YES	YES	YES
A-3	Airspace availability for holding stacks	NO Difficult to establish a holding procedure for air traffic from the north due to Subic Bay TMA and RP-R76.	YES	YES	YES	YES	YES
O-1	ILS Approach Design	YES	YES	YES	YES	YES	YES
O-2	Initial/ Intermediate Approach Design	YES	YES	YES	YES	YES	YES FAP Altitude should be 3000FT to avoid conflict between RP-R74 and Interm. Seg.
O-3	Missed Approach Design	YES More than 2.5% climb gradient is required due to two high-rise buildings.	YES	YES	YES	YES	YES
O-4	Departure Design	YES More than 3.3% climb gradient is required due to four high-rise buildings.	YES	YES More than 3.3% climb gradient is required due to a high-rise buildings. No turn before MAPt is also required.	YES	YES	YES

Note
RP-P1: MALACANANG RP-P72: LIPA (Acrobatic operations by PAF)
RP-P73: Barbados (Skydiving, etc.) RP-R74: Antenna Farm
RP-R75: MAKATI (High structure) RP-R76: LIMAY (Oil Corporation)

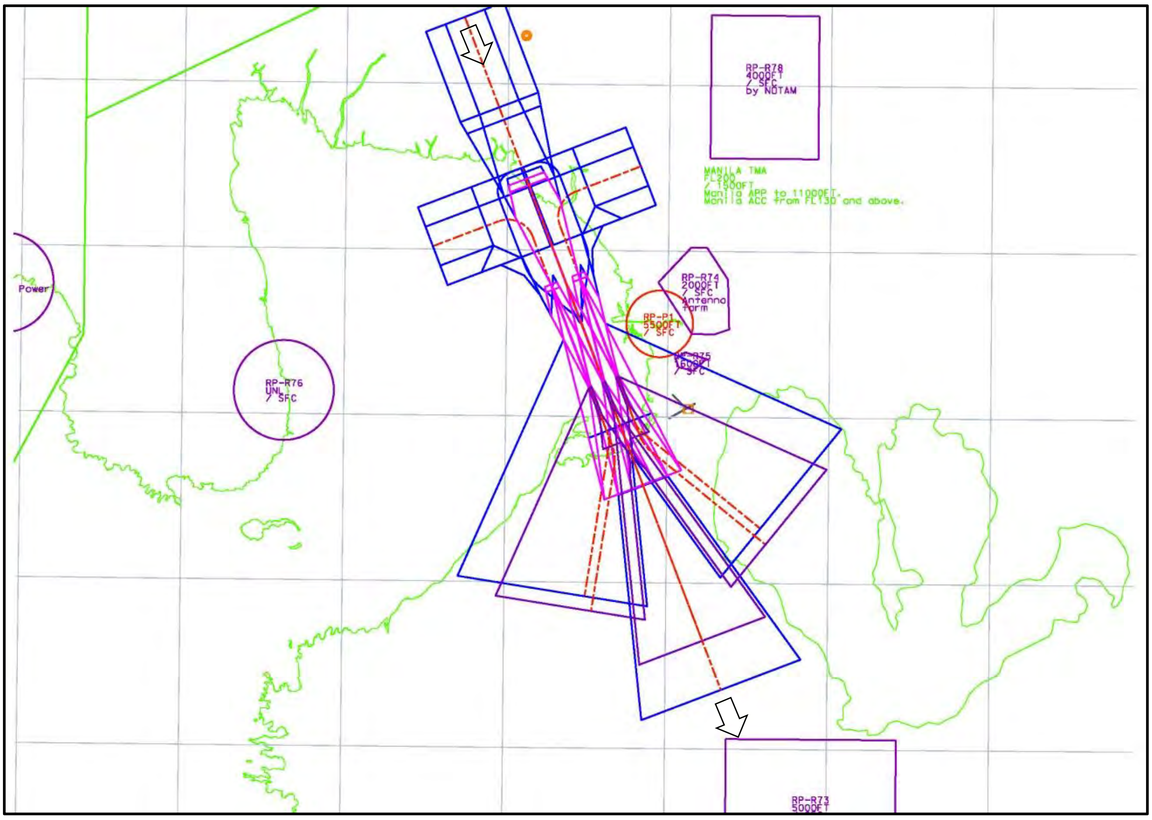


Figure 8.3.2-6 Protected Area Template of IFPs – Central Portion of Manila Bay (RWY16)

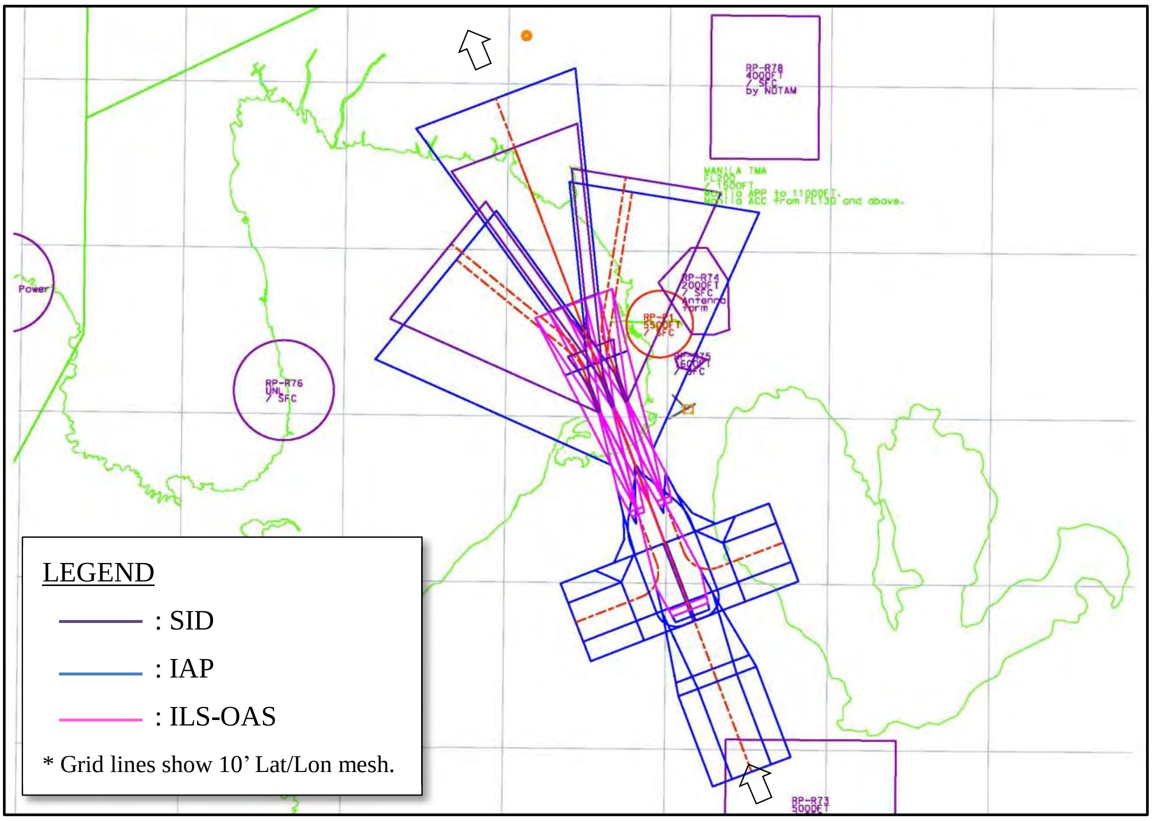


Figure 8.3.2-7 Protected Area Template of IFPs – Central Portion of Manila Bay (RWY34)

Table 8.2.3-4 Criteria Evaluation Matrix – Central Portion of Manila Bay

Comparative Criteria		Operational Runway					
		RWY16L	RWY16C	RWY16R	RWY34L	RWY34C	RWY34R
A-1	Preservation of existing airspace	YES RP-P1 and RP-R75 conflict with Missed APCH OASs, but can be preserved by specifying "No turn before THR".	YES	YES	YES	YES	NO RP-P1 conflict with SID and Missed APCH OASs. RP-R74 conflict with Missed APCH OAS. Successful coordination could not be expected.
A-2	Airspace availability for arrival routes	YES	YES Arrival routes overflying Clark TMA should be detoured to maintain moderate descent gradient.	YES	YES	YES	YES
A-3	Airspace availability for holding stacks	YES	YES	YES Holding location may be limited due to PR-R76.	YES	YES Holding location may be limited due to PR-R72.	YES
O-1	ILS Approach Design	YES	YES	YES	YES	YES	YES
O-2	Initial/ Intermediate Approach Design	YES	YES	YES	YES	YES	YES
O-3	Missed Approach Design	YES "No turn before THR" is required to avoid three buildings beside the ILS-OAS.	YES	YES	YES	YES	YES 5% climb gradient is required due to three high-rise buildings. "No turn before MAPt" is also required.
O-4	Departure Design	YES "No turn before DER" is required to avoid two buildings beside the turn initiation area. More than 3.3% climb gradient is required due to elec. power line towers.	YES	YES	YES	YES	YES "No turn before DER" is required to avoid a building beside the turn initiation area.

Note
RP-P1: MALACANANG RP-P72: LIPA (Acrobatic operations by PAF)
RP-P73: Barbados (Skydiving, etc.) RP-R74: Antenna Farm
RP-R75: MAKATI (High structure) RP-R76: LIMAY (Oil Corporation)

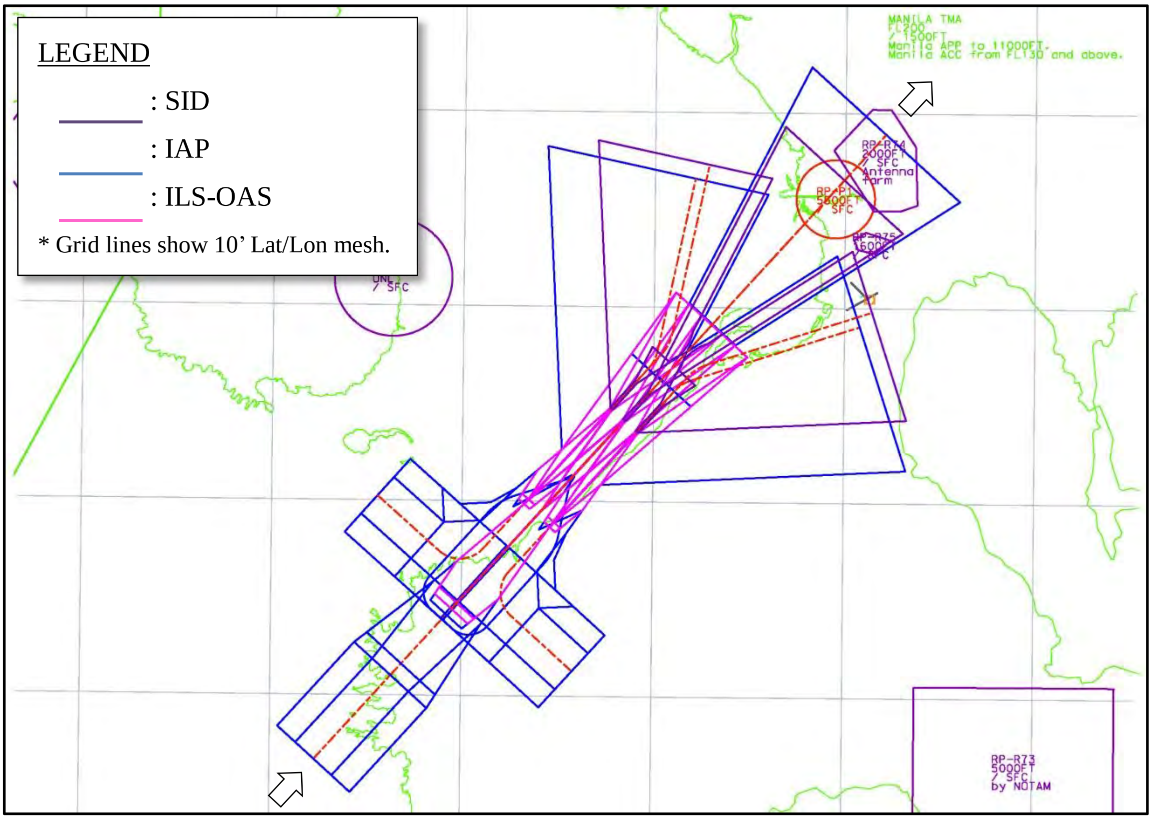


Figure 8.3.2-8 Protected Area Template of IFPs - San Nicholas Shoals (RWY04)

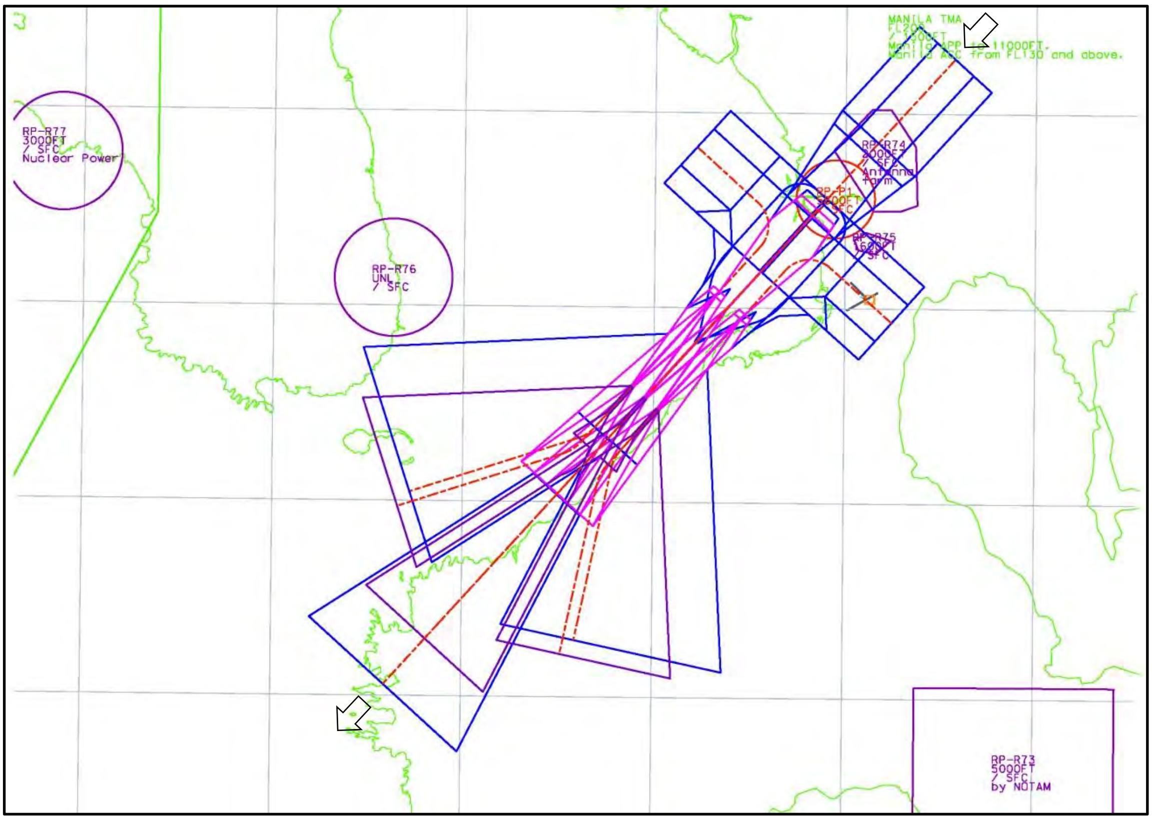


Figure 8.3.2-9 Protected Area Template of IFPs - San Nicholas Shoals (RWY22)

Table 8.3.2-5 Criteria Evaluation Matrix – San Nicholas Shoals

Comparative Criteria		Operational Runway					
		RWY04L	RWY04C	RWY04R	RWY22L	RWY22C	RWY22R
A-1	Preservation of existing airspace	YES	NO RP-P1 conflict with SID & Missed APCH OASs. Successful coordination could not be expected.	YES	NO IAP overflying RP-P1 require more than 5.2% descent gradient. Successful coordination could not be expected.	NO RP-P1 conflict with ILS OAS. APCH overflying RP-P1 require more than 5.2% descent gradient. Successful coordination could not be expected.	NO IAP overflying RP-P1 require more than 5.2% descent gradient. Successful coordination could not be expected.
A-2	Airspace availability for arrival routes	YES	YES	YES	YES	YES	YES
A-3	Airspace availability for holding stacks	YES	YES	YES	YES	YES	YES
O-1	ILS Approach Design	YES	YES	YES	YES	YES	YES
O-2	Initial/ Intermediate Approach Design	YES A step down fix on Intermediate Segment is required due to terrain.	YES	YES A step down fix on Intermediate Segment is required due to terrain.	YES	YES	YES
O-3	Missed Approach Design	YES	YES	YES	YES	YES	YES
O-4	Departure Design	YES	YES	NO More than 5% climb gradient is required due to an antenna.	YES	YES More than 3.3% climb gradient is required due to terrain.	YES

Note
RP-P1: MALACANANG RP-P72: LIPA (Acrobatic operations by PAF)
RP-P73: Barbados (Skydiving, etc.) RP-R74: Antenna Farm
RP-R75: MAKATI (High structure) RP-R76: LIMAY (Oil Corporation)

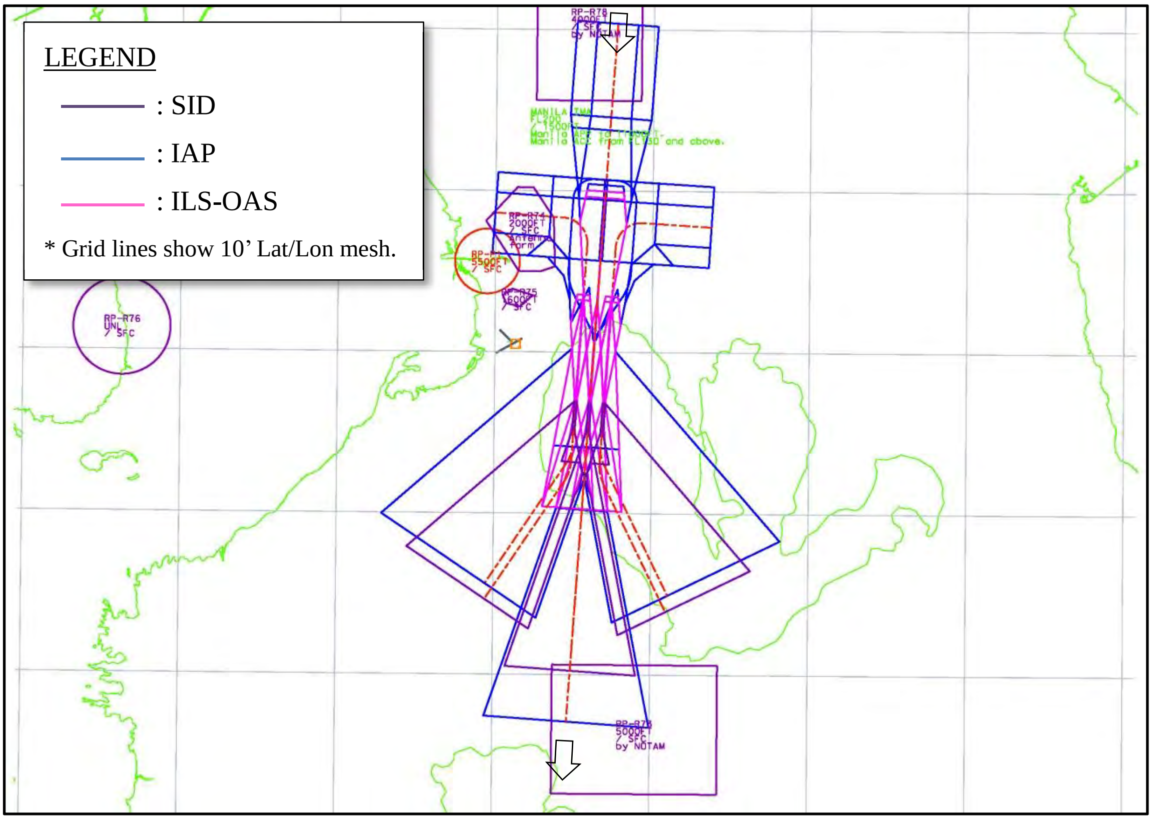


Figure 8.3.2-10 Protected Area Template of IFPs – Western Portion of Laguna de Bay (RWY18)

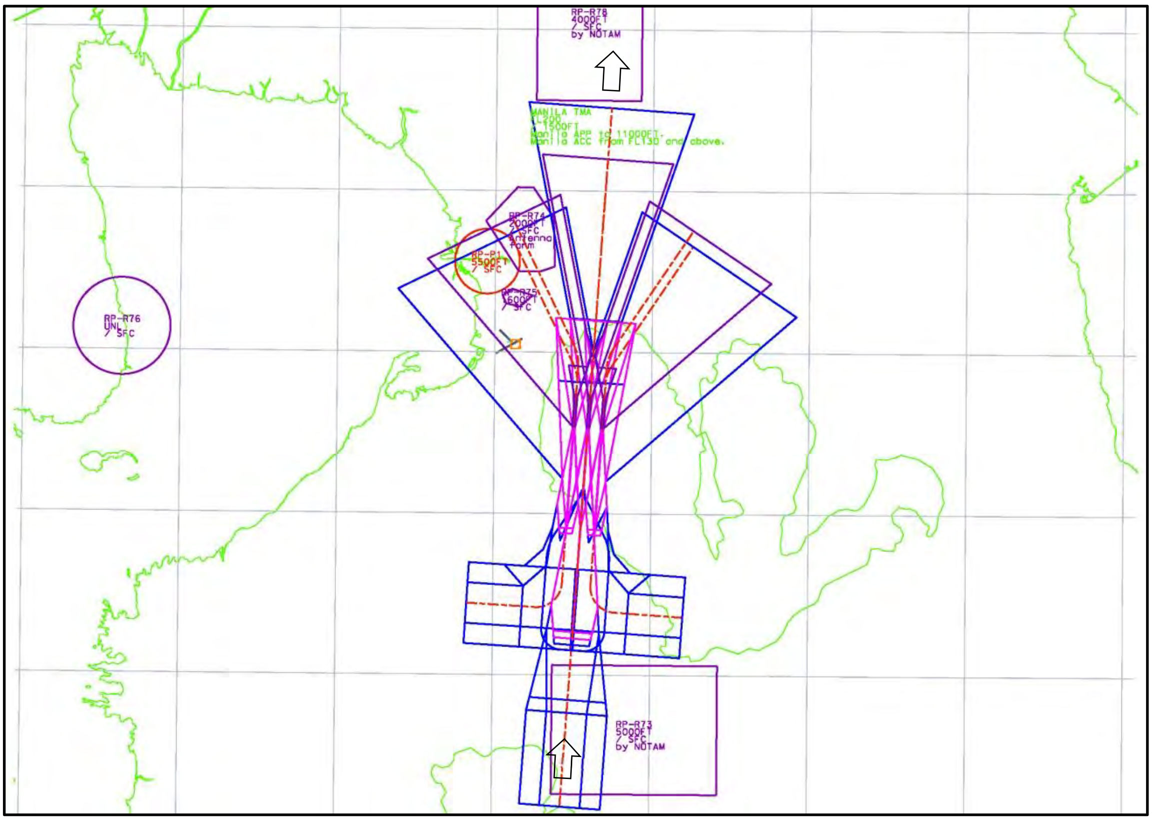


Figure 8.3.2-11 Protected Area Template of IFPs – Western Portion of Laguna de Bay (RWY36)

Table 8.3.2-6 Criteria Evaluation Matrix – Western Portion of Laguna de Bay

Comparative Criteria		Operational Runway					
		RWY18L	RWY18C	RWY18R	RWY36L	RWY36C	RWY36R
A-1	Preservation of existing airspace	YES RP-R73 conflict with SID OAS, but can be preserved by altered (curved) route.	YES RP-R73 conflict with SID OAS, but can be preserved by altered (curved) route.	YES	YES IAP overflying RP-R73 require more than 5.2% descent gradient, however successful coordination to remove/relax the height limitation could be expected. SID & Missed APCH OASs conflict with RP-P1, but can be preserved by altered (straightened) route. SID required more than 3.3% climb gradient to overfly RP-R74 & RP-R75. SID & Missed APCH OASs conflict with RP-P1, RP-R74 & RP-R75 but can be preserved by altered (curved) route. SID require more than 3.3% climb	YES IAP overflying RP-R73 require more than 5.2% descent gradient, however successful coordination to remove/relax the height limitation could be expected. SID & Missed APCH OASs conflict with RP-P1, but can be preserved by altered (straightened) route. SID required more than 3.3% climb gradient to overfly RP-R74 & RP-R75. Missed APCH require more than 2.5% climb gradient due to RP-R74.	YES
A-2	Airspace availability for arrival routes	YES	YES	YES	YES	YES Arrival routes from the south should be detoured due to PR-R72.	YES
A-3	Airspace availability for holding stacks	YES	YES	YES	YES	YES Holding location may be limited due to RP-R72.	YES Holding location may be limited due to RP-R73.
O-1	ILS Approach Design	YES	YES	YES	YES	YES	YES
O-2	Initial/ Intermediate Approach Design	YES	YES	YES	YES	YES	YES
O-3	Missed Approach Design	YES	YES	YES More than 2.5% climb gradient is required due to two chimneys.	YES More than 2.5% climb gradient is required due to two chimneys.	YES	YES
O-4	Departure Design	YES	YES	YES	YES More than 3.3% climb gradient is required due to a high-rise building.	YES	YES

Note
RP-P1: MALACANANG
RP-P72: LIPA (Acrobatic operations by PAF)
RP-P73: Barbados (Skydiving, etc.)
RP-R74: Antenna Farm
RP-R75: MAKATI (High structure)
RP-R76: LIMAY (Oil Corporation)

8.3.2.5 Interference with Prohibited/Restricted Airspaces

1) Changes of Vertical Limit

The Survey Team found that four prospective sites would require resolving conflicts between protected airspace of IFP routes and existing prohibited/restricted airspace more and less. Table 8.3.2-7 summarized amount of penetration to the airspace and new upper limit of the airspace required to resolve conflict for each prospective site. The amount of each airspace penetration has been calculated based on the IFPs with acceptable maximum climb/descent gradient. We see from the table that new upper limit of existing prohibited airspace RP-P1 for Sangley 2 and Manila Bay will be quite low and impracticable.

Table 8.3.2-7 Summary of Prohibited/Restricted Airspace Penetration
Ultimate Phase Option 2: Three Open Parallel Runways

Site Name	Procedure Name	RP-P1		RP-R74		RP-R75		RP-R73	
		Penet. (FT)	New Upper Limit (FT)	Penet. (FT)	New Upper Limit (FT)	Penet. (FT)	New Upper Limit (FT)	Penet. (FT)	New Upper Limit (FT)
1. Sangley Point Option 1		0	-	0	-	0	-	0	-
2. Sangley Point Option 2		4600	900	300	1700	500	1100	0	-
	SID RWY07L	4600	900	100	1900	0	-	0	-
	SID RWY07C	4400	1100	200	1800	100	1500	0	-
	IAP RWY25L	0	-	0	-	100	1500	0	-
	IAP RWY25C	3900	1600	0	-	500	1100	0	-
	IAP RWY25R	4500	1000	300	1700	0	-	0	-
3. Central Portion of Manila Bay		5100	400	100	1900	0	-	0	-
	SID RWY34R	5100	400	0	-	0	-	0	-
	IAP RWY34R	4800	700	100	1900	0	-	0	-
4. San Nicholas Shoals		3100	2400	0	-	0	-	0	-
	SID RWY04C	2500	3000	0	-	0	-	0	-
	IAP RWY22L/R	2900	2600	0	-	0	-	0	-
	IAP RWY22C	3100	2400	0	-	0	-	0	-
5. Western Portion of Laguna de Bay		0	-	0	-	0	-	1900	3100
	IAP RWY36L	0	-	0	-	0	-	1900	3100
	IAP RWY36C	0	-	0	-	0	-	600	4400

Note. Alternative Sangley Point Option 1 site would not involve penetration of IFP to any of the prohibited/restricted airspaces.

2) Changes of Lateral Limit

There will be possibility to change the airspace boundary laterally when overlapped area between the protected area of IFP routes and the RP-P1 is relatively small. Although the Survey Team have applied various alternatives of IFP design (such as limitation of early turn or increase of climb gradient) to minimize the overlapped area, the required protection area remained overlapping with the RP-P1 entirely. Figure 8.3.2-12 shows overlapped area of one of the prospective sites: Central

Portion of Manila Bay, which will have the smallest overlapped area with RP-P1 among three prospective sites. The Survey Team concluded that there would be no way in modifying the lateral limit of RP-P1.

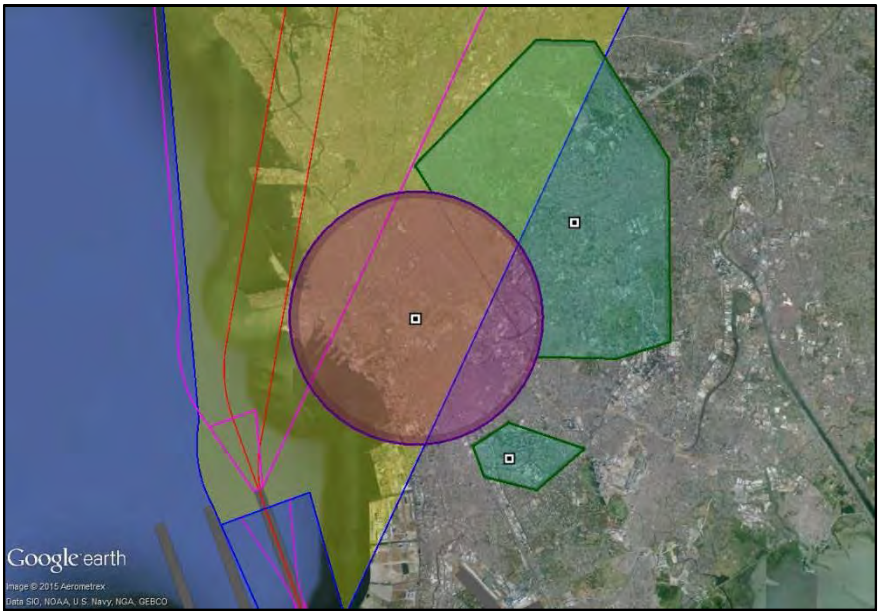


Figure 8.3.2-12 Overlap between IAP Protection Area (Central Portion of Manila Bay) and RP-P1

8.3.3 Usability Factors

As mentioned in section 6.2.7, wind rose analysis data at NAIA, Sangley Point and Port Area of Manila are available and are shown in Tables 6.2-2 through 6.2-4 as well as Figures 6.2-9 through 6.2-11. Based on the data and orientation of the runway of five prospective sites, wind coverages in case of 10 knots (5.27 m/s) crosswind component have been examined and results are shown in Table 8.3.3-1 and Figures 8.3.3-1 through 8.3.3-8. The crosswind component of 10 knots (19 km/h or 5.27 m/s) is applicable to any aircraft whose reference field length is less than 1200 m

In case of the Wester Portion Laguna de Bay for which the weather data at NAIA was used, the estimated usability factor was 93.89%; a little bit less than 95%. Usability factors of more than 95% have been obtained for all of the other cases.

Table 8.3.3-1 Estimated Usability Factors (Crosswind Component of 10 knots)

Wind Data	Sangley Option 1	Sangley Option 1	Central Manila Bay	San Nicholas Shoals	Western Laguna
NAIA	-	-	95.16%	-	93.89%
Port Area	-	-	-	-	98.24%
Sangley	96.13%	98.92%	98.27%	96.92%	96.43%

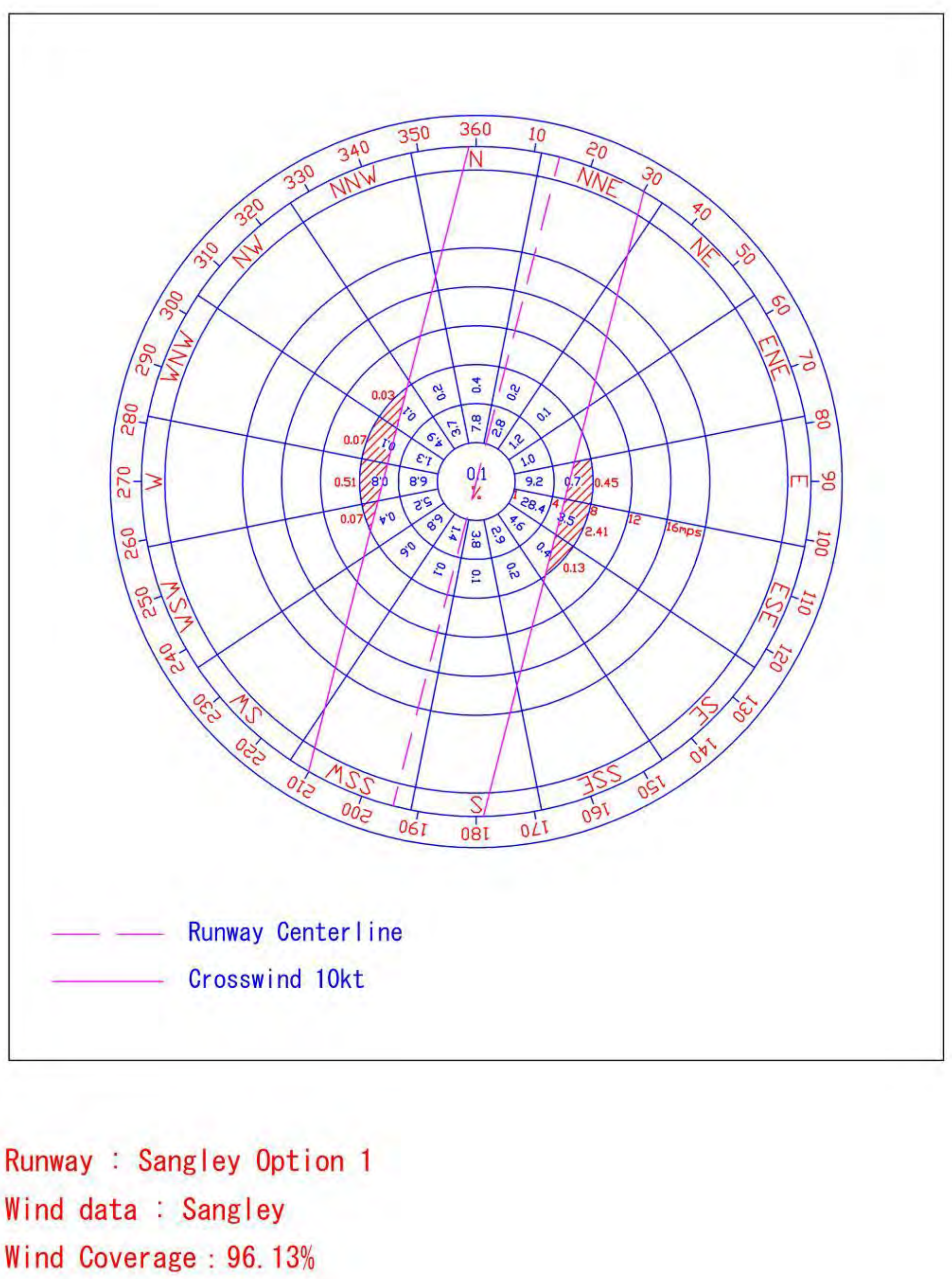
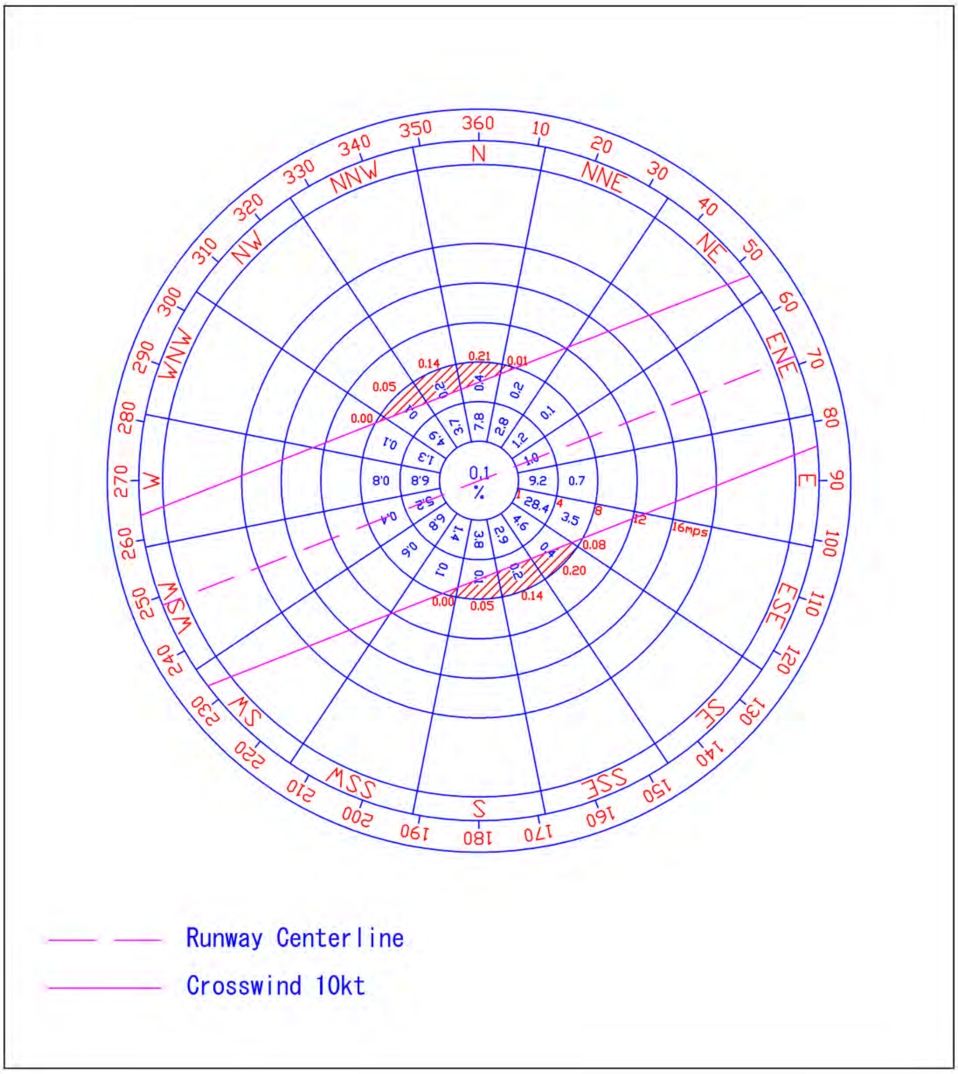


Figure 8.3.3-1 Wind coverage of Sangley Option 1 for the wind data of Sangley

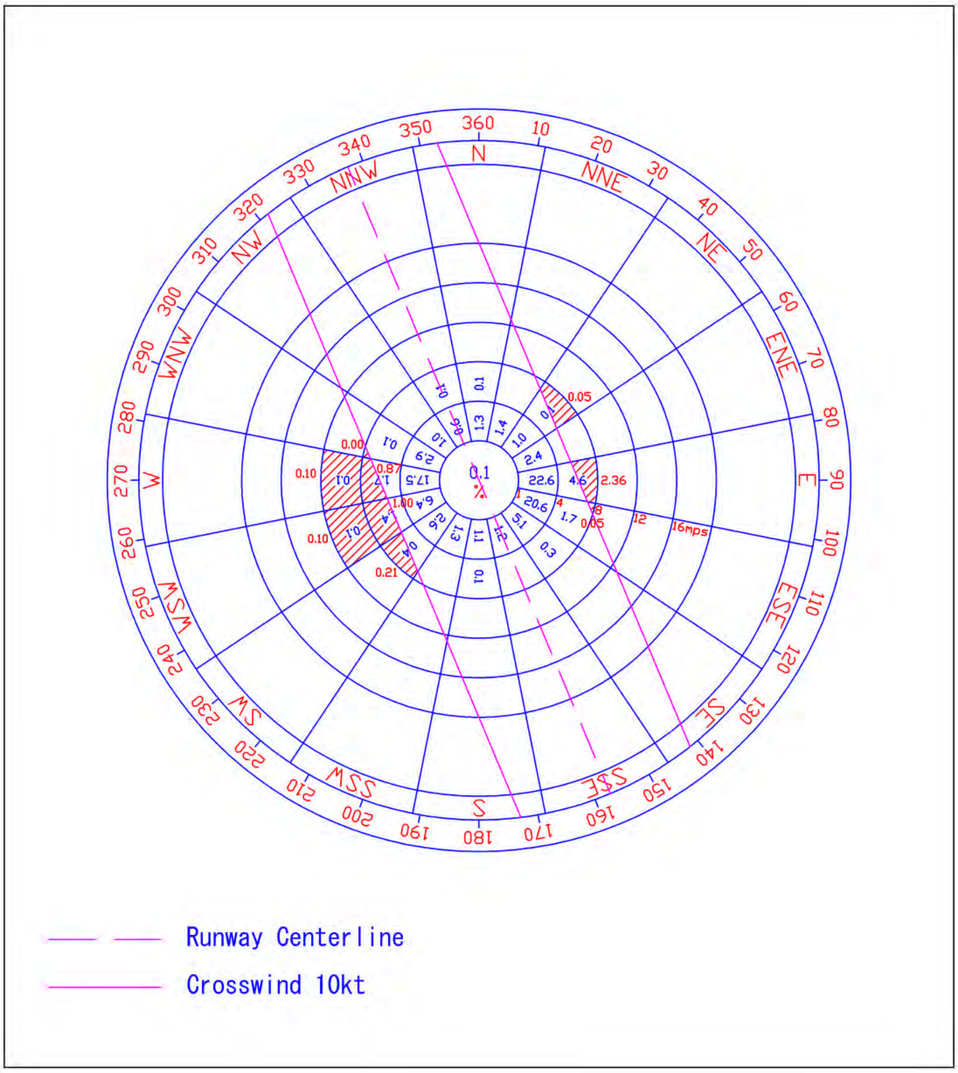


Runway : Sangley Option 2

Wind data : Sangley

Wind Coverage : 98.92%

Figure 8.3.3-2 Wind coverage of Sangley Option 2 for the wind data of Sangley

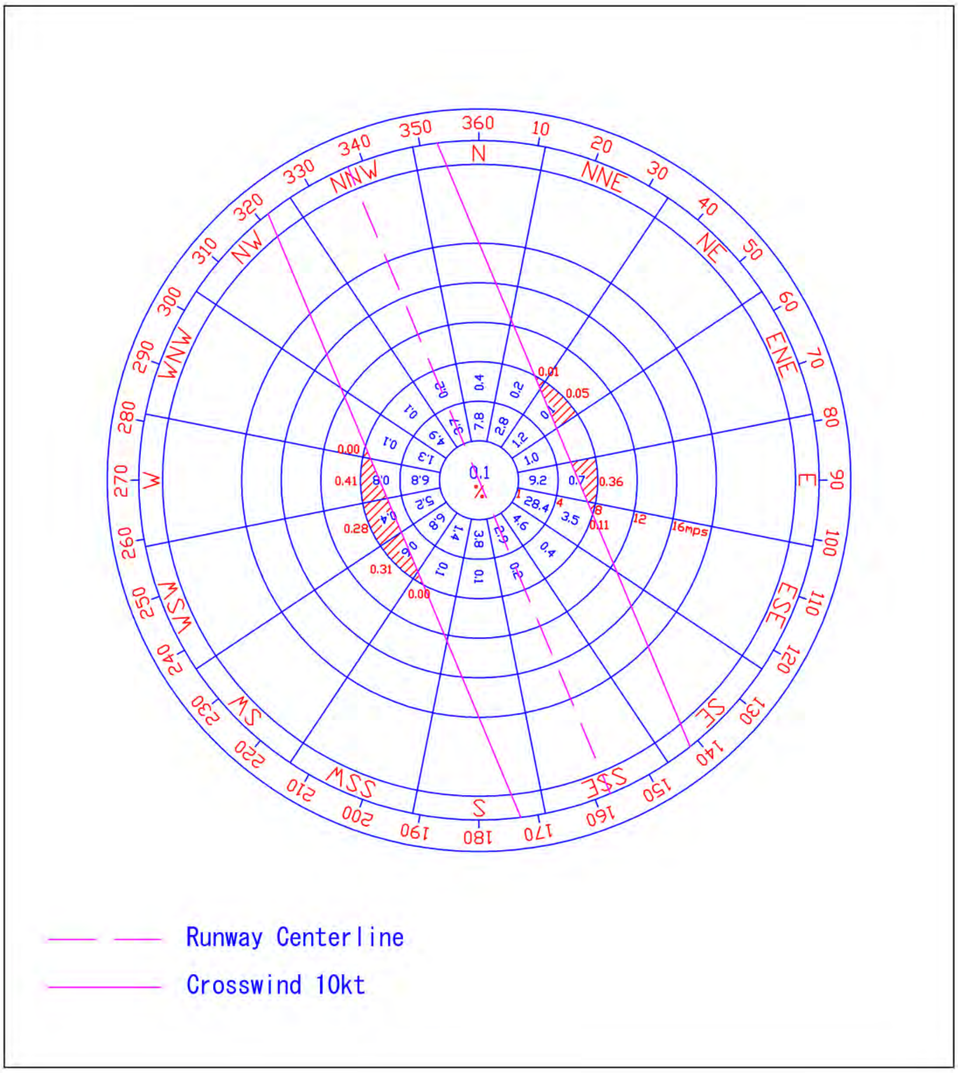


Runway : Manila Bay Center

Wind data : NAIA

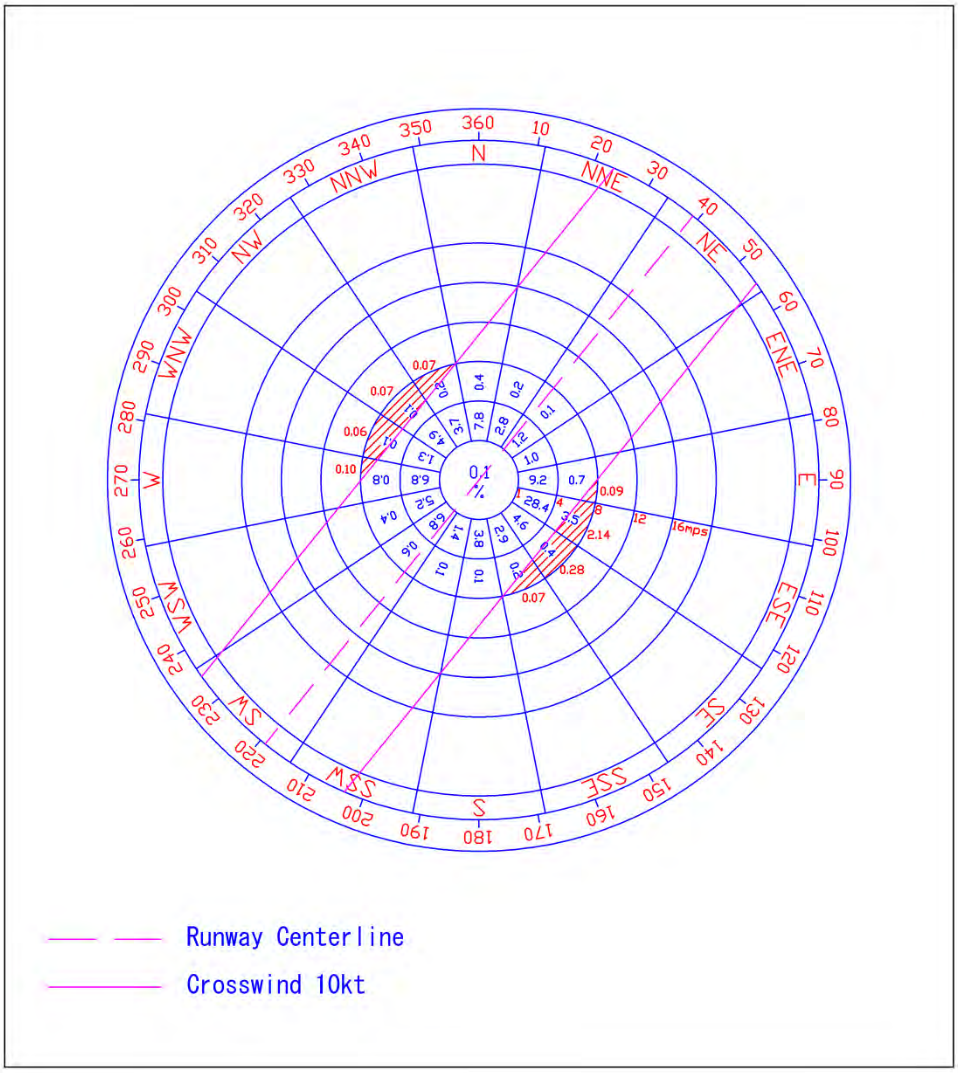
Wind Coverage : 95.16%

Figure 8.3.3-3 Wind coverage of Manila Bay Center for the wind data of NAIA



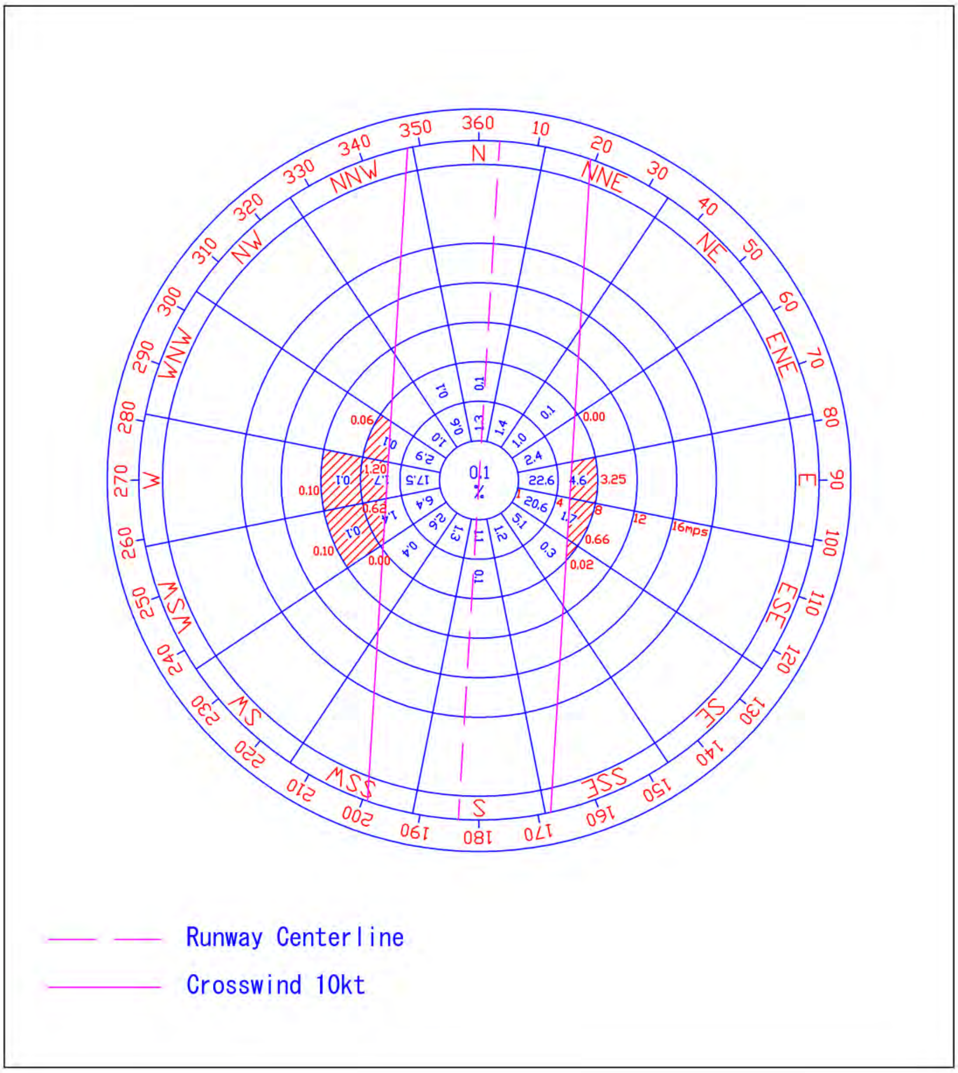
Runway : Manila Bay Center
Wind data : Sangley
Wind Coverage : 98.27%

Figure 8.3.3-4 Wind coverage of Manila Bay Center for the wind data of Port Area



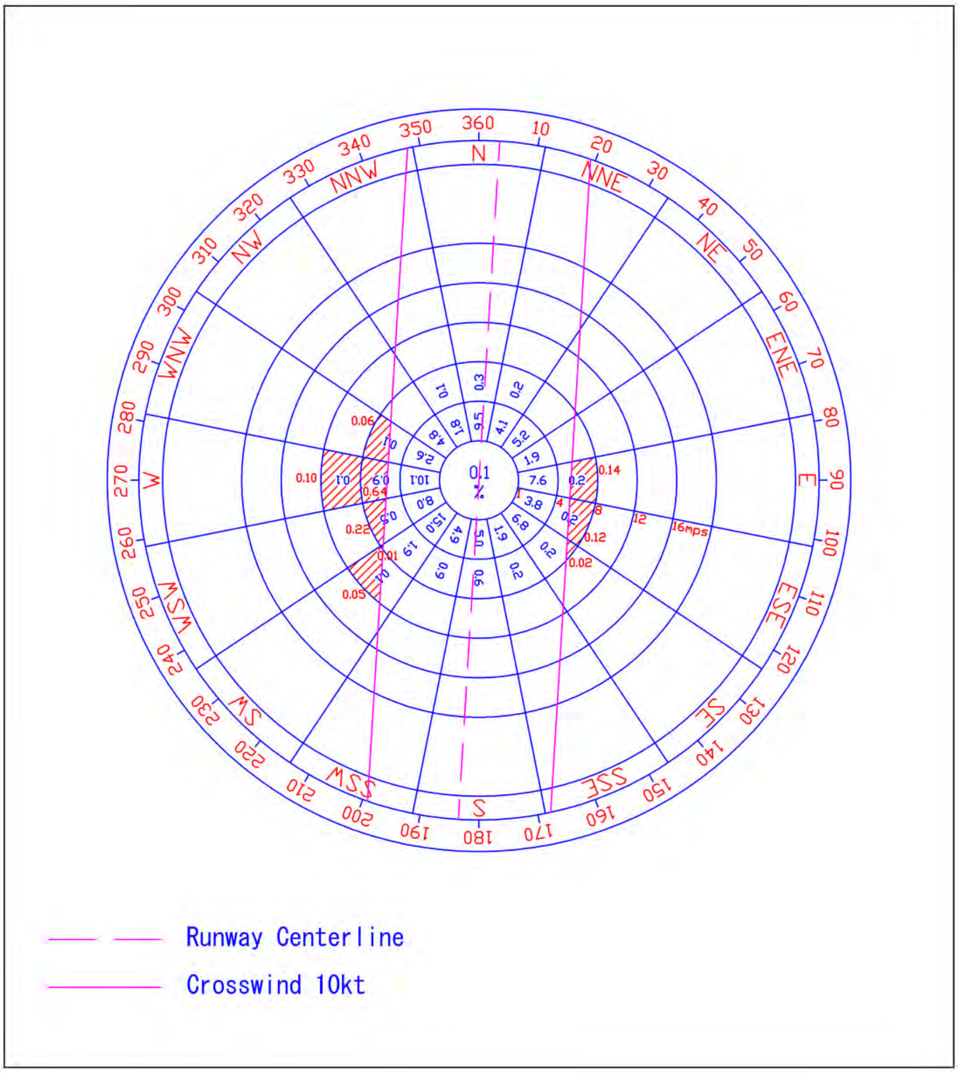
Runway : San Nicholas Shoals
Wind data : Sangley
Wind Coverage : 96.92%

Figure 8.3.3-5 Wind coverage of San Nicholas Shoals for the wind data of Sangley



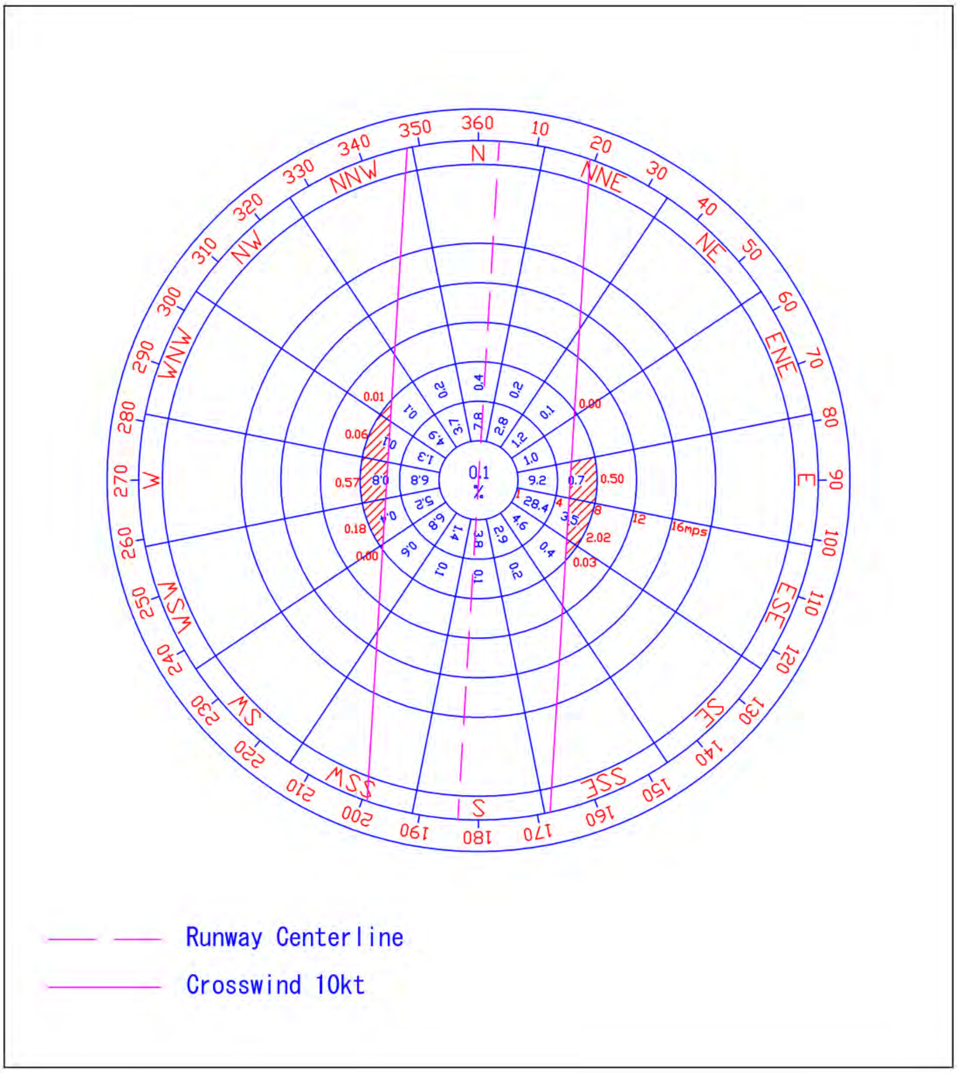
Runway : Laguna de Bay
Wind data : NAIA
Wind Coverage : 93.89%

Figure 8.3.3-6 Wind coverage of Laguna de Bay for the wind data of NAIA



Runway : Laguna de Bay
Wind data : Port area
Wind Coverage : 98.24%

Figure 8.3.3-7 Wind coverage of Laguna de Bay for the wind data of Port Area



Runway : Laguna de Bay

Wind data : Sangley

Wind Coverage : 96.43%

Figure 8.3.3-8 Wind coverage of Laguna de Bay for the wind data of Sangley

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8.4 Environmental and Social Consideration

8.4.1 Sangley Point Option 1

8.4.1.1 Project Description

Major components are Airfield (2,400 hectare) off the coast of Noveleta and Rosario, access road, access rail road, and sand excavation. The total land necessary for access road and rail is 90.5 hectares. Land area necessary for railroad is the same for San Nicholas Shoal (Figure 8.4-1).

a) Reclamation for Airport : 2,400 hectare

b) Airport Access Route : 90.5 hectare

Tentatively estimated rail head: FTI Railway Station, Philippines National Railway, Taguig
Starting road-junction: B. Marulas, Kawit, Cavite

Distance on land: 21.3 km
18.0 km (Section of Rail only, width: 21 meters), 3.3 km (Section of rail and road, with: 60 m)

Figure 8.4-1 Access Road and Railroad for Sangley Option 1 Site

c) Sand Excavation

Seabed quarry site is proposed at offshore areas of Rosario, Tanza and Naic (10,000 ha) for the reclamation project by PRA. The areas at north and the south of the quarry site are also proposed as additional quarry area (Figure 8.4-2).

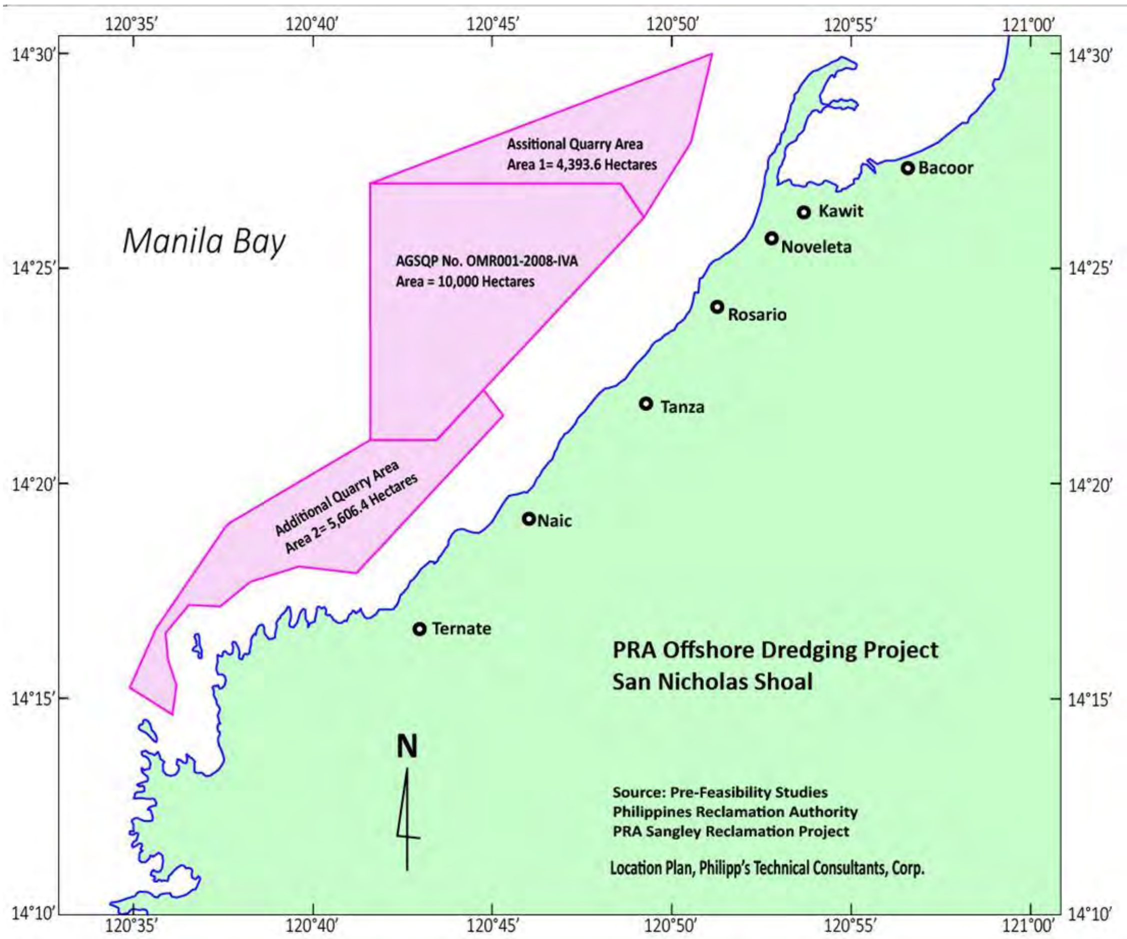


Figure 8.4-2 Proposed Locations of Sand Excavation

8.4.1.2 Site Settings

Land area of Parañaque, Las Peñas area is fast developing area as suburban area of Metro Manila, it is increasingly difficult to find appropriate routes of rails. The seawater surface is heavily used for fishing and aquiculture of shellfish. Bacoor Bay is also used for push nets and shellfish culturing. Fisherman at the other side of Cavite Peninsula practice open-sea fishing. Baccor Bay is getting shallower and the alluvium at the estuary of Ilong-Ilong River is enlarging due to sediment supply from the upstream.

The coastal area of the western side of Cavite Peninsula is used for tourism in addition to fishery.

8.4.1.3 Expected Impact

1) Involuntary Resettlement

Total number of involuntary resettlement is estimated as 4,081 people who reside in the courses of rail and road. For the estimation, buildings within the routes are counted, and the figure is multiplied by average number of household in a house (1.2) and average number of household of Cavite (4.4, NSO 2010). The number of counted houses are 773, by the area are as follows.

a) Pasay, Parañaque, and Las Peñas: 243
b) Bacoor: 357
c) Kawit: 165
d) Neveleta: 8

2) Impact on Livelihood by Construction and Operation

a) Impacts on Fishery

[Loss of Fishing Grounds]

Fishing grounds used by fishermen residing near the vicinity of the site, 2400 hectare will be converted to airport. There are about 20 Zaphra installed, four push net are found within the airport site. These facilities need to be demolished.

Fisher folks of Rosario, Noveleta, and Cavite will have to go around the new airport to reach their fishing ground at offshore area.

One of the biggest impacts expected on fishery is by sand quarry for the reclamation material in offshore area. Although the exact offshore area is not determined as of December, 2015, sand excavation works will completely change the subject sea bottom environment which is rich sources of fish production and being important livelihood for fisher folks. According to interviews with Rosario officials by JICA survey team, the fishery income is not low, and financial impact by sand excavation will be significant (Figure 8.4-3).

- Income during lean season (Oct – February) : Php. 300 - 400 per fishing night
- Squid season (March - May) : Php. 5,000 - 10,000 per fishing night
- Shrimp and crab season (June - September) : Php. 10,000 - 20,000 per fishing night

The number of fisherman is shown in Table 8.4-1. The most significant impact will be on fisher folks of Rosario and Tanza (and possibly of Naic). Since there are unregistered fishermen, the actual number of fishermen are estimated as 1.2 times of the figures in the Table 8.4-1. According to JICA survey with fisher folks, the impact of sand excavation will be significant due to the fact that bottom trawling is practiced by approximately 20% of the total fisher folks, and more than a half amount of their income is coming from fishing activities.

Table 8.4-1 Number of Fisher Folks

City/Municipality	Number of Fisherman in LGU	Significant impact expected by sand quarry
Cavite City	3,528	-
Kawit	1,840	-
Noveleta	240	-

Rosario	3,606	✔
City of Bacoor	723	-
Tanza	2,449	✔
Maragondon	443	✔
Naic	4,778	✔
Ternate	899	✔

Source: Province of Cavite 2013

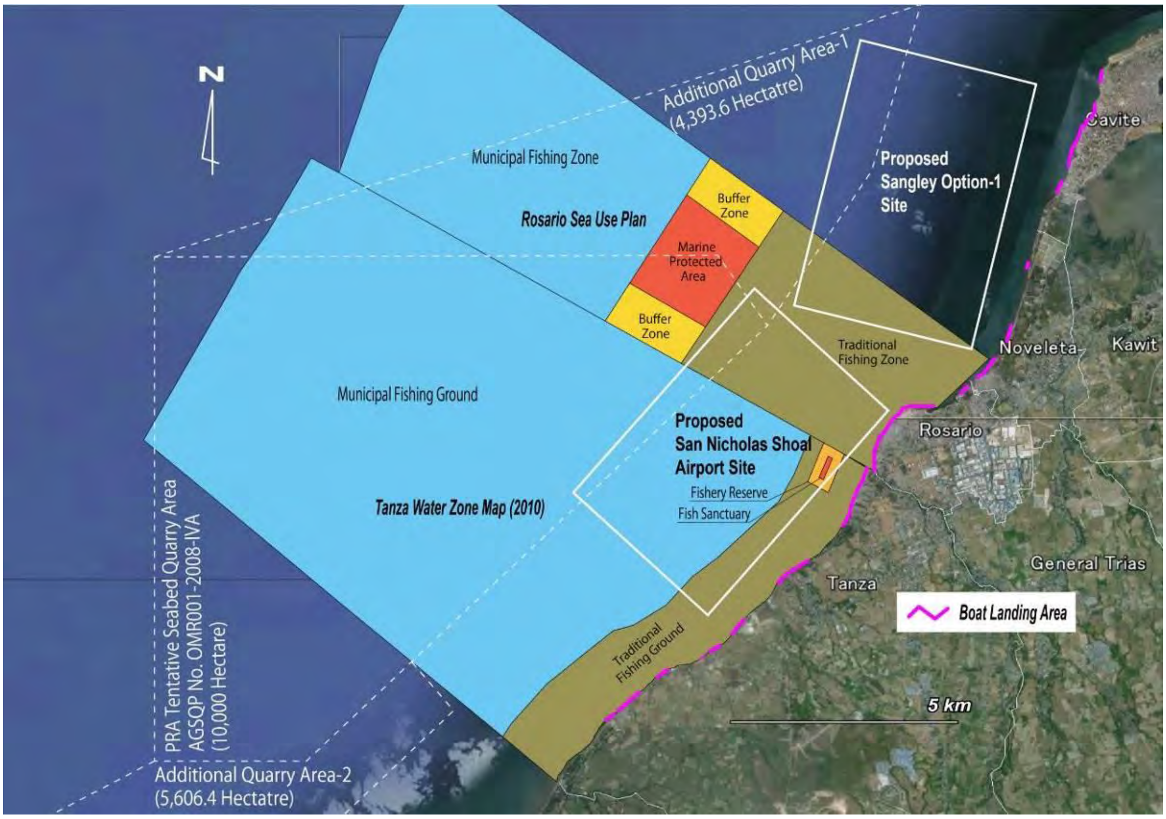


Figure 8.4-3 Tentative Location of Sand Quarry

Benthic fishery resources living in proposed sand quarry area of Rosario and Tanza

[Impact of Civil Works in Sea Area]

Civil works with concrete in water body may proliferate calcium hydroxide ($Ca(OH)2$) to the surrounding area. Calcium hydroxide is a major content of concrete and easily dissolves into water and raise pH. It damages fish gills and cause severe respiratory problem. In addition to calcium hydroxide, turbidity of water will also affect fish respiration by clogging of their gills and eventually suffocating. Since this biological problem will apply to all alternative sites, the impact should be examined with the surrounding water movement and diameter of the particles of seabed during next stage.

Seabed quarry site is not determined yet; however, it will be the same for all candidate sites except Laguna Lake West site. The impact study and control measures of seabed quarry should be conducted as soon as the quarry site is chosen as follows.

- Changes of direction and velocity of coastal current in the surrounding area of quarry site
- Estimation of affected area by suspended solid and turbidity based on the particle size and settling speed
- Estimation of area of high pH caused by civil reclamation works

b) Impacts on Tourism

There are four tourism businesses along the shore behind the proposed site. It is expected that the tourism business will be difficult as they are at present. The open sea environment will be lost, and due to the reclamation, the sea water in front of the businesses will be half-closed water environment. The quality of sea water and the view will totally be changed due to less-circulated water body remaining behind the new airport.

3) Ban on Seabed Quarry

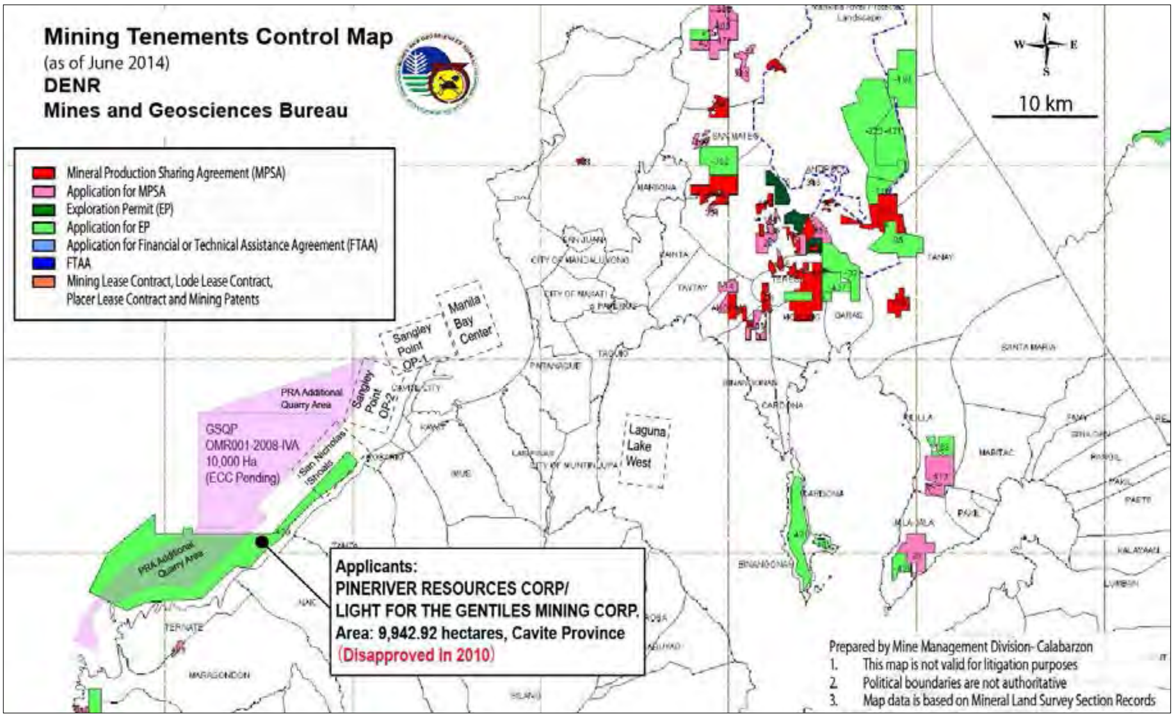
Although Environmental Clearance Certificate (ECC) is not issued by DENR yet, Government Seabed Quarry Permit (GSQP) is established as sand quarry area near Sangley Option-1 and San Nicholas Shoals sites. See Figure 8.4-3 Tentative Location of Sand Quarry. As soon as the results of EIA becomes available, social impacts on the fisher folks should be evaluated thoroughly. And some portion is overlapping with the alternative airport sites, and arrangement of sand quarry site may be necessary.

In 2008, DENR Secretary Jose Atienza Jr. ordered the Philippine Reclamation Authority (PRA) to stop its quarrying activities in Rosario and Tanza, upon receiving a petition from Rosario Mayor Jose Ricafrente Jr., in Cavite Province and the excavation is not resumed as of today (December 2015). The DENR Secretary also required PRA to file Environmental Impact Statement for an approval of the sand quarry. Related law and regulations are listed below.

- Tanza Municipal Ordinance: No 11-95 prohibits the dredging, excavation, hauling of sand within Municipal fishery area in Tanza, Cavite Province.
- Fisheries Code of 1998: a permit to quarry is not issued to projects within a marine

habitat

DENR is receiving other application for mining in the proximity areas as shown in Figure 8.4-4. Applications of seabed quarry at offshore area of Tanza, Naic, and Ternate were not approved up to now (December 2015).



Source： DENR (modified by JICA Study Team)

Figure 8.4-4 Mining Tenements Control Map of Vicinity Areas

4) Impacts on Natural Environment

a) Protected Area and Rare Species

There is no protected area or endangered species in and around the site except Ramsar Site (LPPCHEA). See Figure 8.4-5 for protected sites in vicinity area.

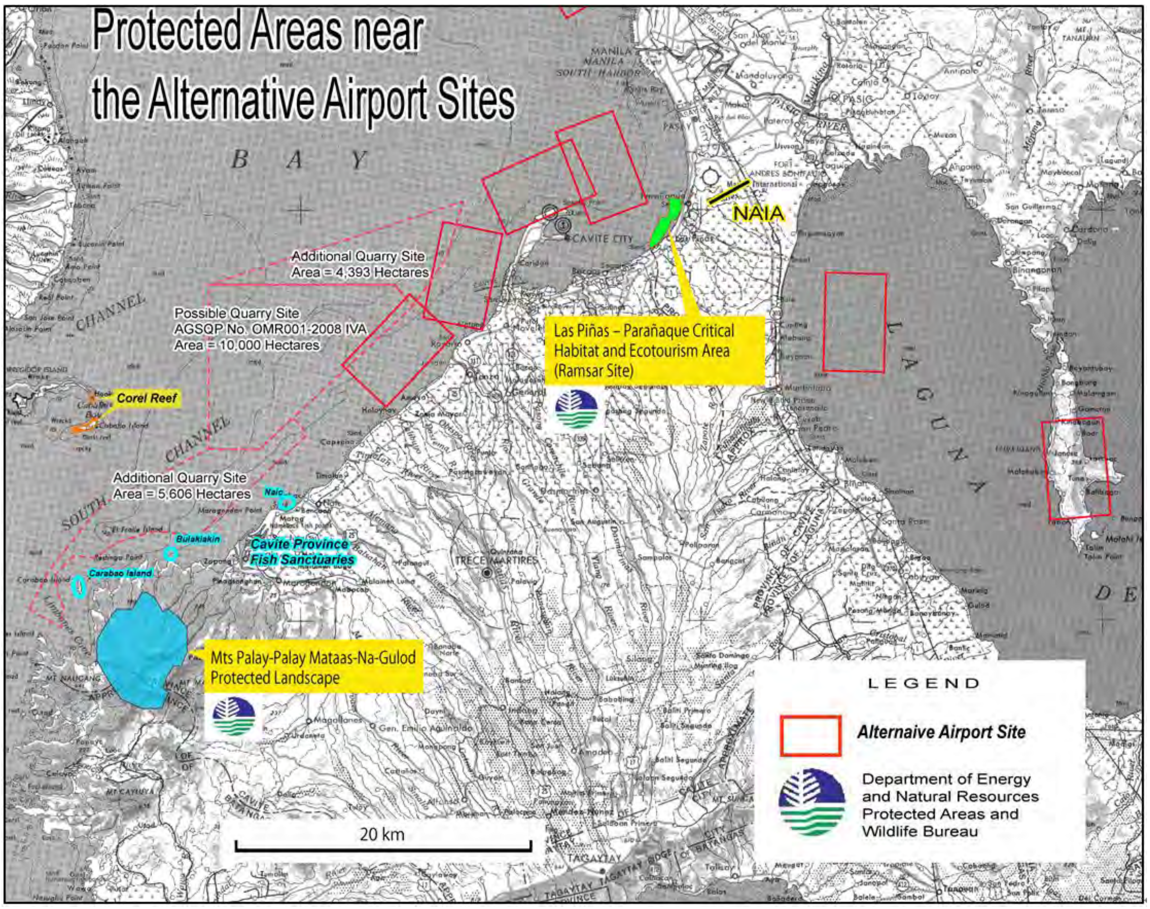


Figure 8.4-5 Protected Areas near Airport Alternative Sites

b) Erosion and Accretion

Direction of littoral drift along the shore is to the northeast (Figure 8.4.6). In general, large-scale offshore structures cover the shore behind from incoming wave, sand accumulation will likely to occur in the shoreline of the hinterland. Figure 8.4.7 shows of sand accumulation behind new offshore structure as an instance. Eventually the sand accumulation behind the airport may block the littoral drift at Binakayan, Rosario City, and may erode Noveleta and Cavite City's shores due to decreased sand supply from the west. Accretion at the western side of the airport may also clog the navigation channel for fishery boats.

Source: JICA Study Team

Figure 8.4-6 Recent Littoral Drift at the Southern Corner of Sangley Option-1 Site

Figure 8.4-7 An Instance of Sand Accumulation behind Offshore Structure
(A fishery port in Japan)

8.4.2 Sangley Point Option 2

8.4.2.1 Land Acquisition

Major components are an airfield (2,300 hectare, excluding existing Atienza air force base) at coastal area of Cavite City, access road, access rail road, and sand excavation. The total land necessary for access is about 35 hectares (Figure 8.4-8).

a) Reclamation for Airport : 2,300 hectare

b) Airport Access Route : 35.26 hectare

Tentatively estimated rail head: FTI Railway Station, Philippines National Railway, Taguig
Starting road-junction: B. Marulas, Kawit, Cavite

Distance on land: 10.3 km (Rail road: width 21 m) 21.76 hectare for rail road, and 13.5 hectare for a road junction

Figure 8.4-8 Distribution of Income Source behind Sangley Option-2 Site

8.4.2.2 Involuntary Resettlement

Total number of involuntary resettlement is estimated as 6,156 people who reside in the courses of rail and road. For the estimation, buildings are within the routes are counted, and the figure is multiplied by average number of household in a house (1.2) and average number of household of Cavite (4.4, NSO 2010). The number of counted houses are 1166, by the area are as follows.

a) Pasay, Parañaque, and Las Peñas : 243
b) Zapote, Bacoor : 923

8.4.2.3 Impact on Livelihood by Construction and Operation

The impacts are the same with Sangley Option-1, and the number of zaphra, approximately 25, is about the same with Sangley Option-2.

8.4.2.4 Polluted Sludge from Pasig River

There is a fear that new airport at offshore area of Manila Bay may block heavily polluted sludge coming from Pasig River, and deteriorate seabed of offshore area of Parañaque, Las Peñas, Bacoor, and Kawit. However, according to the bathymetry map and vector of effluent from Pasig River, shown in Figure 8.4-9, stagnation of the sludge by the new airport alternatives is not likely to occur. Photos of seabed, which are taken at the locations shown in Figure 8.4-7, also show that sludge from Pasig River is not moving in to offshore area of Parañaque City, suggesting that there is no major southward longshore current existing.

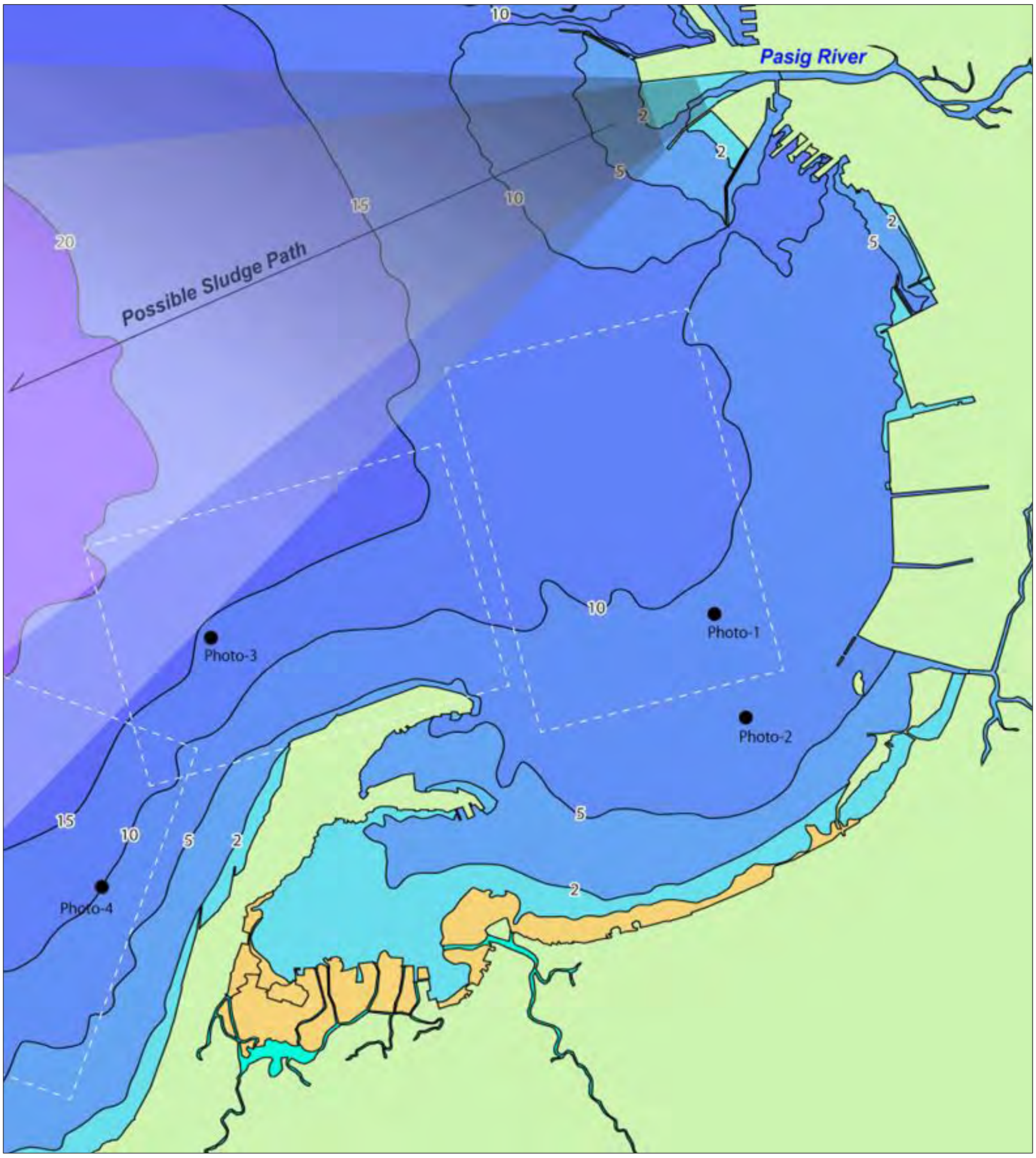
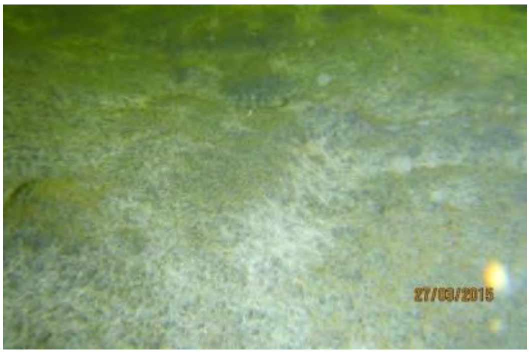


Figure 8.4-9 Possible Sludge Movement based on Bathymetry and Vector of Effluent

Fairly clean seabed of manila Bay Center Site at location "Photo-1" in Figure 8.4-7



Relatively clean seabed at offshore area at Photo-2

Black sludge sample taken at "Photo-3" (Sangley Option-2 Area)

Sludge sample of "Photo-" (Sangley Option-1)

8.4.3 Central Manila Bay

8.4.3.1 Land Acquisition

Major components are an airfield at coastal area of Pasay, Parañaque, Las Peñas, Bacoor, Cavite City; access road, access rail road; and sand excavation. The total land necessary for access is 35.26 hectares (Figure 8.4-10).

a) Reclamation for Airport : 2,400 hectare

b) Airport Access Route : 35.26 hectare

Tentatively estimated rail head: FTI Railway Station, Philippines National Railway, Taguig
Starting road-junction: B. Marulas, Kawit, Cavite

Distance on land: 10.3 km (Rail road: width 21 m) 21.76 hectare for rail road, and 13.5 hectare for a road junction

Figure 8.4-10 Distribution of Income Source behind Manila Center Site

8.4.3.2 Involuntary Resettlement

Total number of involuntary resettlement is estimated as 6,156 people who reside in the courses of rail and road. For the estimation, buildings are within the routes are counted, and the figure is multiplied by average number of household in a house (1.2) and average number of household of Cavite (4.4, NSO 2010). The number of counted houses are 1166, by the area are as follows.

a) Pasay, Parañaque, and Las Peñas: 243
b) Zapote, Bacoor: 923

8.4.3.3 Impact on Livelihood by Construction and Operation

There are approximately 200 "zaphra," or fish lift net, in proposed airport site. Together with zaphra, oyster and mussel farming are also being conducted. It is estimated that more than 1,000 fisherman are working in proposed airport site. Figure 8.4-11 shows distribution of fishing gears in the areas of Sangley Option-1, Sangley Option-2, and Manila Center sites.

An outline of fishery in the proposed site, according to hearing survey to the fisherman is Table 8.4-2.

Table 8.4-2 Outline of Fishery in Seawater Area

Lift-Net ("zafra") fishing	
[Outline of Fishing Method]	
● Target fish species	tilapia, anchovies, squid
● Number of workers/unit	5 people
● Owner status	Individuals, no permission necessary
● Operating hours	night time with light bulbs
[Economics]	
● Installation cost	P250,000/unit
● Gross Income of lift-net	P3,000-5,000/day
● Operating Cost	50% of catch
● Lifespan of zafra installation	1-2 yrs
Mussel/Oyster Farming	
● Common Method of Mussel Farming	Stake/Raft method
● Investment Cost for Mussel Farm	P60,000 to P120,000/ha/yr
● Lifespan of Stake/Raft	4-5 yrs
● Operating cost	Stake method: Php 130,000/ha/yr Raft method: Php 260,000/ha/yr
● Duration of Mussel Cropping	5-6 months
● Gross Earnings from Mussel Sales	Php 700,000 to 1,400,000/ha/yr

Source: Mr. Nilo V. Germedia, City Agricultural Fisheries and Aquatic Services Office, Paranaque City and Fisherman at offshore area of Paranaque on June 2, 2015, interview survey by JICA Study Team

Figure 8.4-11 Location of Zaphra inside and peripheral of Three Sites

Typical Zaphra in proposed area

Mussel harvesting in the airport site

8.4.3.4 Impact on Natural Environment

The offshore area is also under pressure of development. Las Peñas and Parañaque Cities have reclamation plan adjacent to Ramsar Site (Las Peñas-Parañaque Critical Habitat and Ecotourism Area: LPPCHEA). This issue will be discussed later. A proposed airport site, Manila Bay Center, is located near Ramsar Site, the nearest distance from the tentative airport is about 2.3 km away. Outline of the Ramsar Site is summarized in Table 8.4-3.

Table 8.4-3 Outline of LPPCHEA

Name	Las Peñas – Parañaque Critical Habitat and Ecotourism Area (LPPCHEA)
Official Date of designation to Ramsar Site	March 15, 2013
Legal Background as a Critical Habitat	*Presidential Proclamation No. 1412 (2007), *Presidential Proclamation No. 1412-A (2008)
Managing Body	Manila Bay Critical Habitat Management Council, Chaired by

	Department of Environment and Natural Resources (DENR)
Area	175-hectare coastal wetland area
Importance	LPPCHEA lies along the East Asian – Australasian Flyway. The number of wild birds in the area could peak at around 5,000 heads per day.
Major Important Species	*Philippine Duck (Anas luzonica): breeding site *Black-Winged Stilts (Himantopus himantopus) : stopping over

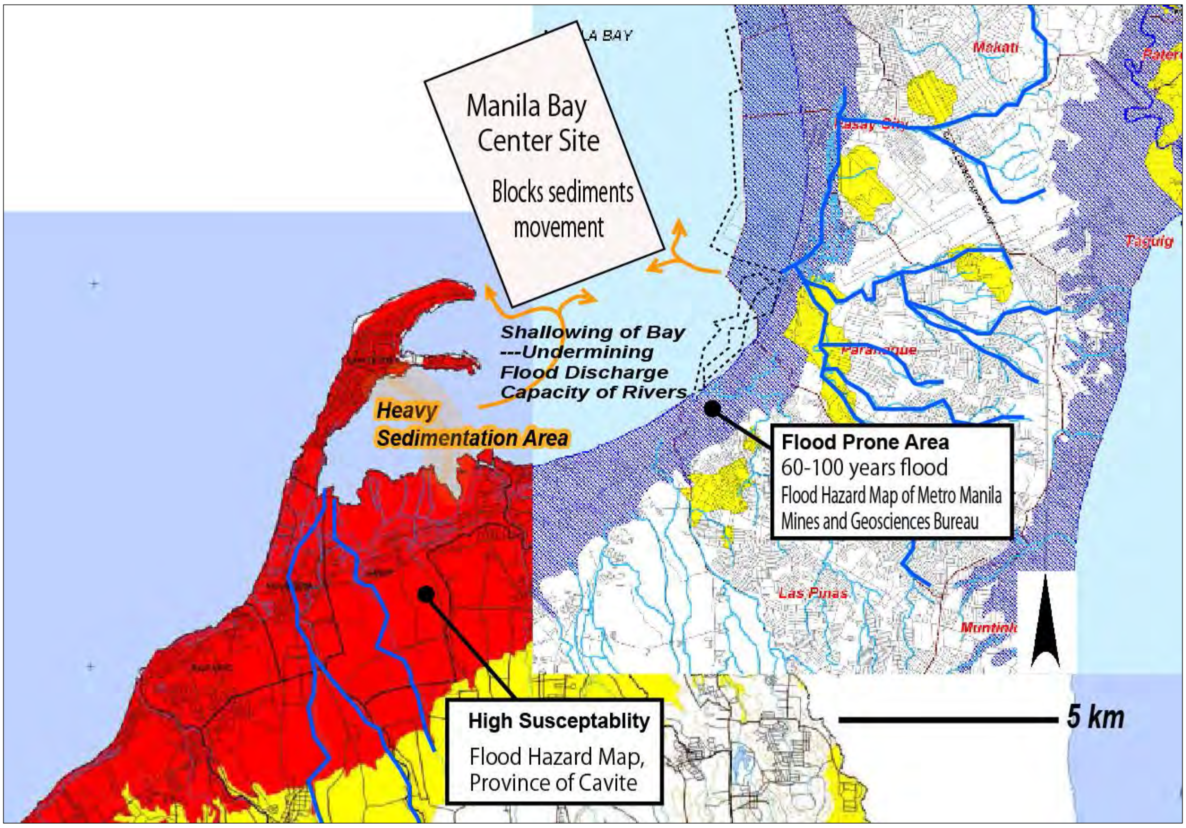
Ocean side view of LLPCHEA

Lagoon side of LLPCHEA

As it was mentioned in section of Sangley Point Option-1, high pH and turbidity during reclamation works will affect living environment of pelagic fish and macro benthos.

8.4.3.5 Decreasing Resilience against Flooding at Hinterland Area

Construction of airport at Manila Bay Center may shallow the area's seabed in the long-term. Figure 8.4-12 shows how Manila Bay Center airport site could disturb sediments from Ilong-Ilong River and Paranaque River running down the underwater slope. Since the areas such as Las Piñas, Parañaque, Bacoor, Noveleta, Kawit, and Imus are officially designated flood prone areas, shallowing of the rivers' estuary areas could aggravate flooding at upstream areas.



Source: JICA Survey Team

Figure 8.4-12 Flood Prone Areas and Long-term Sedimentation

8.4.3.6 Difficulty of Receiving Approval of Seabed Quarry

Area of sand quarry will be the same with Sangley Option1, Sangley Option-2, Manila Bay Center, and San Nicholas Shoals. Sand Quarry at the proposed location by PRA will affect living environment of the area. There are strong opposite opinion against PRA's sand quarry plan from the local fishermen and respective LGUs. DENR has not issued Environmental Clearance Certificate (ECC) yet as of today (July 2015).

8.4.3.7 Other Issues

1) Development Project by Reclamation

Las Peñas City, Parañaque City (both in Metro Manila) are planning to reclaim land of 635.14 hectare (431.71 hectares in Las Peñas City, 203.43 hectares in Parañaque City). This reclamation project is adjacent to LPPCHEA (Figure 8.4-13) and the south of Manila Center site.

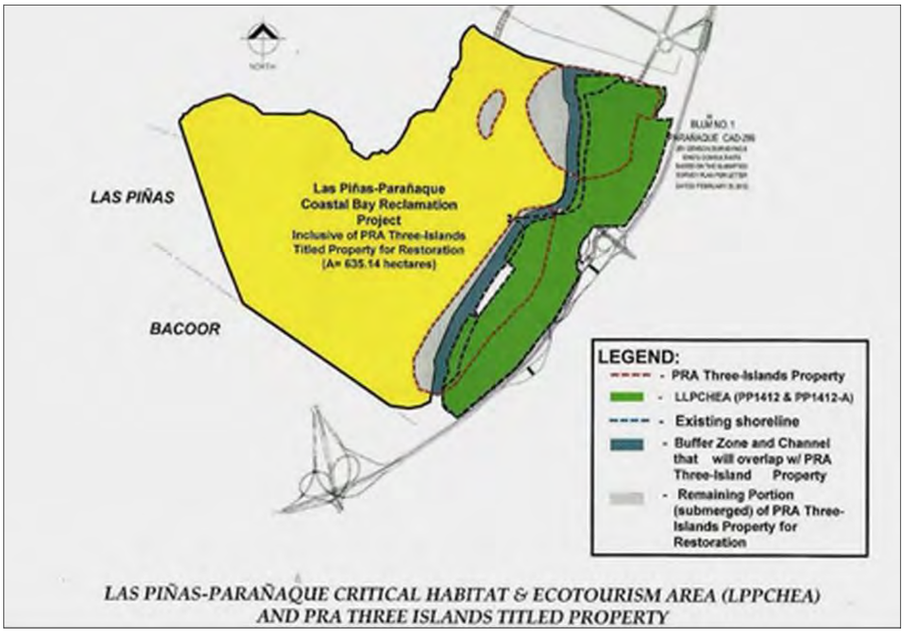


Figure 8.4-13 Las Peñas - Parañaque Coastal Bay Reclamation Project

However, this plan is being contested by Senator Cynthia A. Villar, a former Congress Woman from Las Peñas, who advocates that the reclamation project will have irreversible and fundamental environmental impacts on the wetland, and will also cause severe flooding. Senator Villar claims more than 300 thousand citizens' petitions from the area.

Although Environmental Management Board (EMB) of DENR has issued Environmental Clearance Certificate (ECC) on March 24, 2011, the case is still at the Supreme Court. EMB Director Cuna says the developer still needs to acquire an approval from Manila Bay Critical Habitat Management Council which is a condition to the ECC.

Las Peñas - Parañaque Coastal Bay Reclamation Project is close to Manila Bay Center site, and the buildings have high possibility of interfering with the airfield of the new airport at Manila Bay Center site.

2) Bird Strike

Flight paths of airplanes using proposed eastern runways will cross over the LPPCHEA. The runways are closer to the wetland than that of NAIA, which already is claimed that danger of bird strike.

8.4.4 San Nicholas Shoals

8.4.4.1 Land Acquisition

Total area of land necessary for access rail and road is 90.5 hectare. Figure 8.4-14 shows location of San Nicholas Shoal airport site and access routes.

a) Reclamation for Airport : 2,400 hectare

b) Airport Access Route : 90.5 hectare

Tentatively estimated rail head: FTI Railway Station, Philippines National Railway, Taguig
Starting road-junction: B. Marulas, Kawit, Cavite

Distance on land: 21.3 km
18.0 km (Section of Rail only, width: 21 meters), 3.3 km (Section of rail and road, with: 60 m)

Figure 8.4-14 Location Map of Can Nicholas Shoal Alternative Site

8.4.4.2 Involuntary Resettlement

Total number of involuntary resettlement is estimated as 4,081 people who reside in the courses of rail and road. For the estimation, buildings are within the routes are counted, and the figure is multiplied by average number of household in a house (1.2) and average number of household of Cavite (4.4, NSO 2010). The number of counted houses are 773, by the area are as follows.

a) Pasay, Parañaque, and Las Peñas: 243

b) Bacoor: 357

c) Kawit: 165

d) Noveleta: 8

8.4.4.3 Impact on Livelihood by Construction and Operation

1) Fishery

There is no fishing structure in the proposed airport site; however, the 2,400 hectares of fishing ground will be lost. The area is designated as traditional fishing zone by Municipality of Rosario, and traditional and municipal fishing ground by Municipality of Tanza (Figure 8.4-3).

2) Tourism

There are some beach resorts at hinterland of the proposed airport site. Although the airport is more than 1.5 km away from the shoreline, the nature of business need to be altered.

Juna Olibia Beach Resort, Tanza

Outside view of Juna Olibia

8.4.4.4 Impact on Natural Environment: Fish Sanctuary

Proposed San Nicholas Shoals site contains fishery reserves designated by Municipality of Tanza, Cavite Province. According to hearing survey results with responsible Tanza officials, the specific location which designated as the fish sanctuary has dead corals providing good bleeding environment for fish. However the fish sanctuary might not block airport development, and DOTC's plan should be brought to municipal discussions, according to Tanza Municipal Environmental and Natural Resources Officer (MENRO).

As it was addressed in the section of Sangley Point1, extremely high pH and turbidity during construction may well affect living environment of pelagic fish and macro benthos in surrounding area.

8.4.4.5 Difficulty of Receiving Approval of Seabed Quarry

Area of sand quarry will be the same with Sangley Option1, Sangley Option-2, Manila Bay Center, and San Nicholas Shoals. Sand Quarry at the proposed location by PRA will affect living environment of the area. There are strong opposite opinion against PRA's sand quarry plan from the local fishermen and respective LGUs. DENR has not issued Environmental Clearance Certificate (ECC) yet as of today (July 2015).

8.4.5 Western Portion of Laguna de Bay

8.4.5.1 Land Acquisition

Given Laguna Lakeshore Expressway Dike (LLED, shown in Figure 8.4-15) is to be constructed, and LLED will be connected to South Luzon Expressway (SULEX) at Sucat, no land acquisition or resettlement will be necessary by the airport project side. GOP will provide ROW for LLED, and the airport access will be connected to it.

For this DPWH project, the National Economic and Development Authority (NEDA) Board, chaired by President Benigno S. Aquino III, gave an approval on June 19, 2014. The construction is expected to commence in late 2015 and end in 2021, according to GOP Gazette issued on June 20, 2014.

Figure 8.4-15 Laguna Lakeshore Expressway Dike Plan

Project Description of LLED
Component A. Expressway Dike, Taguig–Los Baños, 47 km * 6–lane tollway with 8 interchanges and access roads * Dike designed for 100–year flood, and 16 floodgates/pumping stations designed for 60–year flood Component B. Reclamation, 700 hectares, Taguig–Muntinlupa * 7 islands, about 450–500m wide and 15.6km long * With horizontal development (roads, drainage, open spaces) * 100–150m channel between lakeshore and reclamation

8.4.5.2 Involuntary Resettlement

If a road between SULEX and LLED at Sucat, Muntinlupa becomes a component of the airport project, the following resettlement will be necessary. Access road and rail require less than one kilometer stretch from the South Luzon Expressway and Scat Station. Moreover LLED will also connect to the airport access. Hence resettlement will be limited to approximately 60 houses, it is to estimate about 270 people will be affected by the access road and rail.

8.4.5.3 Impact on Fishery

Water surface of Laguna Lake is heavily used for fish production by fish pen. The southern half of fish pens is in jurisdiction of Muntinlupa, and the rest of surface belongs to Taguig City, Metro Manila. The Cities' jurisdiction covers inside area of 11 km line from the lakeshore.

The rental fee is paid to LLDA, which controls water surface. The total area of affected fish pen is measured as approximately 1,400 hectares by the JICA Study Team (Figure 8.4-16).

No.	Area (ha.)	No.	Area (ha.)
1	21.9	21	13.4
2	15.0	22	43.6
3	70.6	23	44.6
4	9.4	24	51.0
5	6.3	25	56.0
6	46.6	26	53.7
7	4.8	27	49.7
8	5.5	28	30.2
9	30.0	29	42.0
10	52.0	30	25.9
11	49.5	31	11.8
12	49.7	32	28.2
13	103.0	33	25.5
14	108.0	34	9.8
15	9.6	35	49.3
16	16.2	36	28.7
17	24.5	37	21.4
18	117.0	38	49.0
19	16.1	Total	1,395.7
20	6.2		

Figure 8.4-16 Location of Fish Pens within and periphery of Laguna West Alternative Site

Outlines of fishing activities and impact expected are described below based on an interview survey at Muntinlupa Management office by JICA study team. The summary is shown in Table 8.4-4.

Table 8.4-4 Outline of Fishing Activities in Proposed Laguna West Site

[Outline of Aquiculture]	
● Management	Muntinlupa City, the owner of the water surface, rents the lake water space to individuals and corporations. The LGU also provides fingerings of tilapia and milkfish.
● Number of Fisherman (total in Muntinlupa)	3,000 people in Muntinlupa
● Fisherman within the area of airport (estimated)	Approx. total 250 of fisherman in Taguig and Muntinlupa will be affected proportionally (Proposed airport reclamation area occupies 8.48% of total rented area by Muntinlupa)
● Average size/ renter	20 – 100 hectares
● Target Fish species	Milk fish (bangus), tilapia, bighead carp
● Common method of culture	Fish pens
● Muntinlupa and Taguig City	16,500 hectares (from shoreline up to 11 km towards the bay center, 18.1% of the Lake)
● Number of bangus cropping season	3 cropping/ 2 yrs (Cropping 1.5 times /yr)
● Approx. No. of Fingerlings	30,000 fingerlings/hectare (Survival rate 50%)
● Average weight of bangus/tilapia	250 grams
[Economics]	
● Average harvest per cropping/hectare	3,750 kg/ha/cropping/season
● Farm gate price of bangus	Php 60/kg
● Gross sales	Php 225,000/cropping/ha. (Php 337,500/ha/year)
● Installation Cost of Fish Pen	450,000 Php/5 ha (Milkfish) (Loss of 12.6 mil. Php in the airport area)
● Replacement period	5-10 years
● Water area rental fee to LLDA	Php 1,400/ha/yr (Loss of LLDA's income by 19.6 mil. Php/yr by the proposed airport)
● Total cost	Php 250,000/ha
● Net revenue	Php 88,000/ha
● Revenue to LGU	Muntinlupa earned P2.8 Million by income tax from the fish pen operators

Source: Field interview with Manager, Lake Management Office, Muntinlupa City, June 3, 2015, interview survey by JICA Study Team

Typical fish pen over the navigation route

Hatchery of fingerings operated by Muntinlupa

8.4.5.4 Impact on Natural Environment

The water quality of the lake has been critically deteriorated. Its transparency is extremely low by result of eutrophication; the pH is high due to lack of carbon dioxide; and dissolved oxygen is below or near 3 mg/l. In addition to that, the sediment is ever increasing due to its topography, making the lake shallower. Reclamation works may add suspended solid, and can lower the pH of lake water of surroundings if without proper measurement applied.

8.4.5.5 Decreasing Resilience against Flooding Incident in Hinterland

Lake-water rise of Laguna Lake causes flooding in the low elevated area around it and at the islands. Proposed Laguna Lakeshore Expressway Dike (LLED) is also being controversial issue because the dike is designed to prevent flooding of the western side of lake shores only. The residents in other area have strong discontentment, such as Pambansang Lakas ng Kilusang Mamamalakaya ng Pilipinas (Pamalakaya), Save Laguna Lake Movement. Napindan Gate, the only outlet from Laguna Lake through Pasig River, will be closed during flood to protect the downstream area. As a result, the high water level of Laguna Lake during flood will be maintained until the Napindan Gate opens again.

New reclamations are feared that they would aggravate the flooding. Since the proposal of reclamation decreases the lake's flood absorbing capacity, the same anti-development movement with LLED may be triggered.

8.4.6 Comparison of Alternatives

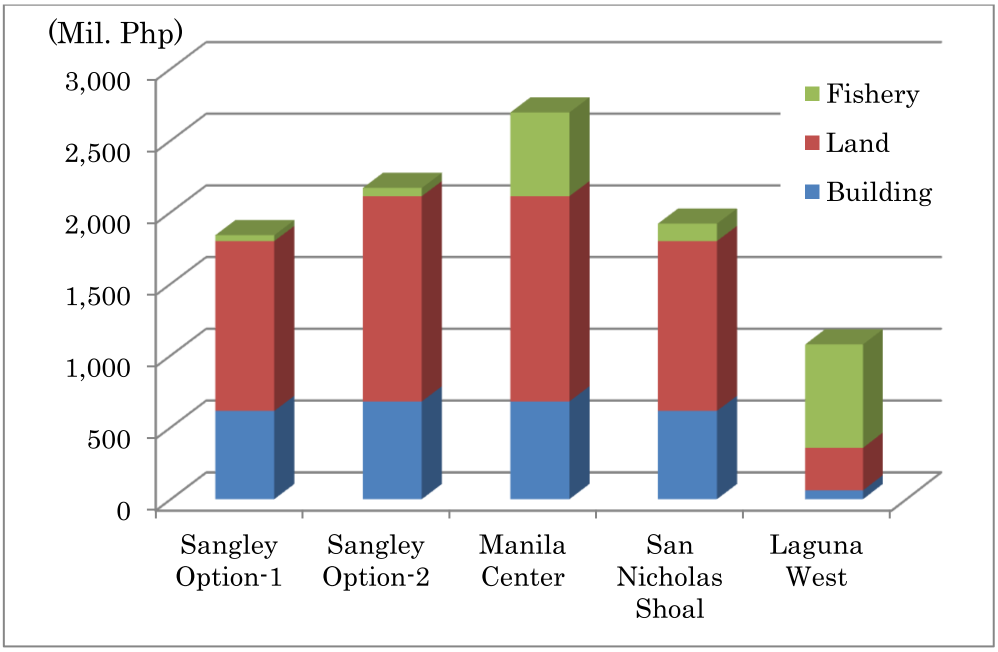
8.4.6.1 Compensation Cost

Approximate compensation cost is estimated by assessing reconstruction of affected buildings, land acquisition cost, (BIR zonal value for comparison purpose only), and impacts on fishery. Land acquisition and building cost is the same for Manila Bay Center and Sangley Option-2; likewise, San

Nicholas Shoals and Sangley Point Option-1 share the same values because these alternative sites share the same access rail and road. The Laguna West site appreciates the least cost because of the proximity to the existing railroad station and expressway, and there are new expressway and railroad plan in the vicinity also (Table 8.4-5, Figure 8.4-17).

Table 8.4-5 Comparison of Compensation Cost (Mil. Php)

	Sangley Option-1	Sangley Option-2	Manila Center	San Nicholas Shoal	Laguna West
Building	613	679	679	613	61
Land	1,184	1,431	1,431	1,184	296
Fishery	41	57	584	121	719
Total	**1,838**	**2,168**	**2,695**	**1,918**	**1,076**



Note: Compensation for impact by sand quarry is not included

Figure 8.4-17 Comparison of Compensation Cost (Mil. Php)

Details of estimated compensation cost are shown in tables below.

Table 8.4-6 Compensation Cost of Sangley Option-1 Site

Sangley Option-1					
Project Component/Location	Qty	Unit	Unit Price (Php)	Expected Compensation Price (Mil. Php)	Remarks
1. Buildings					
a. Paranaque, Las Penas	243	house	15,000 /sqm	291.60	Tentative floor area: 80 sqm/unit
b. Bacoor	327	house	10,000 /sqm	98.10	Tentative floor area: 30 sqm/unit
c. Bacoor (B. Maliksi I)	30	house	15,000 /sqm	45.00	Tentative floor area: 35 sqm/unit
d. Kawit (Samala Marquez)	72	house	15,000 /sqm	108.00	Tentative floor area: 100 sqm/unit
e. Kawit (B. Aplaya)	93	house	10,000 /sqm	46.50	Tentative floor area: 50 sqm/unit
f. Noveleta	8	house	15,000 /sqm	24.00	Tentative floor area: 200 sqm/unit
2. Land					
a. B. Merville, Paranyaque	1.62	ha	15,000 /sqm*	243.00	21 m width, Industrial area
b. do	1.25	ha	6,500 /sqm*	81.25	21 m width, Residential
c. do	9.38	ha	3,000 /sqm*	281.40	21 m width, Airport
d. B. Manuyo Uno, Las Penas	5.55	ha	3,000 /sqm*	166.50	21 m width, Residential
e. do	1.49	ha	3,000 /sqm*	44.70	21 m width, Cemetary Lot
f. B. Plung Lupa, Las Penas	2.47	ha	3,000 /sqm*	74.10	21 m width, Residential
g. B. Zapote V, B. Talaba, Bacoor	4.89	ha	150 /sqm*	7.34	21 m width, Fishpond area
h. B. Maliksi I, Baccor	0.52	ha	3,500 /sqm*	18.08	21 m width, Residential
i. B. Kaingin, Mabolo II, etc. Bacoor	5.93	ha	150 /sqm*	8.89	21 m width, Fishpond area
j. B. Marulus, Bacoor City	2.73	ha	2,600 /sqm*	70.98	Residential area, for an interchange
k. do	22.83	ha	150 /sqm*	34.25	Fishpond area for an interchangenterchange
l. do	1.31	ha	3,250 /sqm*	42.58	Residential area for an interchange
m. B. Samala Marquez, Kawit	2.29	ha	3,000 /sqm*	68.67	21 m width, Residential
n. B. Wakas, Santa Isabel, Kawit	21.11	ha	150 /sqm*	31.66	60 m width, Fishpond area
o. B. San Rafael 3, Noveletas	7.16	ha	150 /sqm*	10.75	60 m width, Fishpond area
3. Fishery					
a. Airport/fish lift net	17	Unit	250,000	2.13**	17 Fish lift net in 2400 ha
b. Airport/detour route	200	boat	32	38.40	10 km excess/day (32Php: 10km/liter) 20yrs***
			Total	1,837.86	

* Bureau of Intrnal Revenue Zonal Value, for comparison purpose only
** Depreciation inclusive
*** Next generation will not count

Table 8.4-7 Compensation Cost of Sangley Option-2 Site

Sangley Option-2					
Type of Project Component	Qty	Unit	Unit Price (Php)	Expected Compensation Price (Mil. Php)	Remarks
1. Buildings					
a. Paranaque, Las Penas, others	243	house	15,000 /sqm	291.60	Tentative floor area: 80 sqm/unit
b. Zapote V, B. Bacoor	923	house	12,000 /sqm	387.66	Tentative floor area: 35 sqm/unit
2. Land					
a. B. Merville, Paranyaque	1.62	ha	15,000 /sqm*	243.00	21 m width, Industrial area
b. do	1.25	ha	6,500 /sqm*	81.25	21 m width, Residential
c. do	9.38	ha	3,000 /sqm*	281.40	21 m width, Airport
d. B. Manuyo Uno, Las Penas	5.55	ha	3,000 /sqm*	166.50	21 m width, Residential
e. do	1.49	ha	3,000 /sqm*	44.70	21 m width, Cemetary Lot
f. B. Plung Lupa, Las Penas	2.47	ha	3,000 /sqm*	74.10	21 m width, Residential
g. B. Zapote V, Bacoor	13.5	ha	4,000 /sqm*	540.00	Residential
3. Fishery					
a. Zapote Interchange- Airport	16	Unit	250,000	2.00**	250 m with, Fish lift net
b. Airport area	8	Unit	250,000	1.00**	2400 ha., Fish lift net
c. Compensation for Fish Lift	17	Unit	1,200,000	20.40	Avg. 4,000/unit (x 300 days)**
d. Compensation for mussel farm	34	Unit	1,000,000	34.00	One year**
			Total	2,167.61	

* Bureau of Intrnal Revenue Zonal Value, for comparison purpose only
** Depreciation inclusive

Table 8.4-8 Compensation Cost of Manila Bay Center Site

Manila Center					
Type of Project Component	Qty	Unit	Unit Price (Php)	Expected Compensation Price (Mil. Php)	Remarks
1. Buildings					
a. Paranaque, Las Penas, others	243	house	15,000 /sqm	291.60	Tentative floor area: 80 sqm/unit
b. Zapote V, B. Bacoor	923	house	12,000 /sqm	387.66	Tentative floor area: 35 sqm/unit
2. Land					
a. B. Merville, Paranyaque	1.62	ha	15,000 /sqm*	243.00	21 m width, Industrial area
b. do	1.25	ha	6,500 /sqm*	81.25	21 m width, Residential
c. do	9.38	ha	3,000 /sqm*	281.40	21 m width, Airport
d. B. Manuyo Uno, Las Penas	5.55	ha	3,000 /sqm*	166.50	21 m width, Residential
e. do	1.49	ha	3,000 /sqm*	44.70	21 m width, Cemetary Lot
f. B. Plung Lupa, Las Penas	2.47	ha	3,000 /sqm*	74.10	21 m width, Residential
g. B. Zapote V, Bacoor	13.5	ha	4,000 /sqm*	540.00	Residential
3. Fishery					
a. Zapote Interchange- Airport access	16	Unit	250,000	2.00**	250 m with, Fish lift net
b. Compensation for Fish lift net	182	Unit	1,200,000	218.40	Avg. 4,000/unit (x 300 days: one yr**)
c. Compensation for mussel farm	364	Unit	1,000,000	364.00	One year**
			Total	2,694.61	

* Bureau of Intrnal Revenue Zonal Value, for comparison purpose only
** Depreciation inclusive (2 years of net life, average one year)

Table 8.4-9 Compensation Cost of San Nicholas Shoals Site

San Nicholas Shoal					
Type of Project Component	Qty	Unit	Unit Price (Php)	Expected Compensation Price (Mil. Php)	Location
1. Buildings					
a. Paranaque, Las Penas	243	house	15,000 /sqm	291.60	Tentative floor area: 80 sqm/unit
b. Bacoor	327	house	10,000 /sqm	98.10	Tentative floor area: 30 sqm/unit
c. Bacoor (B. Maliksi I)	30	house	15,000 /sqm	45.00	Tentative floor area: 35 sqm/unit
d. Kawit (Samala Marquez)	72	house	15,000 /sqm	108.00	Tentative floor area: 100 sqm/unit
e. Kawit (B. Aplaya)	93	house	10,000 /sqm	46.50	Tentative floor area: 50 sqm/unit
f. Noveleta	8	house	15,000 /sqm	24.00	Tentative floor area: 200 sqm/unit
2. Land					
a. B. Merville, Paranyaque	1.62	ha	15,000 /sqm*	243.00	21 m width, Industrial area
b. do	1.25	ha	6,500 /sqm*	81.25	21 m width, Residential
c. do	9.38	ha	3,000 /sqm*	281.40	21 m width, Airport
d. B. Manuyo Uno, Las Penas	5.55	ha	3,000 /sqm*	166.50	21 m width, Residential
e. do	1.49	ha	3,000 /sqm*	44.70	21 m width, Cemetary Lot
f. B. Plung Lupa, Las Penas	2.47	ha	3,000 /sqm*	74.10	21 m width, Residential
g. B. Zapote V, B. Talaba, Bacoor	4.89	ha	150 /sqm*	7.34	21 m width, Fishpond area
h. B. Maliksi I, Baccor	0.52	ha	3,500 /sqm*	18.08	21 m width, Residential
i. B. Kaingin, Mabolo II, etc. Bacoor	5.93	ha	150 /sqm*	8.89	21 m width, Fishpond area
j. B. Marulus, Bacoor City	2.73	ha	2,600 /sqm*	70.98	Residential area, for an interchange
k. do	22.83	ha	150 /sqm*	34.25	Fishpond area for an interchangenterchange
l. do	1.31	ha	3,250 /sqm*	42.58	Residential area for an interchange
m. B. Samala Marquez, Kawit	2.29	ha	3,000 /sqm*	68.67	21 m width, Residential
n. B. Wakas, Santa Isabel, Kawit	21.11	ha	150 /sqm*	31.66	60 m width, Fishpond area
o. B. San Rafael 3, Noveletas	7.16	ha	150 /sqm*	10.75	60 m width, Fishpond area
3. Fishery					
a. Airport/detour route	630.8	boat	32	121.11	10 km excess/day (32Php: 10km/liter) 20yrs***
			Total	1,918.45	

* Bureau of Intrnal Revenue Zonal Value, for comparison purpose only
** Depreciation inclusive
*** Next generation will not count

Table 8.4-10 Compensation Cost of Laguna West

Laguna West						
Type of Project Component	Qty	Unit	Unit Price (Php)	Expected Compensation Price (Mil. Php)	Location	Subjects
1. Buildings						
a. Railroad Access	51	house	15,000 /sqm	61.20	B. Sucat, Muntnlupa	Tentative floor area: 60 sqm/unit
2. Land*						
a. Railroad Road Access	4.93	ha	6,000 /sqm*	295.80	B. Sucat, Muntnlupa	60 m width, Residential area
3. Fishery						
a. Reclamation for the airport	1,396	ha.	90,000.00	62.82	West Laguna airport site	Pish pen installation cost w/depreciation
b. Reclamation for the airport	1,396	ha.	14,000.00	195.44	West Laguna airport site	Economic loss of LGU for 10 yrs**
c. Reclamation for the airport	1,396	ha.	88,000.00	460.68	West Laguna airport site	Economic Loss of investors 3.75 yrs***
			Total	1,075.94		

* Bureau of Intrnal Revenue Zonal Value, for comparison purpose only
** Assumed airport construction period
*** Assumed average renewal period :7.5 (yrs), with average (50%) depreciation: 3.75 (yrs)

8.4.6.2 Project Affected People for Resettlement

The rough numbers of project affected people are estimated by roof counting of the buildings which fall in the project area. Sangley Option-1 and San Nicholas have the same 4,081 people, PAPs of Sangley Option-2 and Manila Center require 6,156 people be resettled by railroad and access road, while 269 for Laguna West site. A comparison of five sites is shown in Figure 8.4-18.

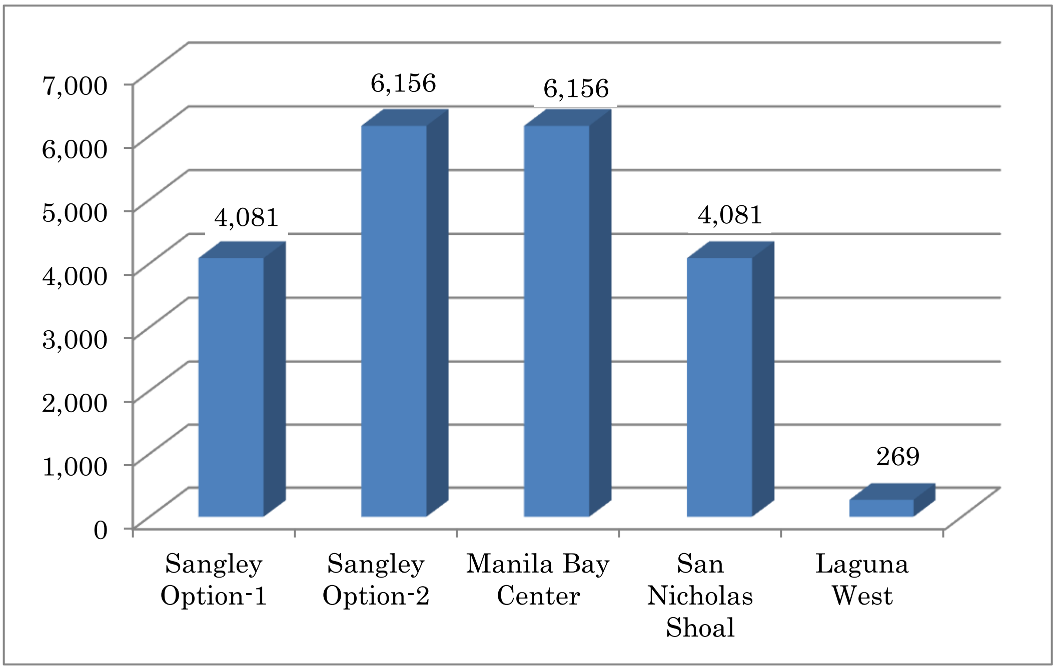


Figure 8.4-18 Comparison of Project Affected People (Resettlement only)

8.4.7 Mitigation Measures

The mitigation measures, described in Table 8.4-11 are proposed based on results of field survey and reviewing water quality and offshore current at the alternative sites. The significant impacts are expected as the scale of resettlement by rail road and access road. Other significant impacts are: fishery ground loss by reclamation in intensive fish culturing in Manila Bay and Laguna Lake; and disturbance of living environment of benthic shellfish by seabed quarries.

Table 8.4-11 Mitigation Measures for Environmental and Social Impacts of Alternative Sites

Type of Impact	Description of Expected Significant Impact	Possible Mitigation Measures	Corresponding Alternative site				
			Sangley OP1	Sangley OP2	Manila Bay Center	San Nicholas Shoal	Laguna West
1. Resettlement	- Access road and the interchanges, and railroad require resettlement for the land	- Alternation of the routes to the offshore area. - Redesigning of interchange locations	✔	✔	✔	✔	-
2. Water quality degradation & Sedimentation (during operation)	- Water surface of Bacoor Bay and nearby areas are susceptible to red tide already due to weak current. Reclaimed land will obstruct the weak littoral	- Modification of airport boundary to secure water exchange - Installation of sewerage treatment plant at estuaries of rivers.	✔	✔	✔	-	-

Type of Impact	Description of Expected Significant Impact	Possible Mitigation Measures	Corresponding Alternative site				
			Sangley OP1	Sangley OP2	Manila Bay Center	San Nicholas Shoal	Laguna West
	current and forms less-interchangeable waterbody. Thereby it aggravates the surrounding sea's water quality. - It also blocks littoral drift of sediment. It may cause the downstream area (northern part) be eroded; on the other hand, the western part will be accreted and clog rivers' outlets.	- Water pollution control at the pollution sources (factories and domestic) - Periodical excavation is required, or setting-off the proposed airport location toward offshore direction					
3. Water quality degradation (During construction)	- Turbid plume emerges at the excavation site and reclamation area. Since settling speed is slow since bottom surface is covered by clay; and the plume may reach remote areas without proper mitigation measure. High pH in at the construction site may affect living environment of the surroundings.	- Avoid using clamshell dredger - Usage of water screens	✔	✔	✔	✔	✔
4. Narrowing of estuary	- Ilong-Ilong River has high sediment load, and the estuary is ever enlarging, making Bacoor Bay shallower. Reclamation of offshore area of Cavite Peninsula will block sediment proliferation away to the estuary. - Narrowed estuary will affect flood flow of the river and may aggravate flooding the flood prone upstream area.	- Periodical excavation of the sediment near the new airport area and estuary channels. - Opening of channel to west side of Cavite Peninsula for another outlet of Ilong-Ilong River			✔		
5. Livelihood (Airport construction on Fishery)	- Fisherman will lose 2,400 ha of municipal fishing ground - Fisherman who moor their boats behind the new airport will have to travel extra mileages for going outside of the airport costing more fuel and time	- Monetary compensation, providing motorized boats - Creation of mooring facilities or land for fishing industries as compensation	✔	✔	✔	✔	✔

Type of Impact	Description of Expected Significant Impact	Possible Mitigation Measures	Corresponding Alternative site				
			Sangley OP1	Sangley OP2	Manila Bay Center	San Nicholas Shoal	Laguna West
	- Intensity of fishing gear is higher at Manila Bay Center site and Laguna Lake site						
6. Livelihood (Seabed quarry on Fishery)	- Seabed quarry at the PRA proposed site will devastate impacts on Rosario and Tanza's (and may Naic, Ternate also) fishery resources. Severe damage on income source of fisher folks is expected.	- Compensation based on thorough survey and consultation with fisherman and LGU. - Support for alternative employment	✔	✔	✔	✔	
7. Livelihood (Tourism)	- Offshore reclamation will eliminate tourism assets (beach environment with view) of the area, causing the tourism industry less attractive.	- Compensation - Providing priority opportunities at new airport site	✔			✔	
8. Biodiversity	- There are fish sanctuaries in Rosario, Tanza and Muntinlupa, Laguna Lake. Tanza fish sanctuary will be totally lost by reclamation while the one in Muntinlupa will be behind the airport.	- Providing artificial fish reef near the airport area. Offshore structure may very well be good fish sanctuary with some modifications.				✔	✔
9. Resilience against flooding (Laguna Lake)	- Losing flood capacity of Laguna Lake for flood control purpose by replacing more than 36 million cum of waterbody by structure	- Excavation of the same amount of sediments from the Lake - Resettlement of people who live on low laying area - Create new discharge channel by using part of Ninoy Aquino International Airport, or by other routes.					✔

8.5 Assessment on Natural Disaster Risks

8.5.1 Introduction

A comprehensive seismic hazard and geohazard (non-seismic) identification is prerequisite to investigate appropriate site for new airport. The results of the study will serve as input for the selection of appropriate site which will be subjected to the consequent study stage.

Data have been collected from various government agencies such as National Mapping and Resource Information Authority (NAMRIA)[1], Philippine Institute of Volcanology and Seismology (PHIVOLCS)[2] and Mines and Geosciences Bureau (MGB)[3]. In addition, the READY Project which is an inter-agency undertaking between CSCAND, NDCC, OCD, MGB, NAMRIA, PAASA, PHIVOLCS, UNDP and AUSAid provides various detailed hazard maps. Aside from maps, relevant reports are available from PHIVOLCS.

8.5.2 Overall Condition

1) Tectonic Setting

All five prospective sites are located within the Philippine Mobile Belt. This refers to the portion of the Philippine archipelago bounded by the Manila-Negros and Cotabato Trenches on the west and the East Luzon and Philippine Trench to the east and traversed along its entire length by the active, 1200 kilometer long Philippine Fault Zone. The Philippine Mobile Belt is therefore tectonically, seismically and volcanically active. This is in contrast to the generally aseismic Eurasian margin which includes Palawan. Figure 8.5-1 shows the distribution of the trenches and faults in the Philippines.

2) Regional Geology

The elevation ranges from below sea level to more than 1,000m as shown in Figure 8.5-2. This map is interpreted to a slope map in Figure 8.5-3. The slope map shows that gradual slope areas are spread in the western part of Greater Capital Region (GCR) and hilly steep slope areas are located in the eastern and southern part of GCR.

The regional geology in GCR is described in detail with respect to following two regions of a) Manila Bay and b) Laguna Lake and Marikina Valley.

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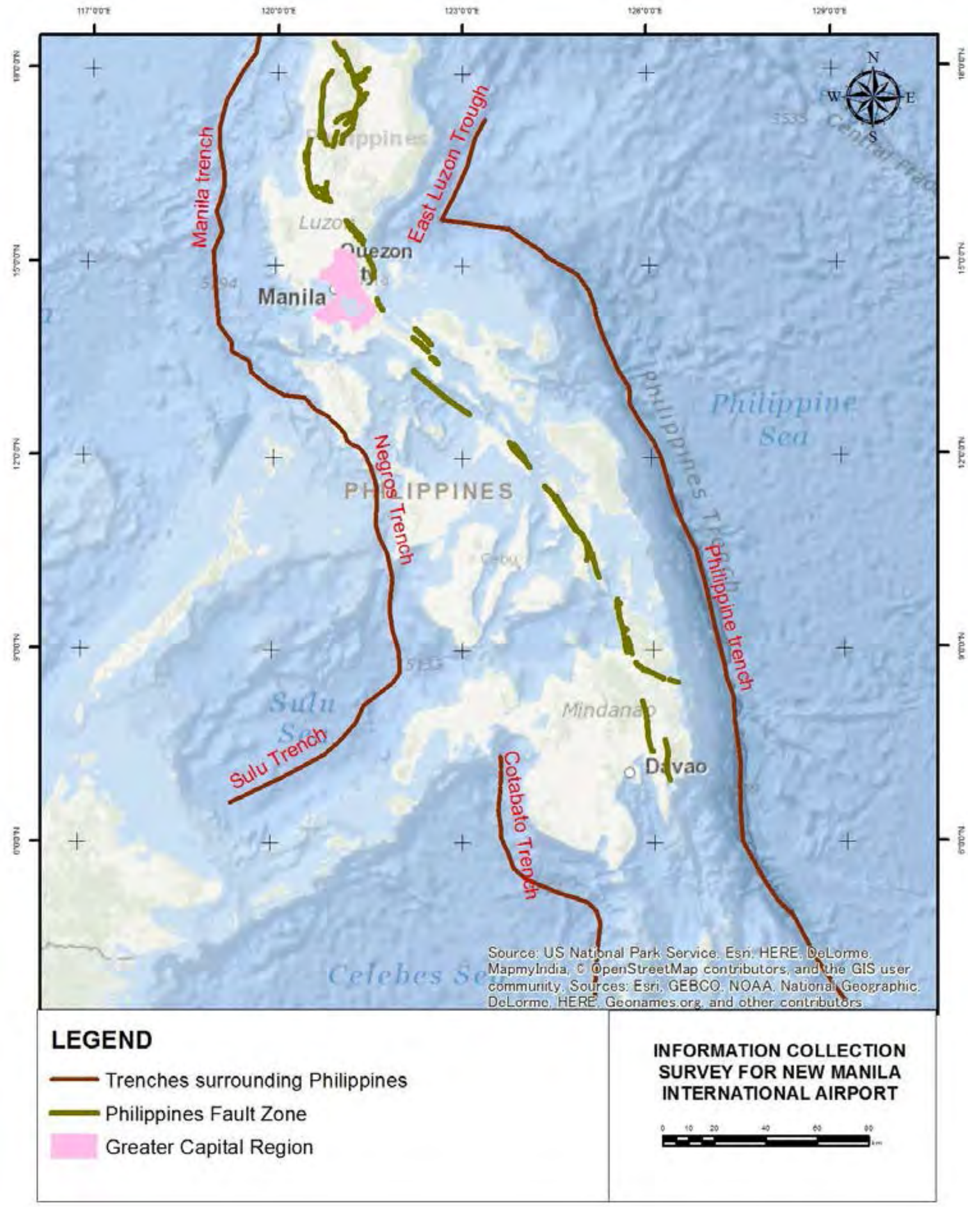
1 NAMRIA produces basic topographic, bathymetric and nautical maps of various scales.

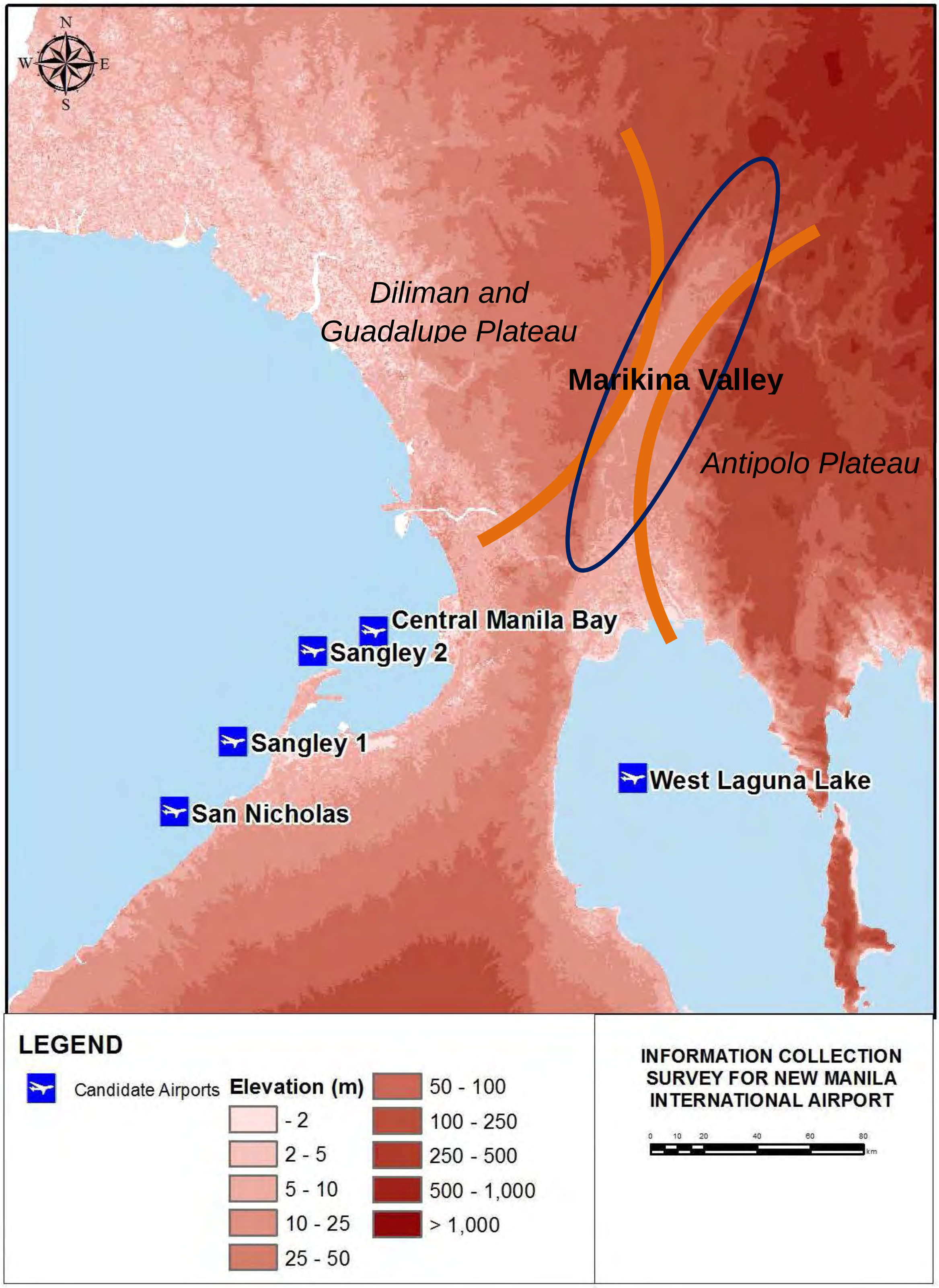
2 PHIVOLCS has the mandate over seismic and volcanic hazards. It produces geohazard maps and reports which includes a recently released Atlas of the Valley Fault System in the Greater Metro Manila Area.

3 MGB has the mandate over flooding and landslides. Landslide and flooding susceptibility maps are available at the 1:50,000 and 1:10,000 scale.



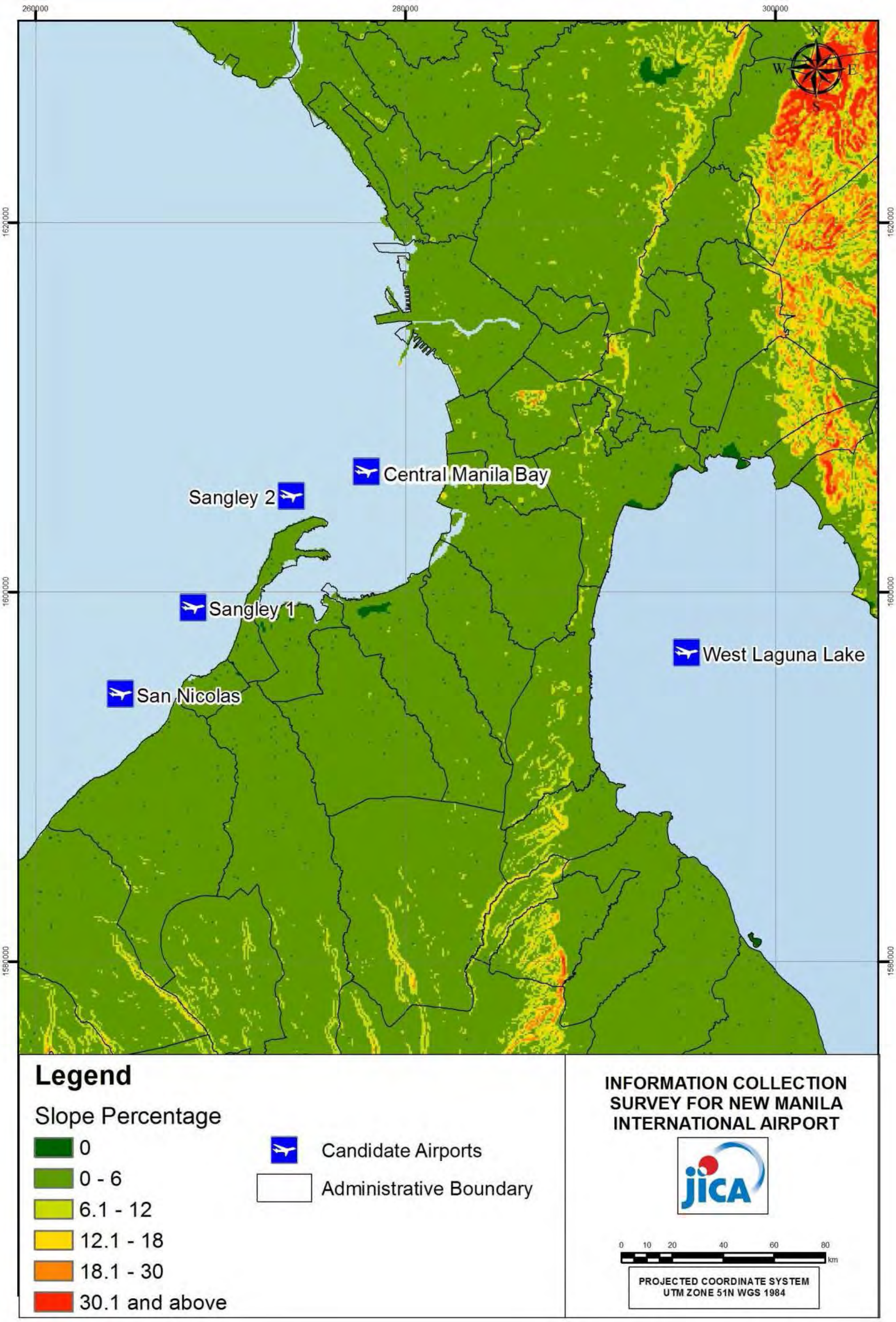
Source: Prepared by JICA Survey Team based on data from PHIVOLCS

Figure 8.5-1 Major Trenches and Faults in the Philippines



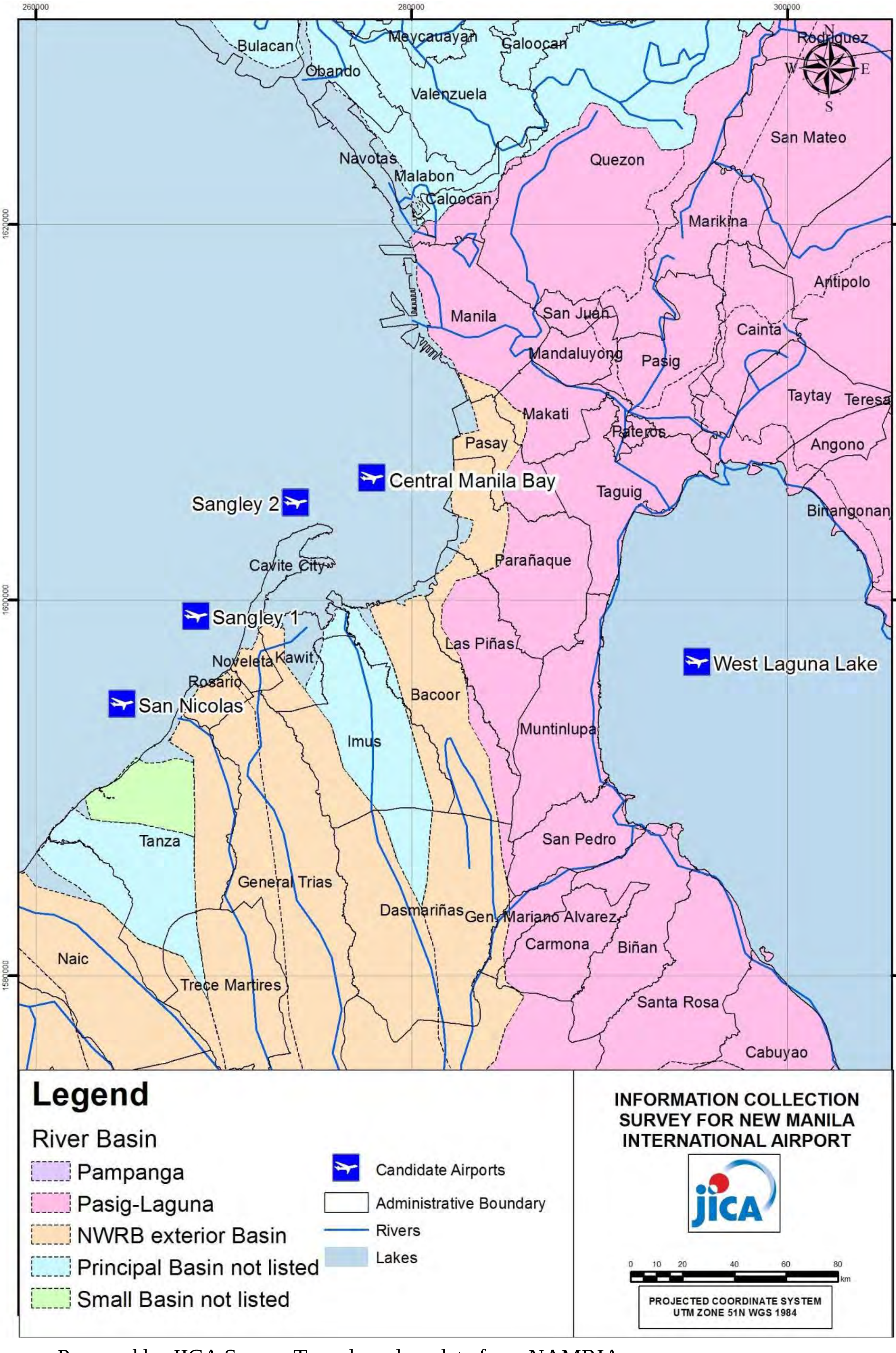
Source: Prepared by JICA Survey Team based on data from NAMRIA

Figure 8.5-2 Elevation



Source: Prepared by JICA Survey Team based on data from NAMRIA

Figure 8.5-3 Slope



Source: Prepared by JICA Survey Team based on data from NAMRIA

Figure 8.5-4 Water System

a) Manila Bay

North of the mouth of Manila Bay and partly enclosing the bay is Bataan Peninsula which consists of two potentially active major stratovolcanoes: Mounts Natib and Mariveles. The island of Corregidor, at the mouth of the bay, represents the remnants of a caldera rim.

North of Manila Bay is the Luzon Central Basin, a present-day sedimentary basin which extends all the way to Lingayen Gulf. A major river, the Pampanga River, empties into the bay from the basin.

South of Manila Bay, the dip slope of Tagaytay Ridge descends gently to the north towards Manila Bay. The slope is underlain by Quaternary Tuffs. A prominent feature along the coast of Cavite is a sand spit which is concave to the east.

In the Manila area, east of the bay, deposits of Pasig River are superposed on the Quaternary tuffs of the Diliman and Guadalupe Plateaus.

b) Laguna Lake and Marikina Valley

A relief map of Metro Manila (refer to Figure 8.5-2 Elevation Map) shows the Marikina Valley sandwiched between the Guadalupe and Diliman Plateaus on the west and the Antipolo Plateau on the east. To the south, the Marikina Valley opens up towards Laguna Lake.

A pronounced, east-facing escarpment separates Marikina Valley and Laguna Lake from the Guadalupe and Diliman Plateaus. A shorter, west-facing escarpment separates Marikina Valley from the Antipolo Plateau.

Meandering through the Marikina Valley is Marikina River which joins the Pasig River. In flowing westward, Pasig River traverses the escarpment and incises itself into the Guadalupe-Diliman Plateau near Guadalupe. This serves as the only outlet to Marikina River and Laguna Lake. Figure 8.5-4 shows the water system of the Study Area.

8.5.3 Seismic Hazard Identification

All five prospective sites are located in a region where is tectonically and seismically active. Seismic hazards are therefore major concerns.

1) Earthquake Generators

Earthquake generators may be described as being either far sources or near sources. Near source earthquake generators are those that occur within three or five kilometers of a site. Far source earthquake generators are those that occur beyond a distance of five kilometers from a site.

For far source earthquake generators, the peak ground acceleration (PGA) that a site can experience decreases as a function of distance of the site to the earthquake source. The farther the site is from the source, the lower the ground motion that the site can experience.

For near source earthquake generators, it no longer matters whether a site is five meters or three kilometers from the earthquake source. The sites will more or less experience the same ground motion regardless of distance to the fault.

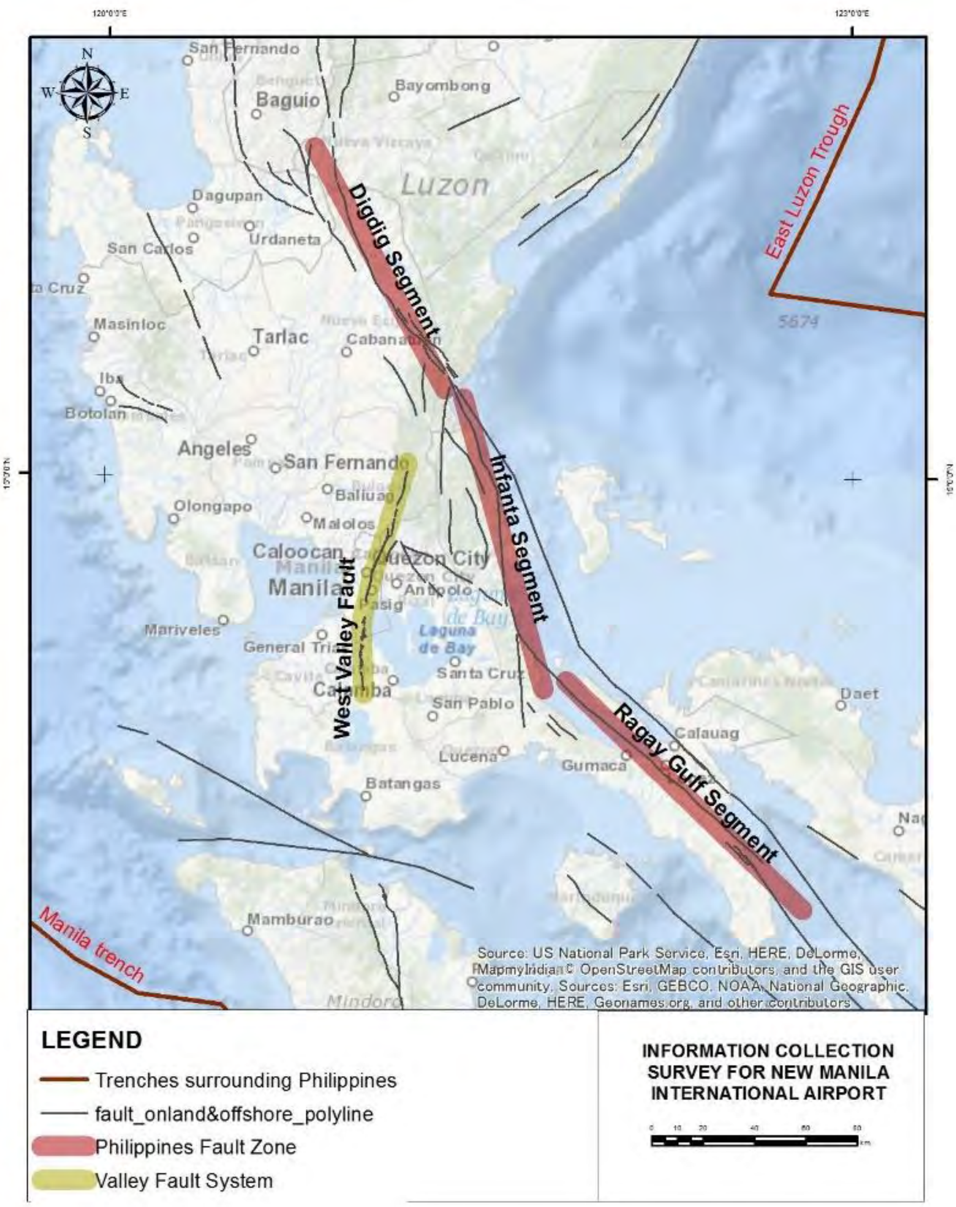
Possible earthquake generators of huge earthquake that affects the candidate sites are a) Valley Fault System, b) Philippine Fault Zone and c) Manila Trench. The Valley Fault System is consisted of West Valley Fault and East Valley Fault. Since the West Valley Fault is nearer to the candidate sites, that is selected for the further analysis on the ground motion. The Philippine Fault Zone is consisted of many segments such as Infanta Segment, Digdig Segment, Ragay Gulf Segment and so on. The Infanta Segment is selected for the further analysis on the ground motion. Distribution of these faults and trench are depicted in Figure 8.5-5.

In the case of all five candidate sites, the West Valley Fault is the nearest earthquake generator. Table 8.5-1 summarizes the possible earthquake generators and distance to the prospective airport sites. The 5th candidate site of Laguna de Bay is locating 3km from the West Valley Fault.

Table 8.5-1 Earthquake Generators and Distance to the Prospective Airport Sites

	Sangley Option 1	Sangley Option 2	Central portion of Manila Bay	San Nicolas	Laguna de Bay
Valley Fault System (West Valley Fault)	19	17	12	23	3
Philippine Fault Zone (Infanta Segment)	79	84	74	85	62
Manila Trench	190	194	202	182	215

Source: Prepared by JICA Survey Team



Source: Prepared by JICA Survey Team based on data from PHIVOLCS

Figure 8.5-5 Trenches and Faults in Southern Luzon Island

a) Valley Fault System

The NNE-SSW trending Valley Fault System, formerly known as the Marikina Fault, is a system of active faults that cuts through Metro Manila. It consists of the West Valley Fault and East Valley Fault.

The West Valley Fault extends from the southern Sierra Madre to Tagaytay over a distance of 110 kilometers. A well-defined, east-facing escarpment separates the Guadalupe-Diliman Plateau from the Marikina Basin.

The shorter East Valley Fault extends over a distance of about thirty kilometers. A prominent, west-facing escarpment observed in the San Mateo-Marikina-Antipolo area separates the Antipolo Plateau from the Marikina Valley. The southern termination of the East Valley Fault is poorly defined.

There is no seismic activity that can be definitely related to the Valley Fault System. Nevertheless, several lines of evidence indicate that the faults are active:

- the presence of young morphological features along the fault
- the presence of a superposed drainage (Pasig River) on the Guadalupe-Diliman Plateau which is underlain by the Quaternary Diliman Tuff
- the presence of fault planes in the Quaternary Diliman Tuff
- the presence of deformation in man-made structures (e.g. roads, houses) in the Muntinlupa-Taguig-Pasig area
- deformation in alluvial material in trenches excavated during paleoseismic studies conducted by PHIVOLCS
- Carbon-14 dating

A recurrence interval of 200 to 400 years during the last 1400 years has been arrived at based on Carbon-14 dating (Daligdig et al, 1997). The same study has the last event occurring during the 18th or 19th century.

No historical information or seismic activity can definitely be associated with the Valley Fault System. However, as shown in the next paragraph, there is geological and paleoseismic evidence to show that the West and East Valley Faults are active.

That there is no seismic activity can mean that stress is accumulating and is not being released. This implies that, despite the absence of seismic activity, the risk of a major earthquake occurring along the West Valley Fault is actually high.

b) Philippine Fault Zone

Another major earthquake generator is the Philippine Fault Zone (*Infanta Fault*) which is a left lateral strike slip fault that extends over a distance of 1,200 kilometers. It is the most active earthquake generator in the country and has been the source of several devastating earthquakes.

The segment north of the Infanta segment of the Philippine Fault Zone, the *Digdig Fault*, was the source of the July 16, 1990 Northern Luzon earthquake which resulted in a magnitude 7.8 earthquake and a left lateral displacement of 5 to 6 meters over a ground rupture of 90 kilometers.

The segment south of it, in Bondoc Peninsula, gave rise to the March 17, 1973 Ragay Gulf earthquake of magnitude 7.3 which likewise gave rise to a ground rupture whose length could not be determined since it extended offshore in both directions. However, a left lateral displacement of 3.2 meters was measured.

The Infanta segment of the Philippine Fault Zone, on the other hand, is seismically quiet. This seismic gap which the fault is associated is believed to indicate that stress is accumulating and is not being released. The Infanta segment is therefore a candidate site for a major earthquake.

c) Manila Trench

The Manila Trench can be traced as a narrow but elongated bathymetric depression that extends from Taiwan to Mindoro. Both Taiwan and Mindoro are sites of collision zones. The trench accommodates eastward subduction of oceanic crust of the South China Sea Basin beneath the Luzon arc.

The trench is associated with an eastward dipping Benioff zone, thrust focal mechanism solutions and a belt of active volcanoes which includes Mounts Pinatubo, Natib and Mariveles. Seismic reflection profiles across the 5,100-meter deep trench show deformation of the sedimentary fill. These show that the trench is active.

2) Recent Earthquakes occurred during 1970 to 2015

A search of the US Geological Survey National Earthquake Information Center (USGS NEIC) earthquake data base for all events stronger than magnitude 4.0 over a 100 kilometer radius of the proposed project site from January 1, 1970 to June 12, 2015 listed a total of 482 events. Of the list of 482 events, only 3 are strong earthquakes with magnitudes are equal to or stronger than magnitude 6.0. All the rest of the events are small to moderate being less than magnitude 6.0 (Table 8.5-2).

The strongest earthquake is the magnitude 7.0 earthquake of April 23, 1985 with epicenter near Mount Arayat (15.344 N, 120.610 E). The focal depth of 188.4 kilometers suggests an affinity with Manila Trench and not Mount Arayat. The second strongest event is the magnitude 6.5 earthquake of October 8, 2004 with epicenter over the Lubang Strait (13.925 N, 120.534 E). A focal depth of 105 kilometers suggests an affinity with the Manila Trench and not Lubang Fault. The magnitude 6.0 earthquake of September 15, 2004 has a focal depth of 115.4 kilometers likewise suggesting the Manila Trench as the source of the earthquake.

Table 8.5-2 Earthquake Magnitude Distribution

interval	number	percentage
7.51 – 8.0	0	00.00
7.01 – 7.5	0	00.00

6.51 – 7.0	1	00.21
6.01 – 6.5	2	00.41
5.51 – 6.0	18	03.73
5.01 – 5.5	52	10.79
4.51 – 5.0	199	41.29
4.00 – 4.5	210	43.57
total	482	100.00

Source: Prepared by JICA Survey Team

3) Design Earthquakes

Design earthquakes can be determined using different empirical formulas relating fault length, rupture length and magnitude[4].

The West Valley Fault is the nearest earthquake generator. A study entitled Metro Manila Earthquake Impact Reduction Study (MMEIRS) jointly conducted by the Metro Manila Development Authority (MMDA), Japan International Cooperation Agency (JICA) and Philippine Institute of Volcanology and Seismology (PHIVOLCS) reports that the West Valley Fault is capable of generating a magnitude 7.2 earthquake. The Philippine Fault Zone, on the other hand, is such a major fault that it is capable of generating a magnitude 8.0 earthquake. A magnitude 8.0 earthquake is such a rare event that it occurs, on the average, only once a year or once in two years worldwide. The Manila Trench, a primary tectonic feature, is assigned a magnitude 8.0 design earthquake.

4) Faulting

An active fault is here defined as a fault which has moved during the last 10,000 years. The criteria (geological, historical, seismological) used for recognizing an active fault and the system for classification (active, potentially active, activity unknown, inactive) of fault activity based on available data are taken from Cluff et al (1972) in Hunt (1984).

There is no known active or potentially active fault cutting through all four sites in Manila Bay. There is therefore no risk of displacement, either through a catastrophic ground rupture or through aseismic fault creep, the Manila Bay sites.

This is in contrast to the site in Laguna Lake which is immediately adjacent to the West Valley Fault which can be considered a near source earthquake generator.

5) Ground Motion

Slopes, structures and foundations will experience seismic loading in case of a major earthquake along any of the nearby earthquake generators. Fortunately, the ground motion that a site can

4 Bonilla (In Weigel (ed), 1970)

experience can be estimated knowing the earthquake magnitude, distance to the earthquake generator and foundation conditions.

In order to determine the ground acceleration that a site can experience in case of a major earthquake, the attenuation model of Fukushima and Tanaka is applied (In Thenhaus et al, 1994). A design earthquake is assumed to occur at a point along the causative fault that is nearest to the site. Correction factors are then applied depending on the type of foundation material.

a) West Valley Fault

As has been mentioned, the West Valley Fault is the nearest earthquake generator. MMEIRS reports that the West Valley Fault is capable of generating a magnitude 7.2 earthquake. All five candidate sites can be considered to be underlain by soft soil which makes poor foundation material in terms of attenuation of seismic waves. We can come up with initial Peak Ground Acceleration (PGA) for all five sites assuming a magnitude 7.2 earthquake occurs along the West Valley Fault.

Results show that, the Laguna Lake site can experience a PGA of 0.56g. This value is increased to 0.78g if corrected for ground conditions which would be soft soil.

PGA would range from 0.30g to 0.41g for the Manila Bay sites. The values are increased to 0.42g to 0.57g if corrected for foundation conditions.

Table 8.5-3 Expected PGA with Magnitude 7.2 Earthquake along the West Valley Fault

Site	Location	M	R	PGA	$PGA_{soft\ soil}$
Site 1	Sangley Option 1	7.2	19 km	0.33g	0.46g
Site 2	Sangley Option 2	7.2	17 km	0.35g	0.49g
Site 3	Central portion of Manila Bay	7.2	12 km	0.41g	0.57g
Site 4	San Nicolas	7.2	23 km	0.30g	0.42g
Site 5	Laguna de Bay	7.2	3 km	0.56g	0.78g

Note: "M" means Magnitude, "R" means Radius, "PGA" means Peak Ground Acceleration, "$PGA_{soft\ soil}$" means Peak Ground Acceleration in case of soft soil condition
Source: JICA Study Team

b) Manila Trench

The trench is approximately 215 kilometers from the Laguna Lake sites and 182 to 202 kilometers from the Manila Bay sites. A magnitude 8.0 design earthquake is assigned to the trench.

Results show very low values in case a very strong magnitude 8.0 earthquake occurs along the Manila Trench.

Table 8.5-4 Expected PGA with Magnitude 8.0 Earthquake along the Manila Trench

Site	Location	M	R	PGA	$PGA_{soft\ soil}$
Site 1	Sangley Point Option 1	8.0	190 km	0.04g	0.06g
Site 2	Sangley Point Option 2	8.0	194 km	0.03g	0.04g
Site 3	Central portion of Manila Bay	8.0	202 km	0.03g	0.04g
Site 4	San Nicolas Shoals	8.0	182 km	0.04g	0.06g
Site 5	Western Portion of Laguna de Bay	8.0	215 km	0.03g	0.04g

Note: "M" means Magnitude, "R" means Radius, "PGA" means Peak Ground Acceleration, "$PGA_{soft\ soil}$" means Peak Ground Acceleration in case of soft soil condition

Source: JICA Study Team

c) Philippine Fault Zone

The Infanta segment of the Philippine Fault Zone which is 62 kilometers from Site 5 and 74 to 85 kilometers from Sites 1 to 4. A magnitude 8.0 earthquake is assigned to the fault. Results range from 0.14g to 0.19g.

Table 8.5-5 Expected PGA with Magnitude 8.0 Earthquake along the Philippine Fault Zone

Site	Location	M	R	PGA	$PGA_{soft\ soil}$
Site 1	Sangley Option 1	8.0	79 km	0.15g	0.21g
Site 2	Sangley Option 2	8.0	84 km	0.14g	0.19g
Site 3	Central portion of Manila Bay	8.0	74 km	0.16g	0.22g
Site 4	San Nicolas	8.0	85 km	0.14g	0.19g
Site 5	Laguna de Bay	8.0	62 km	0.19g	0.26g

Note: "M" means Magnitude, "R" means Radius, "PGA" means Peak Ground Acceleration, "$PGA_{soft\ soil}$" means Peak Ground Acceleration in case of soft soil condition

Source: JICA Study Team

6) Liquefaction and Settlement

The seismic-related hazards such as liquefaction and settlement are concerns since most candidate sites are underlain by Recent Deposits in the form of water-logged soft sediments.

The liquefaction hazard map sourced from PHIVOLCS in Figure 8.5-6 shows that portion of the Luzon central basin, the coastal areas around Manila Bay and Laguna Lake are susceptible to liquefaction.

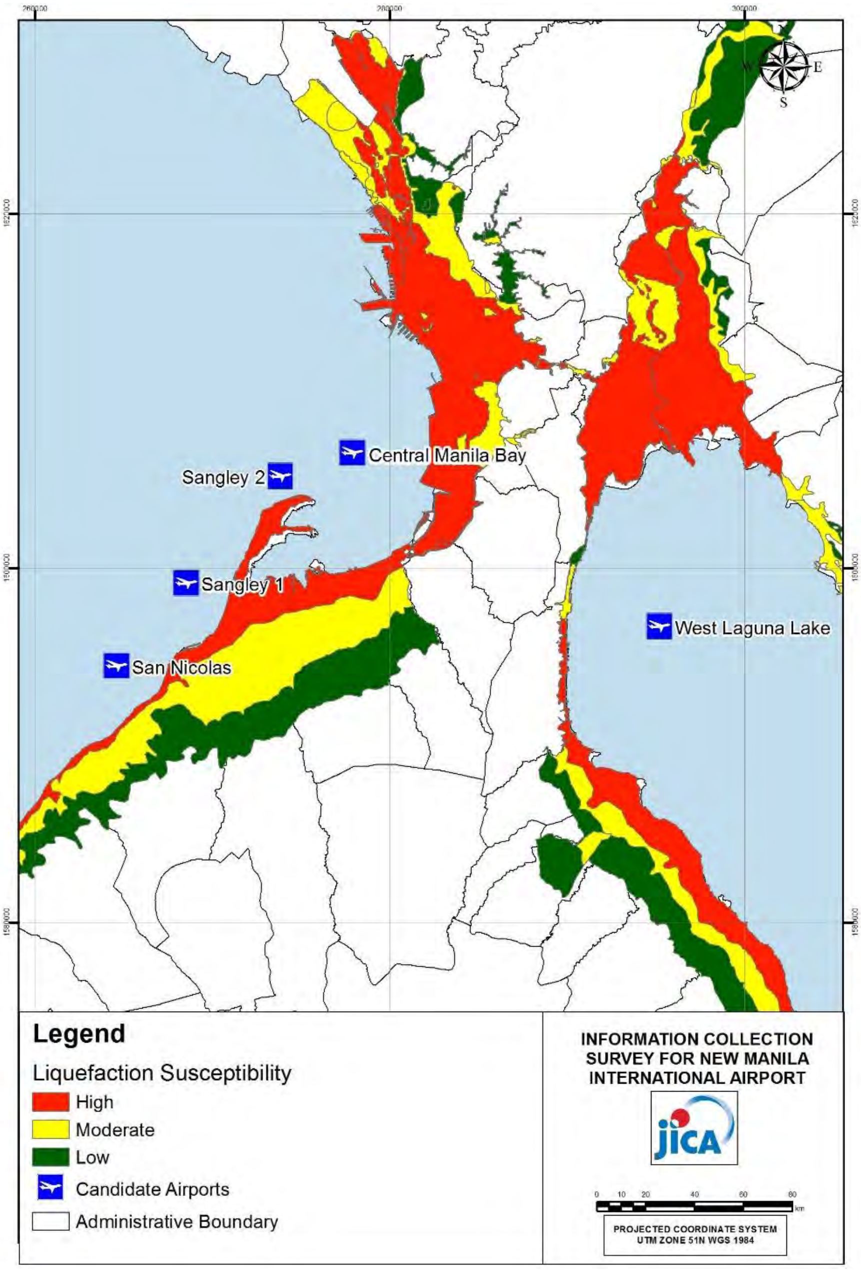
Historical event of liquefaction have been reported. As what happened in Dagupan City during the July 16, 1990 earthquake of magnitude 7.8, usually occurs in loose silt to fine sand with low SPT N-values ($N < 15$) and shallow ground water levels. Liquefaction usually originates from depths less than fifteen (15) meters.

Reclamation areas are known to be generally susceptible to liquefaction. Ingredients for liquefaction to occur are usually inherent in reclamation projects: grain size, low SPT N-values, shallow ground water levels. Differences would usually lie in the capacity of earthquake generators to trigger liquefaction. All five prospective sites are susceptible to liquefaction.

There are several levels in the assessment of liquefaction potential:

- geological assessment which is based basically on morphology and geological environment
- geological assessment of borehole logs which takes into consideration grain size, depth and water level
- quantitative liquefaction potential analysis (e.g. Seed and Idriss) which takes into consideration geotechnical parameters, drilling corrections and ground acceleration

However, it is highly recommended that further geotechnical investigations in the consequent study stage include a quantitative liquefaction potential analysis before and after reclamation.



Source: Prepared by JICA Survey Team based on data from NAMRIA

Figure 8.5-6 Liquefaction Hazard

7) Earthquake-induced Submarine Landslide

The seafloors or lakeshore at the five candidate sites are practically flat or gentle. There are no steep slopes or submarine canyons that can cause instability to all five candidate sites.

However, it is a slope of the reclamation that have to be modeled against failure taking into consideration the slope geometry, the nature of the coastal protection and the engineering properties of the materials used. Slope stability analysis should be conducted in the consequent study stage.

8) Tsunami

Not all earthquakes generate tsunamis. The following are required for an earthquake to be tsunamogenic: i) the epicenter is located offshore, ii) the magnitude is sufficiently strong, iii) earthquake source is shallow and iv) the displacement is vertical.

Tsunami generators may be described as being far source or near source. Far or distant sources often provide ample warning time – for example, 24 hours for a tsunami generated off the west coast of South America.

Near or local sources, on the other hand, do not provide ample warning time. The time between the generation of the tsunami and the time it hits land may be in the order of only several minutes.

Being located on the western seaboard of the country, there is no far source tsunami generator that can impact Manila Bay. In the case of Manila Bay, an additional requirement would be that the epicenter should be fronting the mouth of Manila Bay. An earthquake too far south will have its tsunami deflected by Lubang Island and the northwest tip of Mindoro. Too far north and the bay would be protected by the Bataan Peninsula. The presence of Corregidor Island at the mouth of the bay is a major consideration.

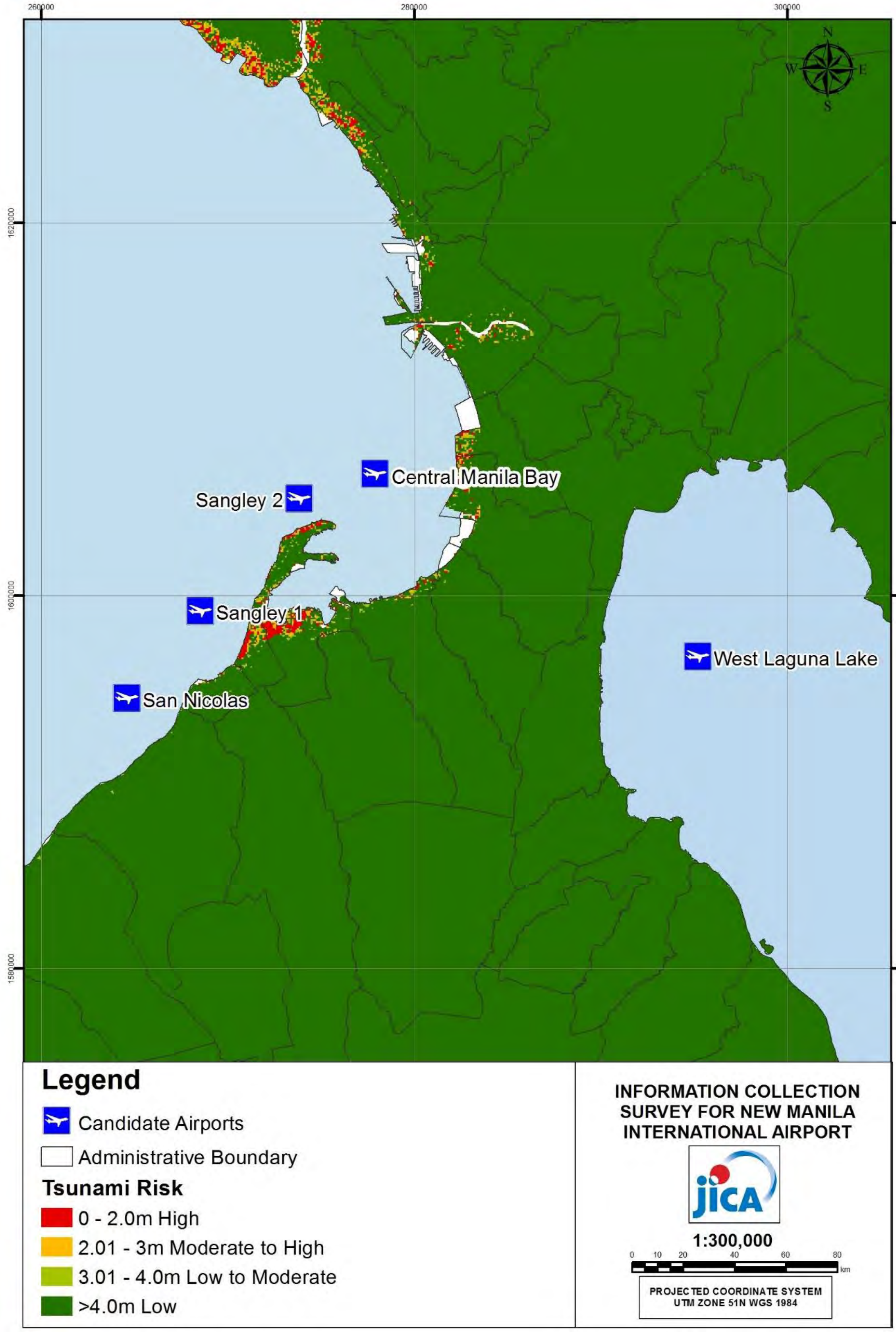
However, the Manila Trench is located just outside the mouth of the bay. The Manila Trench can be considered a local source of tsunamis.

The Tsunami Hazard Map of the Philippines shows that Manila Bay has a high susceptibility rating to tsunamis and has actually experienced historical events. This is in contrast to Laguna Lake which, being an inland lake, is not susceptible to tsunamis.

MMEIRS estimated the tsunami hazard (without consideration of the influence by Corregidor Islands and shape of Manila bay) based on the scenario earthquake which occurs at Manila Trench with magnitude 7.9 and causes tsunami. The possible height of tsunami was estimated to 2m in average and 4m in maximum and arrival time was estimated to 70 minutes after earthquake occurrence.

After occurrence of heavy earthquake in Sumatra in December 2004, USGS pointed out the possibility of magnitude 8 class earthquake and incidental tsunami. Corresponding to this, PHIVOLCS are reviewing the assumption, however, the results have not yet opened to the public.

Figure 8.5-7 shows the tsunami hazard map applying the possible tsunami height in MMEIRS to detail contours in GCR. The hazard level is classified into 4 levels from low to high. High tsunami hazard areas are located along the sea shore with lowland areas. Tsunami incursion studies would have to be conducted in the consequent study stage.



Source: Prepared by JICA Survey Team based on data from NAMRIA

Figure 8.5-7 Tsunami Hazard

9) Seiche

Other from Manila Bay side where is highly susceptible to tsunamis, Laguna Lake is not prone to tsunamis but need consideration to the possibility of seiches. The seiche is a standing wave in an enclosed or partially enclosed body of water. A seiche is occurring due to the extremely long wavelengths. The effect is caused by resonances in a body of water that has been disturbed by one or more of a number of factors, most often meteorological effects (wind and atmospheric pressure variations), seismic activity or by tsunamis.

8.5.4 Geohazard (Non-Seismic) Identification

1) Coastal Hazards

Tsunamis and liquefaction, which may be classified as being both seismic and coastal hazards, have already been discussed on the section on seismic hazards.

a) Coastal Erosion, Aggradation and Scouring

A reclamation project can interfere with longshore currents that distribute sediments along the coast. It can result in coastal erosion on one side of the project and aggradation on the opposite side. The presence and geometry of the Cavite sand spit shows that sediments are being transported and the direction in which they are transported

The cavite sand spit is fed by sediments fed by tributaries to the west all the way to Maragondon. The morphology of the sand spit and the river mouth deposits of these tributaries suggest that longshore currents are directed to the northeast driven by waves from outside the bay.

Scouring is also one of the possible coastal hazard caused by swiftly moving water such as tide.

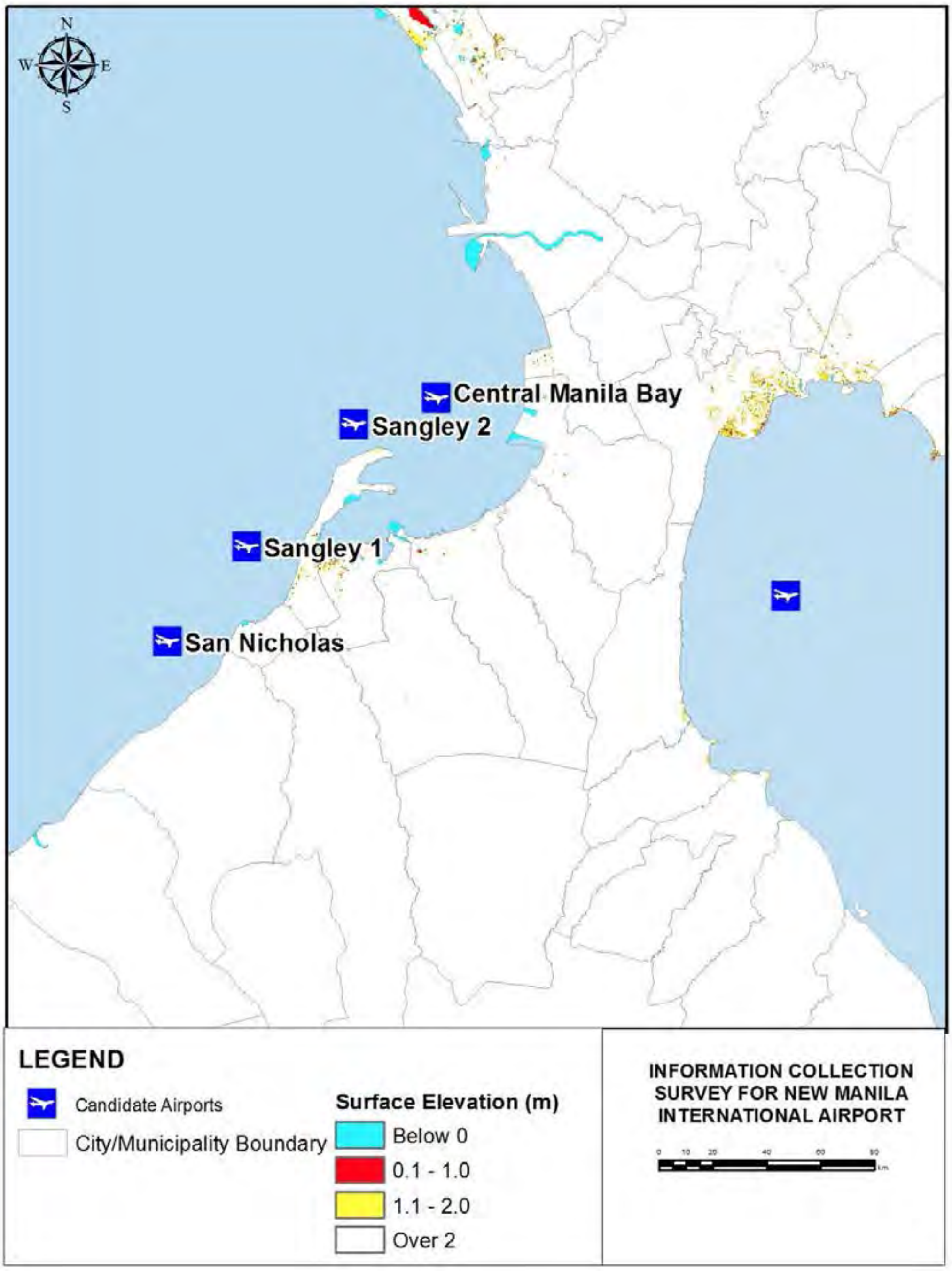
Dredging in San Nicolas Shoal might result in sediment starvation and cause erosion of the sand spit. The impact of the reclamation itself also has to be assessed. This can be addressed by conducting coastal engineering studies in the consequent study stage.

b) Storm Surge

The coastal areas of Manila Bay are highly susceptible to storm surges. The last storm surge was experienced during Typhoon Pedring in September 2011 when Taft Avenue was flooded and a well-known restaurant in a 5-star hotel located on reclaimed land was damaged. Manhole covers of drainage lines in reclamation areas reportedly shot several meters into the air during the storm surges. Since the storm surge did not cause a disaster, it was easily forgotten. Storm surge is a concern for Sites 1 to 4 in Manila Bay.

c) Coastal Flooding

The sea-level rise caused by climate change is one of the possible coastal flooding other from tsunami and storm surge described above. The Intergovernmental Panel on Climate Change (IPCC) estimated global mean sea-level rise in 2100 to be 0.6m in case of the middle case named SRES A1B (refer to Table 7.2-5 in ITR). Figure 8.5-8 shows the lowland areas where elevation is below 1m and 1~2m based on Digital Surface Map (DSM). Those areas are susceptible to inundation caused by sea-level rise.



Source: Prepared by JICA Survey Team based on data from SPOT DSM

Figure 8.5-8 Lowland Hazard

d) Subsidence

Significant subsidence due to large scale ground water extraction have been observed in the Caloocan-Malabon-Navotas-Valenuela (CAMANAVA) area north of Manila and in Barangays Tunasan and Putatan in Muntinlupa City along the west coast of Laguna Lake fronting alternate Site 5. In the case of the CAMANA area, the alleged subsidence rates are subject to dispute due to the methodology applied. All measurements were taken from wells which are all associated with cones of depression. What is measured therefore does not represent regional subsidence. In the case of Barangays Putatan and Tunasan, displacement along the West Valley Fault was largely influenced by ground water extraction since subsidence was concentrated along the faults. Displacements were said to have slowed down when groundwater extraction was reduced (Daligdig, oral communication).

2) Fluvial Hazards

Flooding is the most common and frequently happening disaster in GCR. Recent flood situation is described in the following section targeting Manila Bay and Laguna Lake separately.

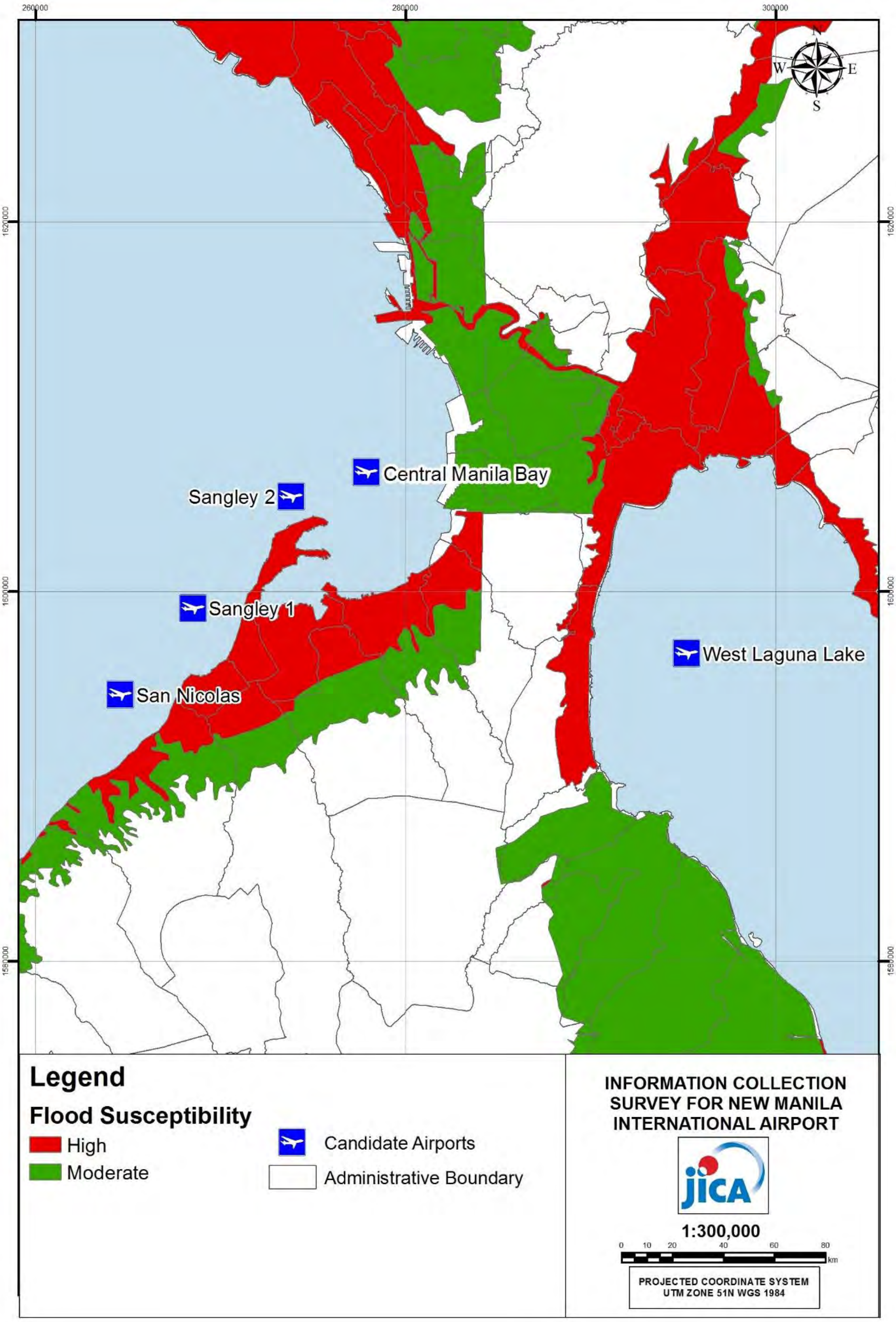
Figure 8.5-9 shows the flood hazard in GCR assessed by MGB in 5 levels from low to high.

a) Inundation in Manila Bay

The issue of flooding to the four alternative sites in the Manila Bay area is more to the mainland fronting the reclamation projects than to the sites themselves.

Whether true or not, the reclamation for the Cavite coastal expressway, for example, has allegedly impacted the drainage of Las Pinas City and Bacoor, Cavite.

Similarly, issues over potential flooding might be raised by the local governments of Naic, Tanza and Rosario over Site 4 and by Kawit, Las Pinas and Paranaque over Site 3. Similar issues are less likely to be raised against Sites 1 and 2 since the Cavite sand spit is narrow and has no major streams traversing it.



Source: Prepared by JICA Survey Team based on data from MGB

Figure 8.5-9 Flood Hazard

b) Inundation in Laguna Lake

The fifth alternative site for the prospective airport is located off the west coast of Laguna Lake within the waters of Muntinlupa City and San Pedro.

The largest fresh water lake in the country with a surface area of 950 square kilometers and a catchment area of 45,000 square kilometers, Laguna Lake is fed by 21 tributaries. Its average surface elevation is between 1 to 2 meters. Its average depth is only 2.8 meters.

At present, its only outlets are Manggahan and Napindan Channels both of which are provided with gates. Taguig River empties into the Napindan Channel. Both Manggahan and Napindan Channels flow into Marikina River which has a larger catchment area to the north. The water of Marikina River then empties to Manila Bay through Pasig River. The only outlet out of Laguna Lake and Marikina River is therefore the Pasig River which is constricted near Guadalupe.

During floods, the gates of Manggahan and Napindan Channels are opened to allow the diversion of floodwaters from Marikina River to Laguna Lake for temporary storage. Once the flood has receded, water is then released and flows through Pasig River to Manila Bay.

The coastal areas of the lake were flooded for about one month during Typhoon Ondoy in September 2009 and during the monsoon rains referred to as Habagat in August 2012. These were the worst floods to hit Metro Manila since Typhoon Yolanda in 1970.

There is morphological evidence to suggest that Ondoy and Habagat are not one-time events. Available 1:50,000 and 1:10,000 scale NAMRIA topographic maps show that Taguig River and Napindan Channel have deltas at their inlets at their upstream ends when it is common knowledge that deltas should form at the mouths of rivers at the downstream ends. This suggests that with the bottleneck along Pasig River at Guadalupe, the Marikina River, when flooded, backflows towards Laguna Lake.

A JICA study on the flood master plan for Metro Manila requires the construction of a 47 kilometer dike - together with bridges, pumping stations and ancillary flood gates - from Taguig City in Metro Manila to Los Banos in Laguna. The dike will also serve as a six-lane expressway and the project is on-going. The project location is shown in Figure 8.5-10.

A potential flooding issue may be raised by communities along the coast that are not protected by the dike. It might be claimed that floodwaters may be displaced by the volume of reclamation for the proposed airport resulting in higher flood levels.

Source: DPWH

Figure 8.5-10 Required Dike for Flood Prevention in Laguna Lake

3) Volcanic Hazards

a) Active Volcanoes

The Catalogue of Active Volcanoes in the Philippines lists three active volcanoes in Regions III and IV-A. These include Mount Pinatubo, Taal Volcano and Banahaw Volcano.

Mount Pinatubo, with a pre-eruption elevation of 1,745 meters, is located at the tri-boundary of Zambales, Tarlac and Pampanga. It forms part of the active volcanic belt of the Manila Trench which includes the Quaternary Mounts Natib and Mariveles in the Bataan Peninsula facing Sites 1 to 4 in Manila Bay.

After being dormant for 450 years, Mount Pinatubo started to show signs of activity on April 2, 1991 with five vents emitting steam on the NNW slope of the volcano. A century eruption eventually occurred in June 1991. Five cubic kilometers of ash was ejected to produce an ash column forty kilometers high. The ash covered the entire globe within 24 hours lowered the average global temperature by one degree. The eruption resulted in the formation of a caldera 2.5 kilometers across which is now filled by a crater lake.

A thirty centimeter ash layer was recognized in an area between Laguna Lake and Taal Lake. The dacitic composition of the ash is different from Quaternary volcanoes in the southern

Tagalog area which are known to be andesitic. The layer beneath the dacitic ash contains garbage which includes a popcorn wrapper with a 1990 expiration date. The dacitic ash layer corresponds to the 1991 Pinatubo eruption (Quebral, unpublished field notes).

If this area between Laguna Lake and Taal Lake could receive thirty centimeters of ash during the Pinatubo eruption, then there is no reason why all five candidate sites cannot experience ashfalls although it should be kept in mind that the Pinatubo eruption was a century eruption.

During the Pinatubo eruption, at least 16 commercial aircraft made damaging encounters while flying with the ash cloud ejected by the June 15 eruption, as well as others on the ground. The encounters caused loss of power to one engine on each of two aircraft. Ten engines were damaged and replaced, including all four engines of one Boeing 747. Longer term damage to aircraft and engines was reported, including accumulation of sulfate deposits on engines. The eruption also irreparably damaged the Philippine Air Force's recently retired fleet of Vought F-8s, as these were in open storage at Basa Air Base at the time.

Taal Volcano in Batangas occupies the center of Taal Lake. It is one of the lowest volcanoes in the world with an elevation of only 311 meters. The island actually consists of 35 cones and 47 craters but submarine volcanic features are recognized in the bathymetry. Taal Volcano is active with 33 historical eruptions - the last being on October 3, 1977.

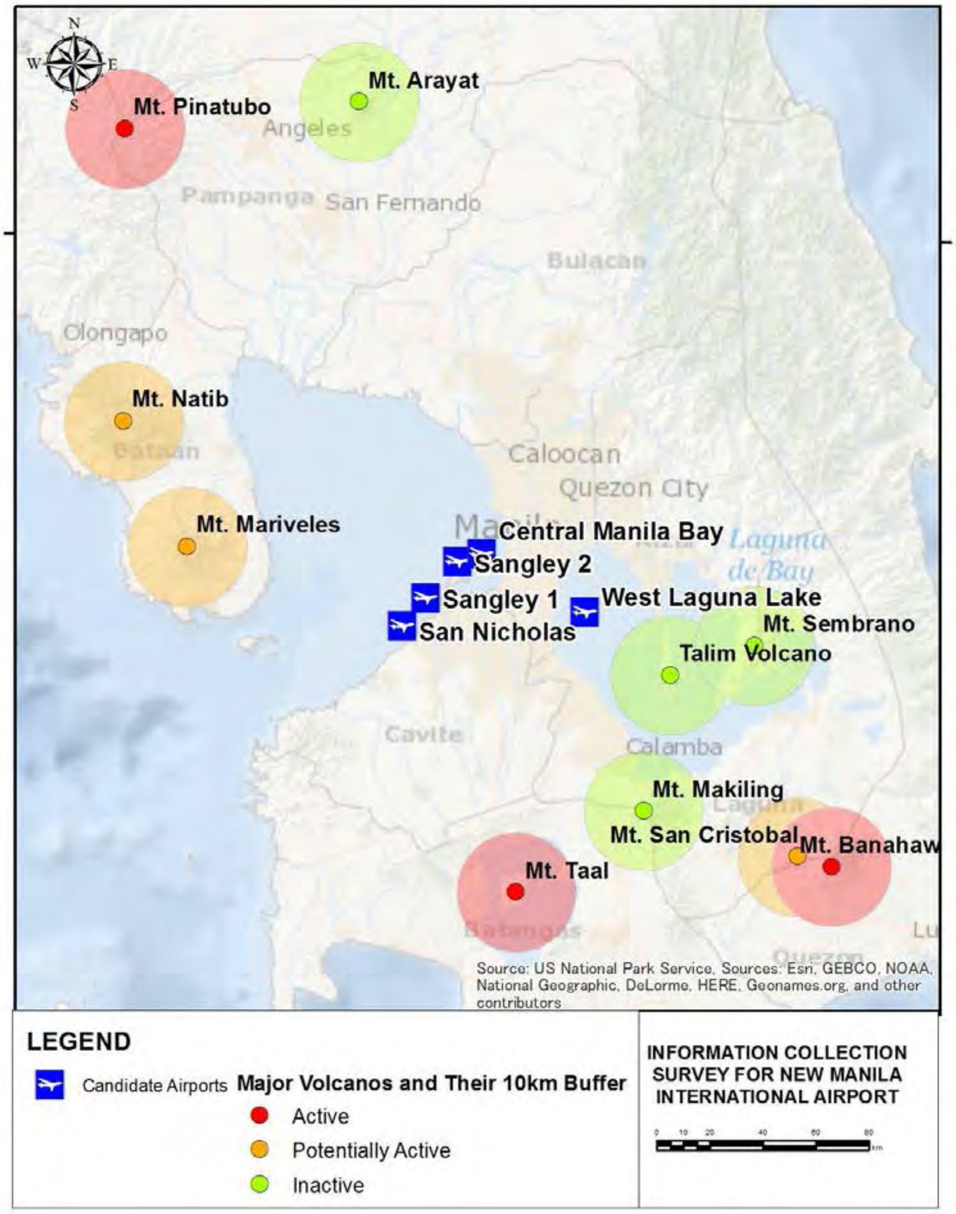
Banahaw Volcano, with an elevation of 2,169 meters, is an active volcano in Laguna. It has had three historical eruptions – the last one of which was in 1843.

b) Potentially Active Volcanoes

Mounts Natib and Mariveles, which occupy the Bataan Peninsula fronting Sites 1 to 4 in Manila Bay, as well as Mount San Cristobal, at the boundary of Laguna and Quezon Provinces, are potentially active volcanoes.

c) Inactive Volcanoes

The catalogue also list the following volcanoes, cones and plugs as inactive: i) Mount Arayat in Pampanga and plugs in Pangasinan and Nueva Ecija; ii) Talim Volcano and Mount Sembrano in the Laguna Lake area; and iii) Mounts Makiling, Macolod, Batulao as well as the cone and maar fields in Cavite, Batangas and Laguna.



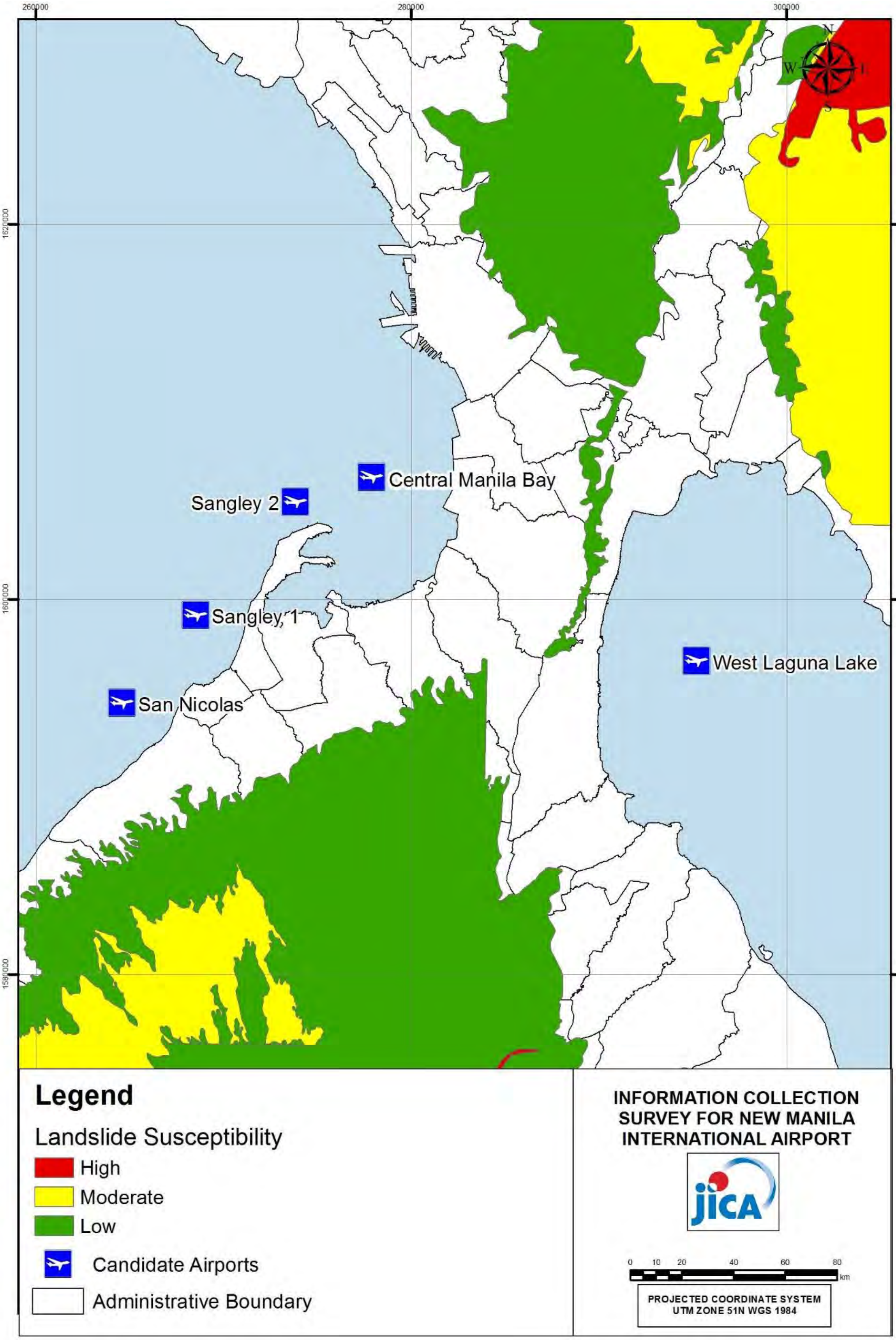
Source: Prepared by JICA Survey Team based on data from PHIVOLCS

Figure 8.5-11 Location of Volcanoes and Their 10km Buffer

4) Slope Instabilities (Submarine Landslides)

Reclaimed land is always flat. Landslides, rockfalls or rockslides are non-issues. However, as has been mentioned, it is the slopes of the reclaimed areas which have to be subjected to Slope Stability Analysis in the consequent study stage.

Figure 8.5-12 shows the landslide hazard map depicted in the geo-hazard map by MGB. The landslide hazard level is classified into 3 levels from low to high.



Source: Prepared by JICA Survey Team based on data from MGB

Figure 8.5-12 Landslide Hazard

8.5.5 Multi-hazard Map

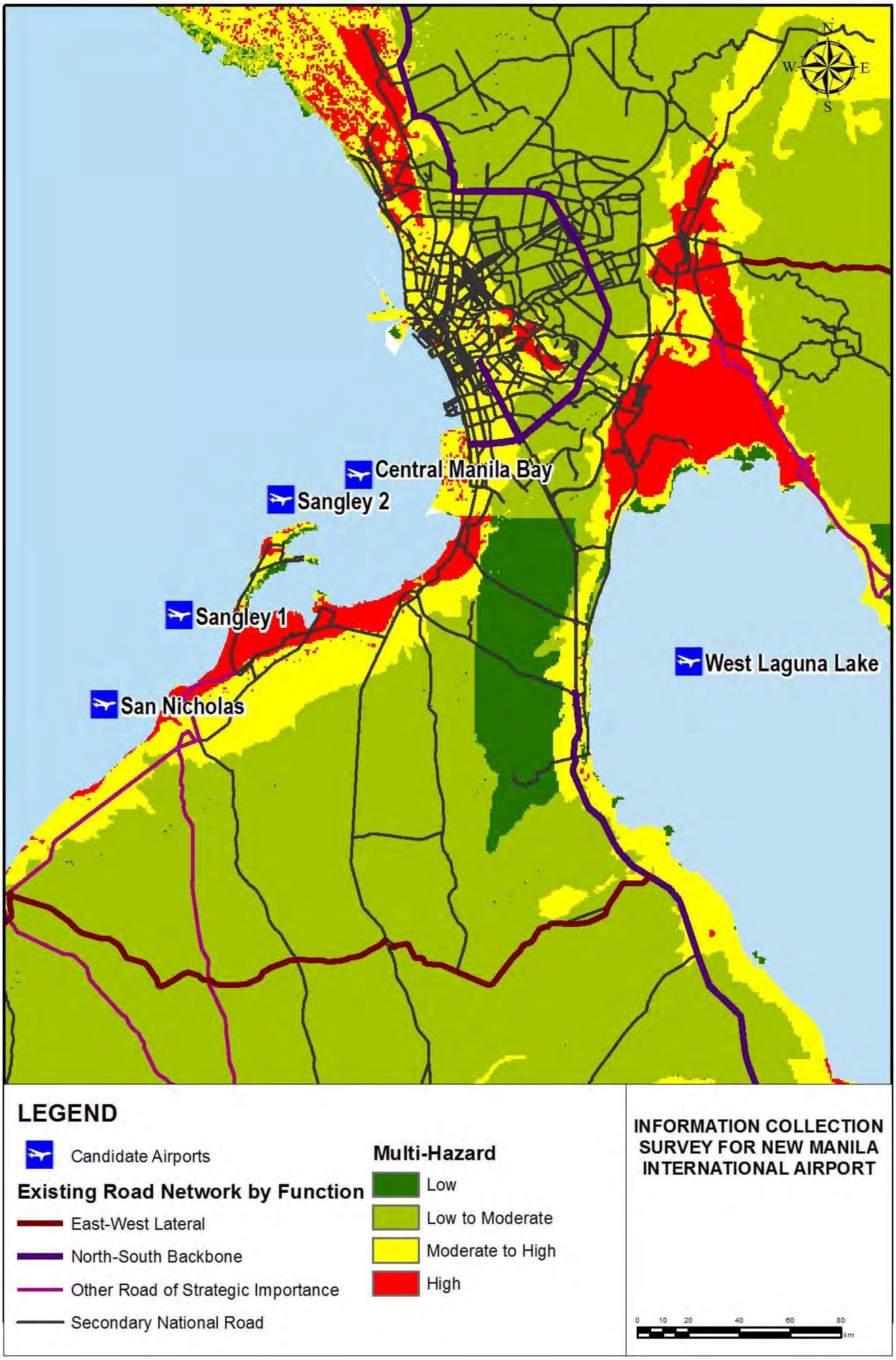
The collected hazard maps are overlaid and compiled into a multi-hazard map by scoring the hazard level in an organized manner to identify the most hazardous areas. The following hazard maps are utilized for this analysis and categorized their hazards into 3~4 levels;

i) Flood: High, Moderate to High, Moderate, Low to Moderate, Low
ii) Landslide: Low, Moderate, High
iii) Liquefaction: Low, Moderate, High
iv) Tsunami: Low, Low to Moderate, Moderate to High, High

The scores according to the hazard levels are aggregated in a small grid unit and compiled in a Multi-hazard Map shown in Figure 8.5-13. The red colored area shows the highest hazard level areas where several hazards have high risk. In addition, the location of existing and proposed road network is overlaid on the multi-hazard map in order to assess the security of the airport access transport. The highest hazard areas are spread in the coastal area facing to Manila Bay and the river basin of Marikina River and its adjoining areas to the Laguna Lake. Those areas have the hazards of flood, liquefaction and tsunami.

The airport access transport should be developed to be resilient to the possible natural hazards. Since all five prospective airport sites are located offshore, structure of the access transport should be carefully investigated. In addition to the access transport, considering any serious disaster occurs in GCR, the alternative access roads to the airport should be secured to maintain contingency of emergency transport system.

The selected hazards exclude the Earthquake Hazard Map such as PGA since its intensity depends on the distance to the earthquake source and geology type, however, any comprehensively analyzed data covering GCR is not available. Only MMEIRS can provide the Earthquake Intensity Hazard Map covering Metro Manila.



Source: Compiled by JICA Survey Team based on data from various sources

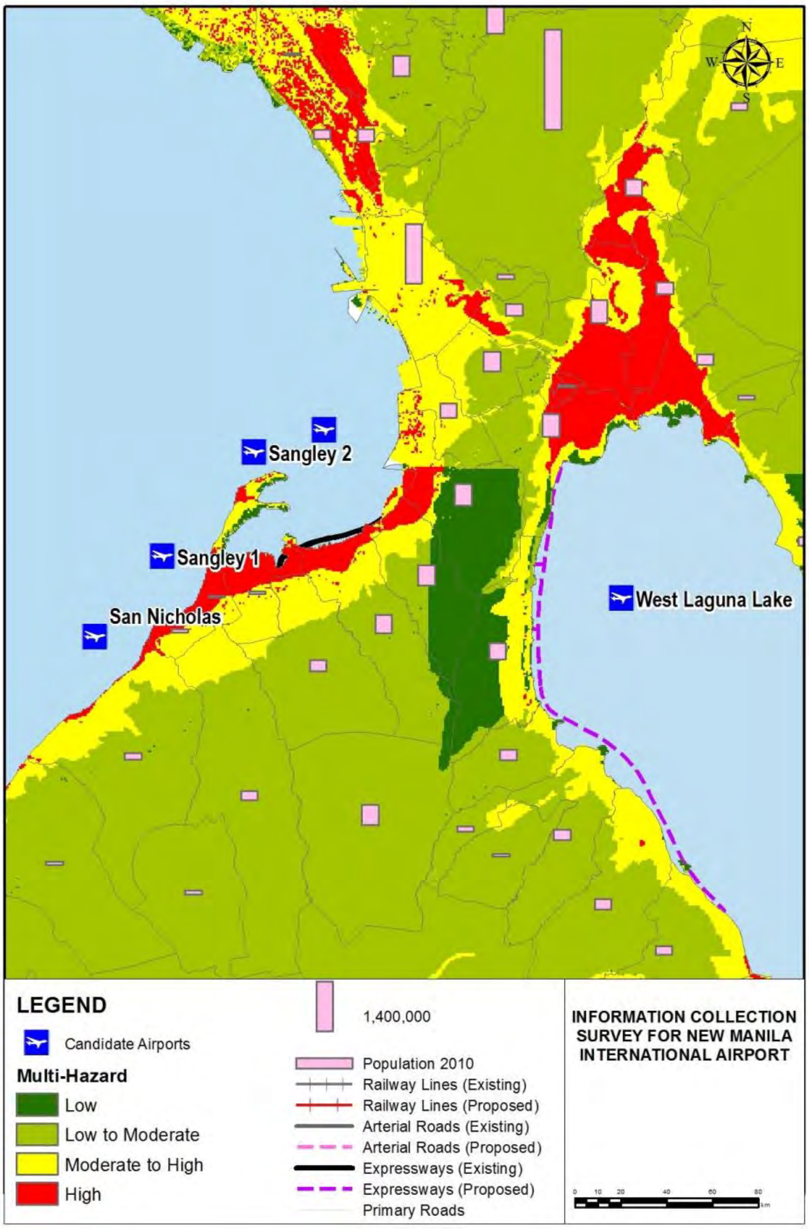
Figure 8.5-13 Multi-hazard Map and Existing Road Network

8.5.6 Vulnerabilities

Vulnerability of the Study Area is assessed using socio-economic factors.

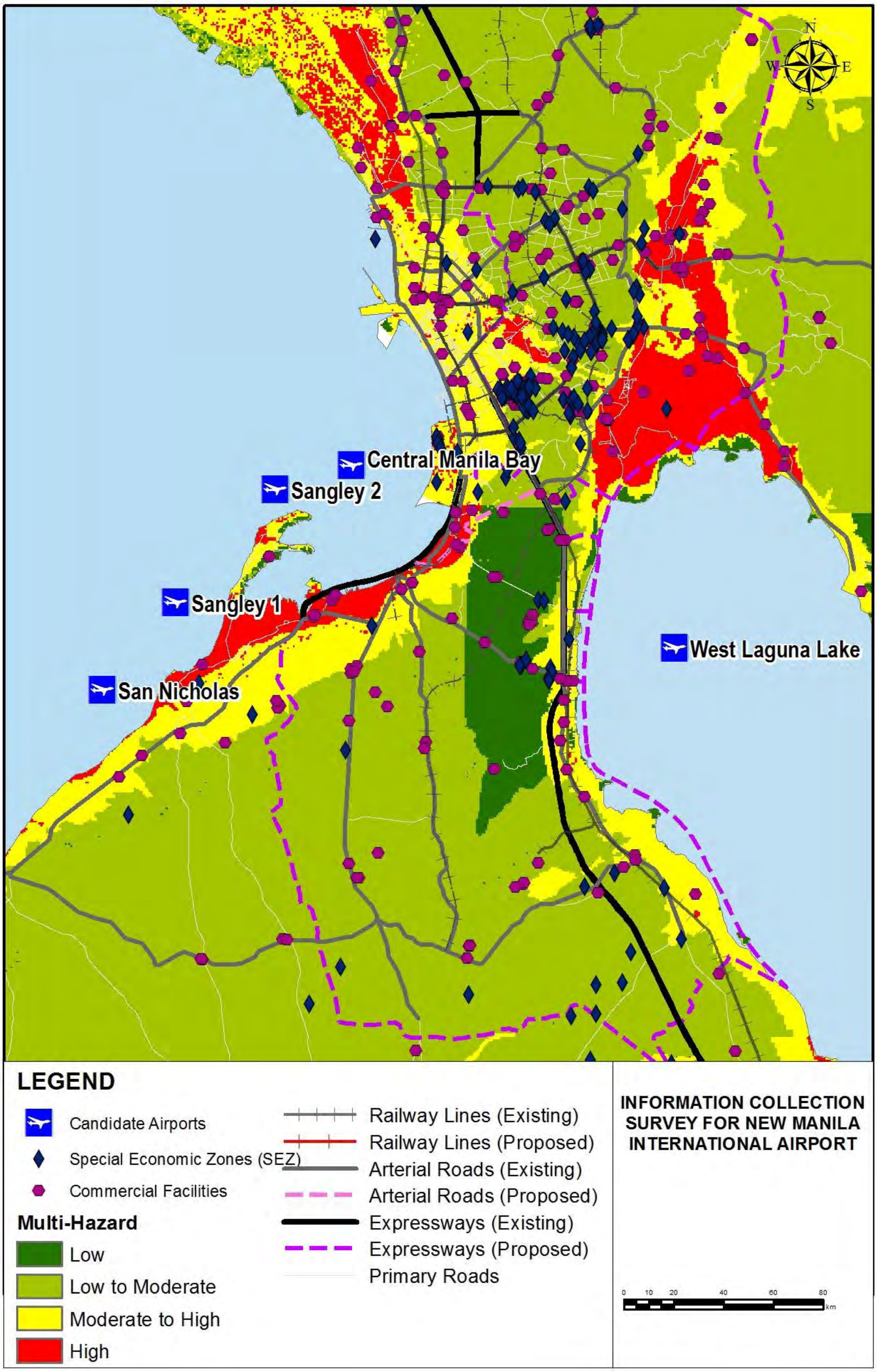
Figure 8.5-14 shows the distribution of population by city/municipality overlaid on the Multi-hazard Map. Population volume which access to the prospective airport sites and their access roads can be assessed based on the map. Figure 8.5-15 shows the distribution of Special Economic Zone (SEZ) and commercial facilities overlaid on the Multi-hazard Map. Economic demands on the airport access can be assessed based on the map.

The alternative access roads for emergency operation should be constructed where has lower hazards and higher access demands.



Source: Prepared by JICA Survey Team based on data from NSO

Figure 8.5-14 Multi-hazard Map and Population Distribution



Source: Prepared by JICA Survey Team based on data from NAMRIA

Figure 8.5-15 SEZ and Commercial Facilities and Multi-hazard Map

8.5.7 Assessment of Candidate Sites

A scoping checklist for Sites 1 to 4 in Manila Bay and Site 5 in Laguna Lake for all possible geohazards is presented. Geohazards which do not apply are coded as yellow (A) while those that are applicable or need further evaluation are in green (B).

Table 8.5-6 Summary of Geohazard Identification

	Site No. 1 Sangley Option 1	Site No. 2 Sangley Option 2	Site No. 3 Central Portion of Manila Bay	Site No. 4 San Nicolas Shoals	Site No. 5 West Laguna
seismic hazards					
faulting	A	A	A	A	A
fault creep	A	A	A	A	A
ground motion	B	B	B	B	B
liquefaction	B	B	B	B	B
settlement	B	B	B	B	B
EQ-induced landslides	A	A	A	A	A
EQ-induced (submarine) landslides	B	B	B	B	B
tsunamis	B	B	B	B	A
seiche	A	A	A	A	B
sinkhole collapse	A	A	A	A	A
coastal hazards					
coastal erosion	B	B	B	B	B
aggradation	B	B	B	B	B
headland erosion	A	A	A	A	A
storm surge	B	B	B	B	B
coastal flooding	B	B	B	B	B
scouring	B	B	B	B	B
subsidence	B	B	B	B	B
fluvial hazards					
flash floods	A	A	A	A	A
inundation	A	A	B	B	B
debris flows	A	A	A	A	A
siltation	A	A	A	A	A
bank erosion & channel migration	A	A	A	A	A
scouring	A	A	A	A	A
volcanic hazards					
lava flow	A	A	A	A	A

	Site No. 1 Sangley Option 1	Site No. 2 Sangley Option 2	Site No. 3 Central Portion of Manila Bay	Site No. 4 San Nicolas Shoals	Site No. 5 West Laguna
pyroclastic flow	A	A	A	A	A
lahar	A	A	A	A	A
mudflow	A	A	A	A	A
debris flow	A	A	A	A	A
ashfall	B	B	B	B	B
ballistic projectiles	A	A	A	A	A
debris avalanche	A	A	A	A	A
volcanic quakes	A	A	A	A	A
rockfalls	A	A	A	A	A
gases	A	A	A	A	A
slope instabilities					
landslides	A	A	A	A	A
submarine landslides	B	B	B	B	B
rockfalls	A	A	A	A	A
rockslides	A	A	A	A	A
sinkholes	A	A	A	A	A

Source: JICA Survey Team

8.5.8 Conclusions

Seismic Hazards: There is no known active or potentially active fault cutting through all five sites although the West Valley Fault is considered a near source earthquake generator to Site 5. Site 5 can experience excessively high PGA if a magnitude 7.2 design earthquake occurs along the adjacent West Valley Fault. Sites 1 to 4 will experience relatively lower PGAs than Site 5. Therefore, this site should be designed to be resilient to the expected earthquake especially for foundation, airport facilities and structure of access transport systems such as roads and railways.

All sites are susceptible to settlement and liquefaction. Although the reclaimed areas themselves would be flat, the stability of the (submarine) slopes along the edges of the reclaimed areas is a concern.

Manila Bay is highly susceptible to tsunamis. The Manila Trench is considered a local source of tsunamis. Laguna Lake is not prone to tsunamis but should be checked against seiches.

Coastal Hazards: The reclaimed areas might interfere with longshore currents which distributes sediments along the coast. This can lead to coastal erosion and aggradation. Manila Bay is prone to tsunamis and storm surges.

Flooding: Laguna Lake is used as a temporary storage for floodwaters. The lake coastal areas were submerged for about one month during Typhoon Ondoy and Habagat. Whether perceived or real, communities along the coastal areas of Sites 3 to 5 are expected to raise the issue of flooding.

Volcanic Hazards: All sites experienced ashfall during the 1991 Pinatubo eruption which can be considered a century eruption. It does not happen often.

8.5.9 Recommendations

It is recommended that further studies be conducted in the consequent study stage on the selected site. The study should include geology, detailed seismic hazard assessment, geohazard (non-seismic) assessment, geotechnical engineering (bearing capacity, settlement and liquefaction) and coastal engineering. It is also recommended that a survey on the possible sources of fill material and armor rock be conducted. However, the damages caused by the expected disasters can be reduced and adopted by applying appropriate measures. Those measures should be investigated to construct a new airport resilient to the natural disasters. Table 8.5-7 summarizes the recommended further studies and mitigating measures to be considered.

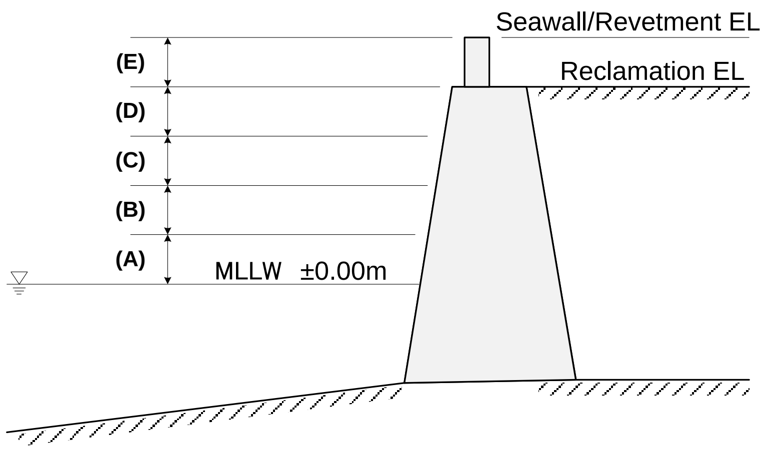
Table 8.5-7 Summary of Expected Further Studies and Mitigating Measures to be considered

issue	further studies	mitigating measures
seismic hazards		
faulting	none	none
ground motion	• detailed seismic studies (e.g. response spectra) • geotechnical investigation	• seismic (structural) design • ground modification • foundation design
liquefaction	• geotechnical investigation • liquefaction potential analysis	• ground modification • foundation design
settlement	• geotechnical investigation • settlement analysis	• ground modification • foundation design
EQ-induced (submarine) landslides	slope stability analysis	coastal protection
tsunamis	tsunami incursion study	coastal protection
coastal hazards		
coastal erosion	coastal engineering studies (sediment transport modelling)	depends on results of study
aggradation	coastal engineering studies (sediment transport modelling)	depends on results of study
storm surge	storm surge incursion study	coastal protection
coastal flooding	none	none
volcanic hazards		
ashfall		• flight restrictions in case of volcanic eruptions with significant ash columns • evacuate planes to other airports if necessary • monitor PHIVOLCS, PAGASA bulletins
geotechnical considerations		
bearing capacity	• geotechnical investigations • bearing capacity analysis	foundation design
settlement	see above	see above
liquefaction	see above	see above
stability	see above	see above
availability of construction materials	• identification of possible sources of armor rock, determination of quantity & quality (diamond drilling, sampling & laboratory testing) • identification of possible sources of fill material, determination of quantity and quality (marine geological & geophysical survey, sampling & laboratory testing)	

8.6 Examination on Seawall and Reclamation for Airport Platform Development

8.6.1 Assumed Elevations of Seawall/Revetment and Reclamation

The elevations of seawall/revetment and reclamation were determined in consideration of possible water level variations in Manila Bay and Laguna Lake as shown in Figure 8.6-1.



Source: Survey Team

Figure 8.6-1 Determination of Seawall/Revetment and Reclamation Elevations

In case of Manila Bay, the following elements of water level variations were considered from MLLW for the elevations of seawall and reclamation of four (4) prospective sites such as Sangley-1, Sangley-2, Manila Bay Center and San Nicholas Shoal:

(A)	HHWL	+1.77	Sourced from PPA Manual at Manila Port
(B)	Historical Tsunami/Storm Surge	+3.00	Historically recorded in 1863
(C)	Global Sea Level Rise	+1.70	Estimated for 2075 by application of predicted formula of SRES A1B in IPCC AR5
	Local Subsidence	+1.20	Estimated for 2075 by application of an assumed formula suggested by Siringan, et al. (2010)
(D)	Freeboard	+0.53	
(E)	Prevention of Wave Overtopping	+1.00	Considered for wave overtopping to be less than 0.02 m^3/m/sec as specified in Japanese Port and Harbor Standard

The elevation of seawall in Manila Bay sites was resultantly given as +7.00 from MLLW by the sum from (A) to (D) above. The elevation of reclamation in Manila Bay sites was estimated as +8.00 from MLLW by the sum from (A) to (E).In case of Laguna Lake, the following elements of water level variations were considered from MLLW for the elevations of revetment and reclamation of Laguna Lake West:

(A)	Annual Max. Lake Water Level	+2.50	Sourced by LLDA
(B)	Considered Additional Elevation for Planned Roadway Elevation in Laguna Lakeshore Expressway Project	+4.00	Sourced by Laguna Lakeshore Expressway Project
(C)	Local Subsidence	+1.20	Estimated for 2075 by application of an assumed formula suggested by Siringan, et al. (2010)
(D)	Freeboard	+0.30	
(E)	Prevention of Wave Overtopping	+1.00	Considered for wave overtopping by ship generated waves during extreme storm condition

The elevation of revetment in Laguna Lake site was resultantly given as +8.00 from MLLW by the sum from (A) to (D) above. The elevation of reclamation in Manila Bay sites was estimated as +9.00 from MLLW by the sum from (A) to (E).

8.6.2 Preliminary Concept Design of Seawall/Revetment and Reclamation

8.6.2.1 Sewall/Revetment

1) Selection of Suitable Structure Type

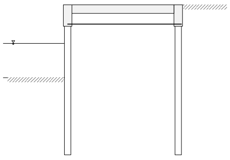
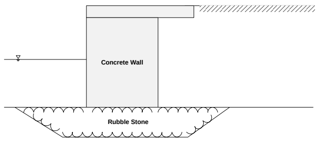
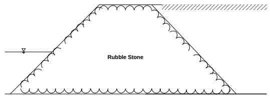
Generally, it is required that the structure types of seawall/revetment for airport platform are to be economical due to long structural length (approx. 20 km long), to be durable for waves, liquefaction and consolidation settlement as a stable important transport infrastructure, and to be easy for material procurement for smooth implementation of actual construction.

Furthermore, the structure types are limited for each prospective site, because each site condition commonly requires over 15 meters seawall/revetment which is categorized as deep wall structure.

In consideration of the above, typical three (3) structure types of such as steel pipe sheet piles, gravity concrete walls and gentle slope were eventually selected for primary comparison as shown in Table 8.6-1.

As shown in the table, each type was compared among eight (8) aspects such as structural rigidity, track record, wave calmness, material procurement, workability, maintenance, construction period and cost. Finally, the gentle slope structure type was suggested as preferable type of seawall/revetment, due to advantages for the said aspects summarized in the table.

Table 8.6-1 Primary Comparison of Typical Structure Types for Seawall/Revetment

Structure Type	Steel Pipe Sheet Pile	Gravity Concrete Wall	Gentle Slope
Schematic Drawing			
Structural Rigidity	Good	Good	Good
Track Record	Many for quay	Many for quay	Many for seawall/revetment for reclamation
Wave Calmness	Poor Reflected waves generated	Poor Reflected waves generated	Fair Less wave reflection
Material Procurement	Fair But depends on market availability	Fair But required fabrication yard and crane barges	Fair
Workability	Moderate	Moderate	Easy
Maintenance	Required for corrosion protection	Not required	Not required
Construction Period	Longer	Longer	Shorter
Cost	Higher	Higher	Lower
Evaluation			Recommended

Source: Survey Team

The gentle slope structure type and its feature are to be further compared as shown in Table 8.6-2. As seen in the table, the concrete amour slope structure type with wave dissipating blocks was favorably suggested for seawall at the Marina Bay sites due to its hydraulic performance and similar track records. In case of Western Laguna Lake, basic structure type was to be same as the one at Manila Bay. However, the structure type does not require wave dissipating blocks as well as steep slope formation due to wave calmness unlike Manila Bay sites. .

Table 8.6-2 Comparison of Sloping-Porous Wall Type of Seawall/Revetment

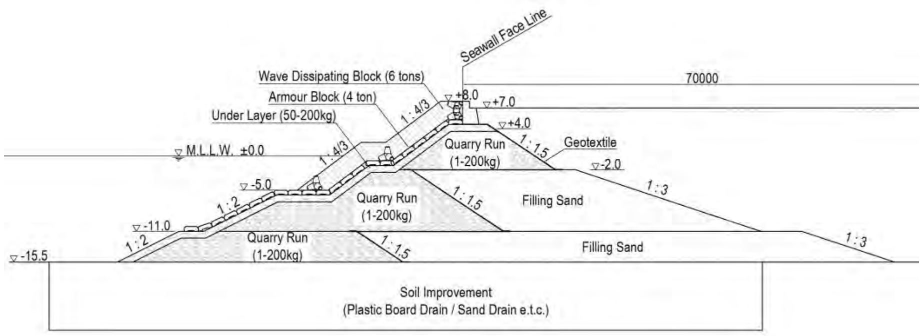
Major Type of Seawall	Stone Mound	Concrete Made Seawall covered by Wave Dissipation Blocks	Gentle Slope Seawall
Images			
Features	Structural Stability: Good, greatly influenced by the adequate size (weight) of amour stone material and its underlayer. Wave climate: All, but not easy to manage quality of armour stones. Stability on Soft Ground: Fair, but soil improvement is required for very soft layer.	Structural Stability: Good, relatively easy to keep the requirement of concrete block weight and it's quality. Wave climate: Moderate to severe. The best for dissipating wave energy. Stability on Soft Ground: Fair, but soil improvement is required for very soft layer.	Structural Stability: Fair, relatively easy to keep the requirement of concrete blocks weight and it's qualities. Wave climate: Mild to moderate, not suitable at offshore site. Stability on Soft Ground ; Fair and/or relatively better than the other types under the same conditions. Soil improvement is required for very soft layer.
Construction Workabilitiy	Most simple, if adequate size and volume of stone materials can be obtained inexpensively and within the timelimit .	Multi construction step, but it can attain high certainty under offshore condition.	Relatively easy under shallow and calm water.
Environmental Friendliness	Most friendly at construction site, however excessive quarrying results in deterioration of environment around the quarry sites.	Fair.	More friendly than Random placed Concrete Armour Units.
Economical Efficiency	Considrable, if stone materials can be obtained inexpensively.	The best hydraulic performance, wave overtopping and runup will be minimize. Thus cost for reclamation can be reduced.	Relatively expensive under the same condition.
Recommendation	Recommended for partial use, such as land side revetment at Manila bay area.	Recommended for the construction of seawalls at Manila bay area.	Recommended for the construction of seawalls at Laguna lake area.

Source: Survey Team

2) Typical Section of Seawall/Revetment

Generally, seawall is often classified into: Sloping (walls with slope of 1:1 or flatter); Vertical (Walls with slope steeper than 1:1); Porous (walls whose face is permeable to wave actions) and Non-porous (walls whose face is non-permeable to wave actions). Among them the sloping-porous walls have the highest hydraulic performance against wave actions as well as structural stability. Given the importance of Manila Airport, it is proposed to use the sloping-porous type seawall to protect the reclamation fill.

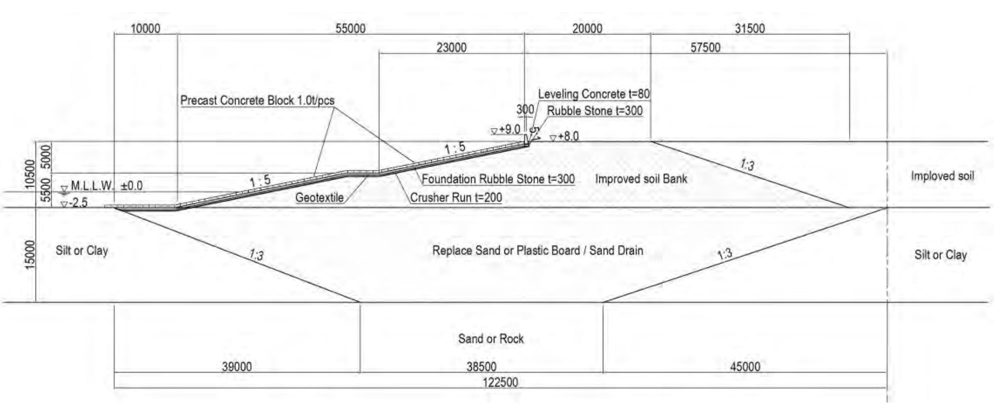
The designed seawall must withstand under highest astronomical tide and extreme wave condition and be able to prevent reclamation area against potential flooding due to wave overtopping. At Manila bay area, sloping seawall covered by wave-dissipating blocks will be used to dissipate the wave energy and restrict the volume of wave overtopping to the landward side. A typical cross-section of seawall at Manila Bay sites is shown in Figure 8.6-2.



Source: Survey Team

Figure 8.6-2 Recommended Typical Section of Seawall at Manila Bay Sites

Western Laguna Lake (LGL) site is located in the large freshwater lake and wave condition here is relatively calm. Therefore, countermeasures for wave run-up and/or overtopping are relatively low. Figure 8.6-3 depicts a typical cross-section of proposed revetment at the Western Laguna Lake (LGL).



Source: Survey Team

Figure 8.6-3 Recommended Typical Section of Revetment at Laguna Lake Site

3) Calculation of Required of Weight of Wave Dissipating Blocks

The minimum required weight of each wave dissipating blocks, used at Manila bay area, are calculated based on the Hudson's equation as:

$$W = \frac{\gamma_r H^3}{K_D \Delta^3 \cot\theta}$$

where

W is the design weight of the rock amour (ton)

γ_r - is the specific weight of the armor blocks (N/m3)

H is the design wave height at the toe of the structure (m), given from the wave climate accessibility report

K_D is a dimensionless stability coefficient, deduced from laboratory experiments for different kinds of armor blocks (K_D = 8.3 for Tetrapod block):

Δ is the dimensionless relative buoyant density of rock, i.e. (ρ_r / ρ_w - 1) = around 1.6 for granite/concrete in sea water

ρ_r and ρ_w are the densities of rock and (sea) water

θ is the angle of revetment with the horizontal

The calculated minimum required weigh of Tetrapod blocks is summarized in the Table 8.6-3.

Table 8.6-3 Minimum Required Weight of Wave Dissipating Blocks (Reference)

(Unit : t / pc)

No.	Direction	Length *	SNS	SG1	SG2	MBC
①	Offshore	6.1km	6.0	6.0	6.0	6.0
②	Right hand	4.1km	4.0	6.0	3.0	3.0
③	Left hand	4.1km	4.0	4.0	6.0	6.0
④	Inshore	6.1km	−	−	−	3.0
Design Wave Height max. (m)			3.75	3.89	3.82	3.27

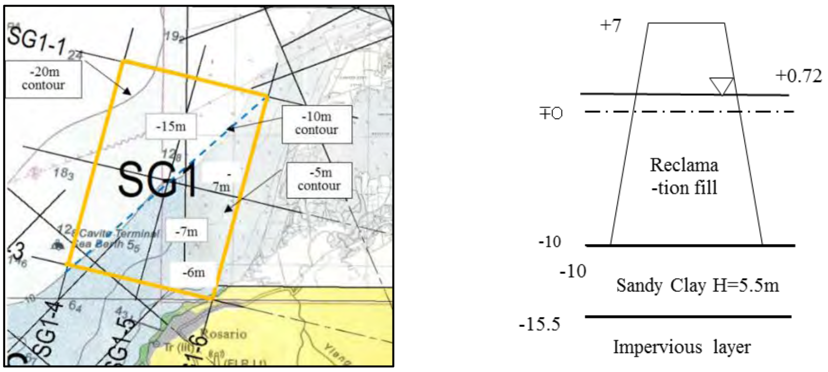
*Note: * 50m width of wave overtopping buffer zone is arranged behind the seawall.*
This space will be used as maintenance road
Sangley Point (1); SG1, Sangley Point (2); SG2, Manila Bay Center; MBC, San Nicolas Shoal; SNS

Source: Survey Team

8.6.2.2 Reclamation

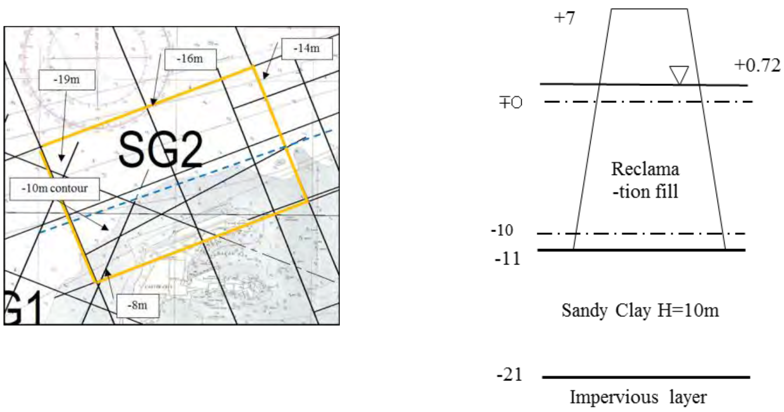
1) General Features

Airport lands for five (5) prospective sites as shown by Figure 8.6-4 to 8.6-8 are planned to be reclaimed on the water in Manila Bay or Laguna Lake. Four (4) sites out of the prospective sites are located in the Manila Bay area and the rest one site is located in the Western Laguna Lake. Those figures also show the modelled geotechnical conditions for the sites. The average water depth for reclamation of Sangley (1), (2) and Manila Bay Center are approximately -10m while -7m at San Nicolas Shoal and -2.5 m at Laguna Lake West. The planned reclamation heights for the prospective sites at area are respectively +7m at Manila Bay and +8m at Laguna Lake West. (Note; Sangley Point (1); SG1, Sangley Point (2); SG2, Manila Bay Center; MBC, San Nicolas Shoal; SNS, Laguna Lake; LGL). As the boring survey is carried out only at Sangley (1) and (2), the thicknesses of clay layer at both sites are reflected from the boring logs. But the stratum at Manila Bay Center, San Nicolas Shoal and Laguna Lake West are assumed by the past boring data adjacent to each project site. Schematic figures of stratifications at each site show the thickness of fill and clay layer.



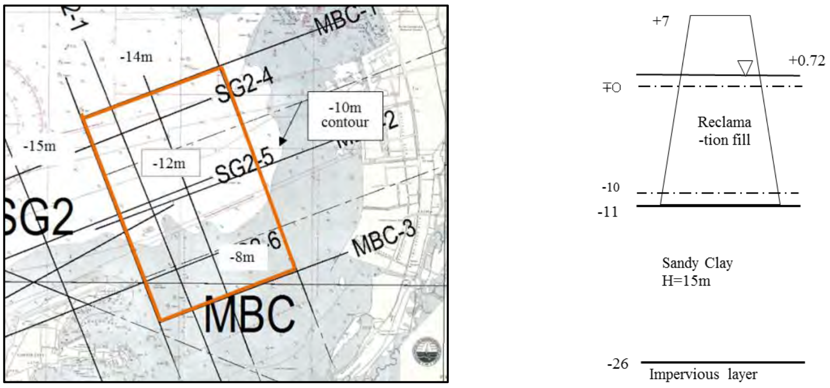
Source: Survey Team

Figure 8.6-4 Reclamation Alignment and Modeled Typical Stratifications at SG1



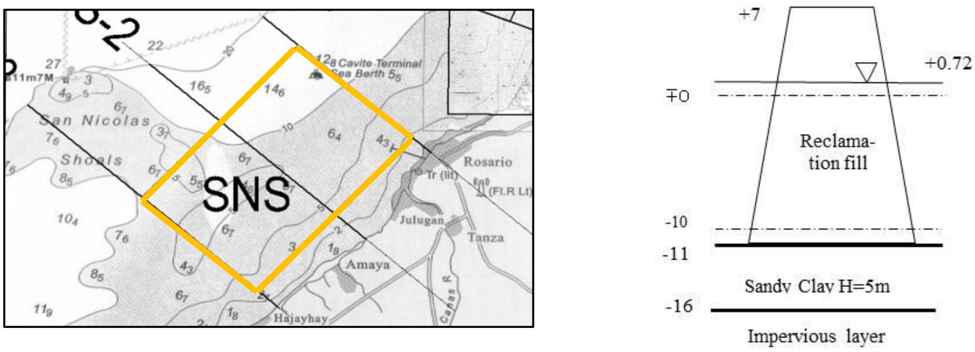
Source: Survey Team

Figure 8.6-5 Reclamation Alignment and Modeled Typical Stratifications at SG2



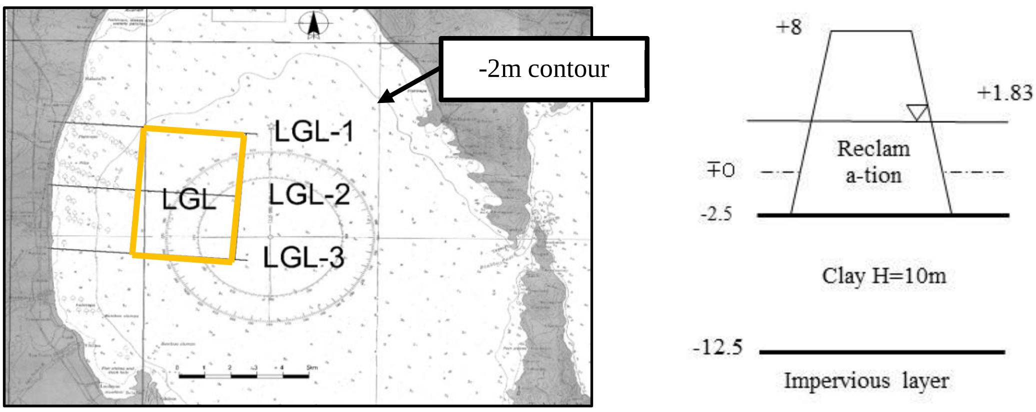
Source: Survey Team

Figure 8.6-6 Reclamation Alignment and Modeled Typical Stratifications at MBC



Source: Survey Team

Figure 8.6-7 Reclamation Alignment and Modeled Typical Stratifications at SNS



Source: Survey Team

Figure 8.6-8 Reclamation Alignment and Modeled Typical Stratifications at LGL

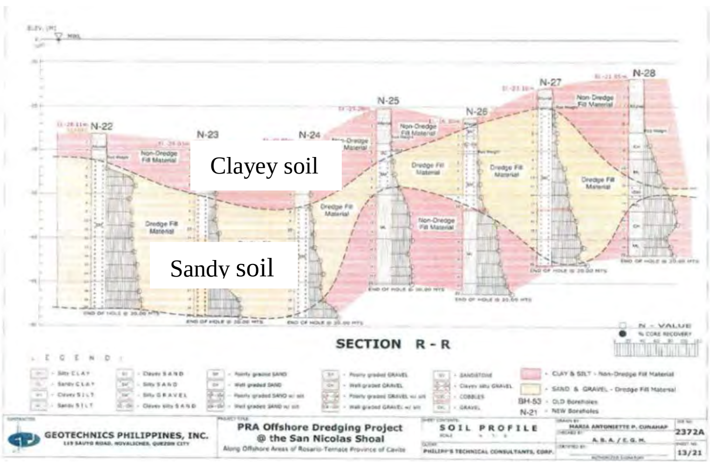
2) Availability of Reclamation Materials

a) Reclamation at Manila Bay area

According to the Feasibility Study carried out by PRA[5], it is concluded that sandy soil adequate for the land reclamation can be available at San Nicolas Shoal as shown in Figure 8.6-9 and its quantity can be sufficient for the whole reclamation. Figure 8.6-10 shows distances from the dredging area to the candidate site other than Laguna Lake West. On the other hand, Figure 8.6-9 shows the fact that overburden clay at places deposit from the surface of sea bottom. Such an inadequate soil for reclamation shall ordinarily be removed and dumped at deposit area with deeper depth on water, if dumping area is not too far distance. In any case, it shall be essential to make sure the distribution of sandy soil by kind of "sand sampler", which is just suitable and convenient for investigation of distribution of sandy soil at sea bottom.

b) Reclamation at Laguna De Bay

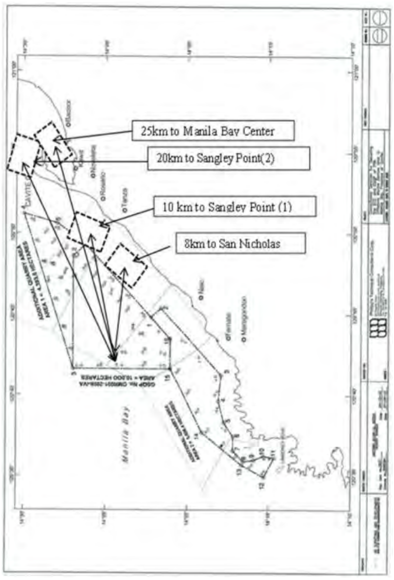
It was realized by the meeting with LLDA that i) filling material for reclamation shall be sourced within the Laguna De Bay Region[6], ii) new reclamation project for the construction of road is now on bidding, iii) the project would use plenty of reclamation material and it may even be short of it. On top of them, available soil seems mostly clay or clayey loam, which is not adequate soil for reclamation in the water. Taking above conditions into consideration, cement mixing method with dredged soil deposited at the bottom of Laguna Lake is put into the study. Figure 8.6-11 shows the distance from the dredging area to the reclamation area. Using bottom soil might mitigate the reduction of storage capacity of water by the Laguna Lake.



Source: PRA Report

Figure 8.6-9 Typical Soil Stratification at San Nicholas Shoals

[5] The Philippine Reclamation Authority (2015) *A pre-feasibility study, The new Manila gate way, NAIA-Sangley point.*
[6] Laguna Lake Development Authority, Serious of 2006, Section 3, Resolution No.283.



Source: PRA Report

Figure 8.6-10 Dredging Point and Distance (Manila)

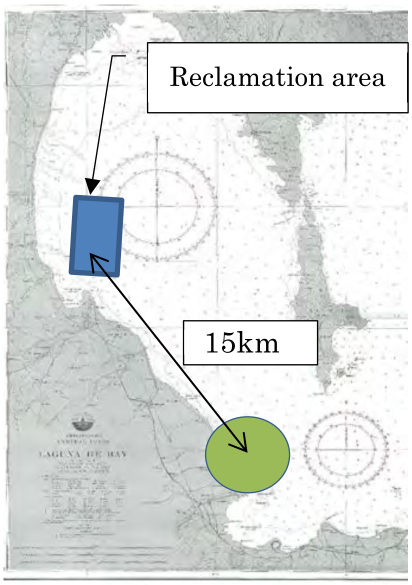


Figure 8.6-11 Dredging Point and Distance (Laguna)

3) Consolidation Settlement

Consolidation settlement of clay layer is calculated by Equation 8.6-1.

$$S_f = \frac{Cc \times H}{(1+e0)} \times \left(1 + \frac{\Delta P}{Pc}\right) \qquad \text{(Equa.8.6-1)}$$

where, S_f ; Total settlement of clay, Cc; Consolidation coefficient,
H; Thickness of clay, e_0; Initial void ratio of clay,
ΔP; Incremental load, Pc; Yield stress of clay.

Settlement vs time relationship in case of one dimensional consolidation shall be obtained by Equa 8.6-2

$$t = \frac{H^2 \times T_v}{C_v} \qquad \text{(Equa. 8.6-2)}$$

where, H ; thickness of clay layer (m), C_v; Consolidation coefficient (m^2/day),
T_v; Consolidation factor

In consideration of Figures 8.6-3 to 8.6-7, Equation 8.6-1 gives the settlement of the reclaimed land as shown in Table 8.6-3. In this table, settlement by planned ground level is calculated by loading of fill from water depth to planned height but after settlement the ground level reach to the lower than planned height. Additional fill shall cover the short of height.

Table 8.6-4 Estimated Consolidation Settlement at Each Prospective Site

	H(m)	e0	Cc	Planned		Additional Fill	
				GL	S(m)	GL	S(m)
Sangley(1)	5.5	1.8	0.5	+7	1.10	+8.1	1.1
Sangley(2)	10	1.8	0.5	+7	1.58	+8.7	1.7
MBC	15	2	1	+7	4.02	+11.7	4.7
SNS	5	1.8	0.5	+7	0.97	+8.0	1.0
LGW	10	2.5	1.2	+8	3.33	+11.7	3.7

Source: Survey Team

Table 8.6-5 shows consolidation time for attaining the consolidation degree of 80, where drainage of clay is to the upward direction with one side. It is realized that as 80% consolidation time for one loading would take more than 10 months, vertical drain method to accelerate the consolidation settlement shall be necessary.

Table 8.6-5 Required Time for Attaining 80% of Consolidation

	Tv at U=80%	Cv	H	t at U80 (month)
Sangley(1)	0.567	0.03	5.5	19
Sangley(2)	0.567	0.03	10	63
MBC	0.567	0.01	15	425
SNS	0.567	0.03	5	16
LGW	0.567	0.01	10	189

Source: Survey Team

4) Liquefaction

As previously presented in Sub-Section 7.3, Liquefaction Susceptibility/Hazard Maps covering five (5) prospective sites suggest high possibility of liquefaction occurrence during earthquake with certain magnitude. In addition to that, the materials to be reclaimed are assumedly sourced from sea sand which has mostly probably the characteristic that will be fallen into the range of possibility of liquefaction. Figure 8.6-12 describes liquefaction judgement diagrams based on grain size as referenced in Japanese Port and Harbor Standard[7].

It is presumed that the materials sourced from the offshore of SNS for reclamation are higher uniformity coefficient and their grain size distribution curves are most likely fallen into the range of the possibility of liquefaction.

[7] OCDI (2009) *Technical Standards and Commentaries for Port and Harbor in Japan*, MLLT, NILIM and PARI

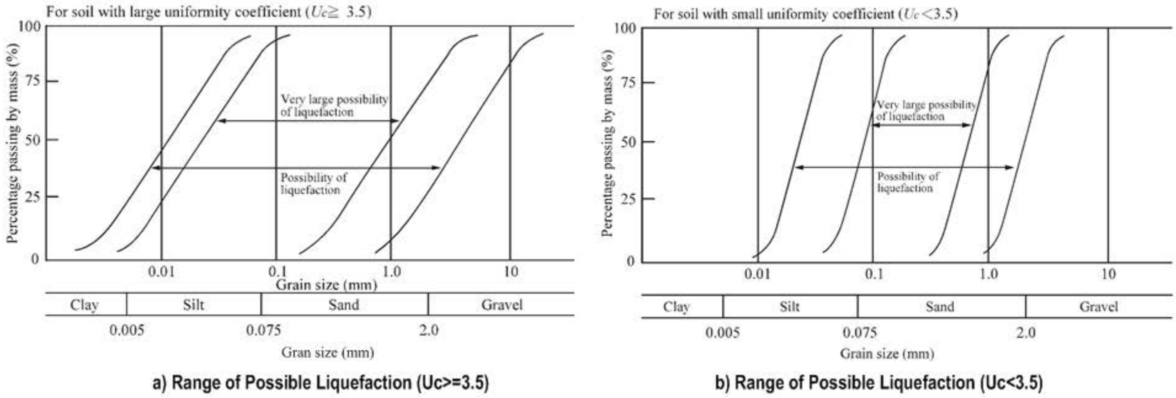


Figure 8.6-12 Liquefaction Judgement Diagrams Based on Grain Size

5) Soil Improvement

a) Acceleration of Consolidation Settlement

Without vertical drain, it is obvious that consolidation settlement for one loading would take more than a year. Therefore vertical drain for accelerating of settlement is essentially recommended. Figure 8.6-13 shows the principle of vertical drain. The water in clay layer shall be drained horizontally into vertical drains and drained vertically upward through vertical drain then drained horizontally through "Sand Mat".

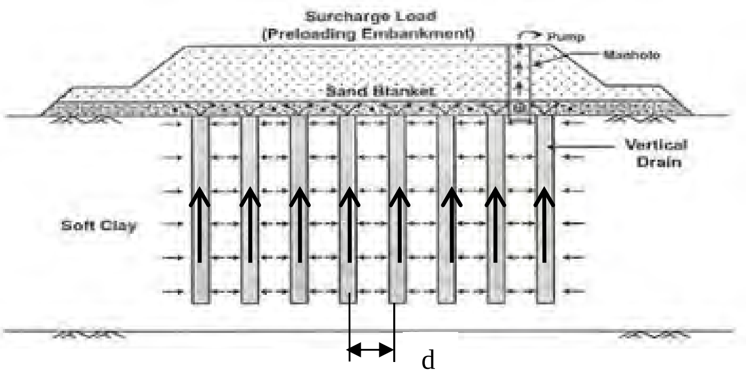


Figure 8.6-13 Typical Soil Stratification at San Nicholas Shoals

The vertical drain is classified into two types, that is to say, sand drain method (SD) and prefabricated vertical drain method (PVD). Table 8.6-5 shows the comparison of SD and PVD upon installation on land and on water. Since SD is in recent years has not been utilized due to depletion of sea sand material, PVD is now commonly utilized as acceleration method of consolidation settlement for many kinds of projects in the world. Furthermore, although installation of PVD on water was carried out in the reclamation project of Kansai Int'l Airport, there is no installation barge in Japan due to decrease of such project. So, it is recommendable that PVD is to be applied on land upon its installation.

Table 8.6-6 Comparison between SD and PVD

Acceleration method	Site situation	On Land (after Reclamation)		On Water (Before Reclamation)	
	Drain material	PVD	Sand	PVD	Sand
Feature Note: ○ ; Advantage ● ; Dis advantage		-Plenty of past experiences. -Many installation machines Note: B=100mm, t=2~3mm	-Plenty of past experience -Depletion of sea-sand Note; Diameter ; 500mm	-One past experience at Kansai Int'l Airport.. But no more vessel. Note: B: 190mm, Installation vessel outfitted with 12 casings.	-Lots of past experience in Japan -High mobilization cost -Depletion of sea-sand Note; D=400mm, Installation vessel with 12 casings
Efficiency (per 1 machine)		2,500m	380m	7,000m	3,500m
Direct Cost	Construction Cost (USD / m)	○M : 1.0 ○E : 1.5 = 2.5 $/m	○M : 5 ○E : 12.5 = 17.5 $/m	○M : 2.5 ○E : 8.3 = 10.8 $/m	○M : 4.1 ○E : 15 = 19.1$/m
	Mobilization Cost (Million USD)	0	+α	+α	+α
Evaluation		○	–	–	–

Source: Survey Team

PVD is further fractionated materially to two (2) types such as plastic drain type (PD) and fiber drain type (FD) as referenced to Photo 8.6-1. FD seems preferable method because of its flexibility and sturdiness against induced energy given by Dynamic Compaction Method (DCM) to be technically suggested as countermeasure for liquefaction particularly for sand fill of reclamation.

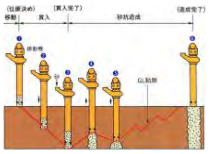
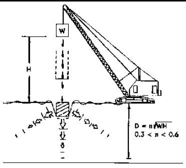
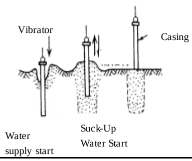
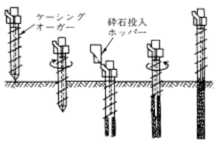
Photo 8.6-1 a) Sample of a Plastic Drain (PD)

Photo 8.6-1 b) Sample of a Fiber Drain (FD)

b) Liquefaction Prevention

It is essential to make a countermeasure against liquefaction of the reclaimed land by sandy soil. Principles of the countermeasure are classified into two types, which are by densification of loose sand layer and by increase the permeability of sand layer. Table 8.6-7 shows a comparison of typical four (4) countermeasure techniques. As shown in Table 8.6-7, taking the effectiveness of the method, economy, past experience and efficiency into consideration, Dynamic Compaction Method (DCM) seems to be most preferable method.

Table 8.6-7 Countermeasure Techniques against Liquefaction

Principles	Name of Technique/Abstract	Image Picture	Applicability	Efficiency Direct Cost (reference)	Evauation
Densification	**Sand Compaction Pile (SCP)** Casing penetrate and form the sand column in the loose sand layer. Sand column is tamped densified by casing with closed bottom. Then loose sand layer is densified by enlarged sand column.		-Sand, gravel -Applicable: 20m -In case debris layer, high power vibrator necessary. -In case of fine clay content (Fc)>15%, lower efficiency.	180 -210m/day 30,000 - 35,000 JPY/m2	△
	Dynamic Compaction (DC) DC consists of providing high energy impacts at the ground surface by repeatedly dropping steel or concrete tampers, 6 to 35 tons in weight from heights ranging from 10 to 30m.		-Sand, gravel, debris -Applicable depth; 15m -Even in case of large debris with 1m, the same applicability. -In case of fine clay content (Fc)>15%, lower efficiency.	55～70m2／day 7,000～9,000JPY／㎡ (Exclusive of 1m3 settlement due compacted soil)	○
	Vibrating bar with Suck-Up-Water Ground is densified by vibrated penetration of rod and dissipation of excess pore pressure induced. Opening is refilled by the supplement (crushed) stone from the surface.		-Sand, Gravel-mixed soil -Applicable depth; 20m -In case of debris and gravel, difficult due to break-down of the toe of casing. -In case of fine clay content (Fc)>20%, lower efficiency.	180～200m/day 17,000 - 20,000 JPY/m2	△
Dissipation of excess pore pressure	**Gravel Drain** After casing auger is installed by rotation up to the targeted depth, crushed stone is dumped and crushed stone column is formed. Excess pore pressure is dissipated through crushed stone column.		-Sand, Gravel -mixed soil-Applicable depth; 20m -In case of debris foundation, lower efficiency	220～250 m/day 55,000 - 65,000 JPY/m2	X

Source: Survey Team

Figure 8.6-14 shows the effectiveness of DCM. It is acknowledged that N value after reclamation by sandy soil is approximately 5 times. However after DCM, N Value seems to be improved up to 20 times.

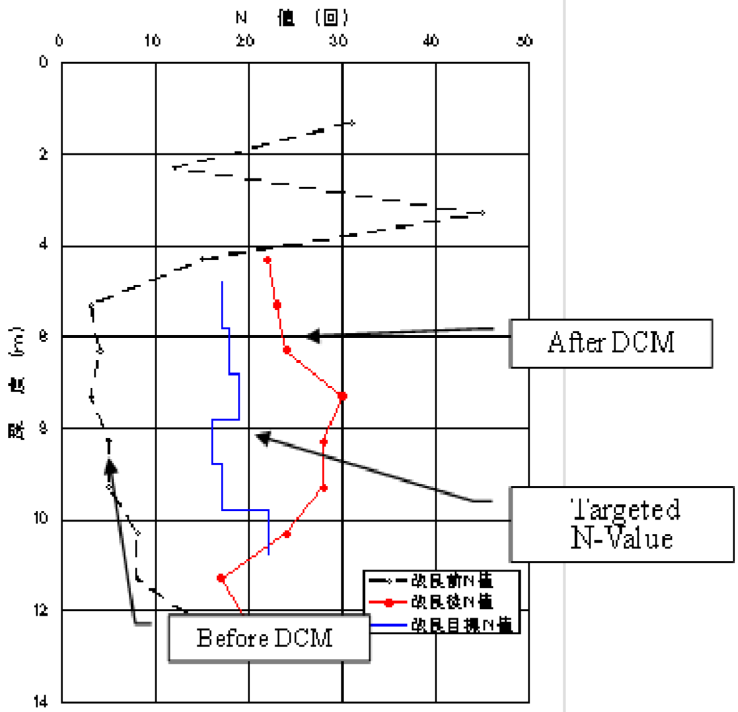


Figure 8.6-14 N-value Distribution with Depth before/after DCM

8.6.3 Construction Methodology for Major Work

8.6.3.1 Dredging and Reclamation

Reclamation methodology is classified into two groups, that is to say, in the area of Manila Bay and in the Laguna Lake. Both methodologies shall be described as the followings.

1) Methodology at Manila Bay using dredged material from San Nicolas Shoal

Taking a consideration of huge quantity of reclamation fill, the distances from the burrow area at the San Nicolas Shoal to the reclamation sites, water depth of reclamation area, it could be concluded that (Self-propelling) Trailing Suction Hopper Dredger (THSD), which dredge the soil-water mixture through the drug head placed on seabed and suck the dredged soil into the side of THSD and transport to the reclamation area, would be the best method of dredging and reclamation as shown by Figure 8.6-15. When water depth at reclamation area is sufficient, direct dumping by opening the bottom of THSD can be possible, and if not, "Rainbow work" as shown by Photo 8.6-2 can be adequate.

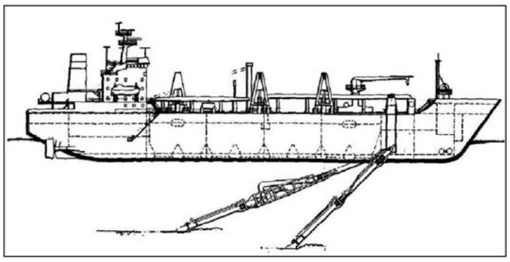


Figure 8.6-15 Trailing Suction Hopper

Photo 8.6-2 Rainbow work by TSHD

2) Methodology at Laguna Lake

Photos 8.6-3 and 8.6-4 show the dredging by clamshell-grab and reclaiming with cement-mixed-soil, respectively. Due to the waste deposited on the bottom of Lake, suction dredging method cannot be possible.

Photo 8.6-3 Dredging by Clamshell-Grab

Photo 8.6-4 Improved Soil with Cement Mixing

8.6.3.2 PVD

When PVD is installed into soft clay ground as shown in Figure 8.6-16, squeezed water from the clay layer induced by reclamation load is seeped into the vertical drain through outer filter, drained upward and then drained horizontally. Photo 8.6-5 shows the site after installation of PVD.

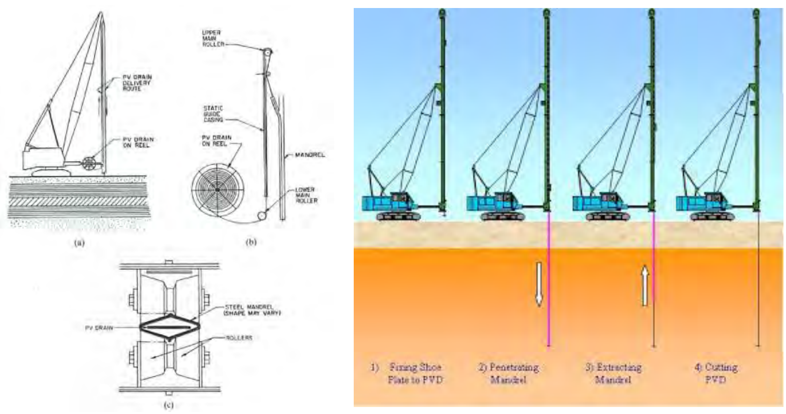


Figure 8.6-16 Sequence of PVD Installation

Photo 8.6-5 PVD Installation at Site

8.6.3.3 DCM

Photos 8.6-6 and 8.6-7 shows the DCM machine and under execution of DCM at Kansai Int'l Airport, respectively.

Photo 8.6-6 DMC Machine

Photo 8.6-7 Runway improvement at Kansai Int'l Airport

8.6.4 Rough Estimate of Construction Cost

8.6.4.1 Work Quantities

The work quantities estimated are based on the latest collected information and data surveyed. However, it is notably highlighted that the accuracy of the quantities is not level of basic/detailed design. The summary of the work quantities is presented in Table 8.6-8 for 1,500 ha and Table 8.6-9 for 2,400 ha.

Table 8.6-8 Summary of Work Quantities for 1,500 ha (Opening Day)

No	Description	Unit	SG1	SG2	MBC	SNS	LGL
1	Seawall	m	17,400	17,400	17,400	17,400	17,400
2	Reclamation	$10^6 m^3$	282	308	355	236	219
3	Soil Improvement						
3.1	PVD	$10^6 m$	143	176	637	116	121
3.2	DCM	ha	1,110	1,110	1,110	1,110	

Table 8.6-9 Summary of Work Quantities for 2,400 ha (Ultimate Phase)

No	Description	Unit	SG1	SG2	MBC	SNS	LGL
1	Seawall	m	20,120	20,120	20,120	20,120	20,120
2	Reclamation	$10^6 m^3$	445	485	560	372	345
3	Soil Improvement						
3.1	PVD	$10^6 m$	225	278	335	183	191
3.2	DCM	ha	1,751	1,751	1,751	1,751	

Source: Survey Team

8.6.4.2 Cost Estimation

Table 8.6-10 and Table 8.6-11 show the estimated rough cost of seawall and reclamation for 1,500 ha and 2,400 ha at each prospective site. The shown figure is still tentative and may further vary from detailed examination for the quantities and unit rates assumed. The comparison suggests that San Nicolas Shoal which is shallowest among other sites in Manila bay is to the cheapest alternative, while deeper sites of such as Sangley (2) and Manila Bay Center are rather more expensive. As Sangley (1) is located near by the San Nicolas Shoal, its reclamation cost seems economical.

In case of a site at Laguna Lake, due to difficulty upon supply of reclamation fill materials from the vicinity area, it was planned that dredged soil from the Lake itself is to be used for reclamation in applying cement-mixing reclamation. However it is too expensive.

Table 8.6-10 Summary of Cost of Seawall and Reclamation for 1,500 ha at Each Prospective Site

Million USD

No	Description	SG1	SG2	MBC	SNS	LGL
1	Seawall	1,218	1,429	1,485	1,112	2,704
2	Reclamation	3,529	3,847	4,437	2,950	13,767
3	Soil Improvement					
3.1	PVD	428	528	1,910	348	303
3.2	DCM	541	550	546	533	
	Total	5,716	6,354	8,379	4,942	16,774

Table 8.6-11 Summary of Cost of Seawall and Reclamation for 2,400 ha at Each Prospective Site

Million USD

No	Description	SG1	SG2	MBC	SNS	LGL
1	Seawall	1,409	1,652	1,717	1,286	3,127
2	Reclamation	5,564	6,066	6,997	4,652	21,709
3	Soil Improvement					
3.1	PVD	675	833	1,004	548	478
3.2	DCM	853	867	861	840	
	Total	8,501	9,418	10,580	7,326	25,314

Source: Survey Team

8.7 Airport Access Traffic and Network

8.7.1 Basic Considerations

1) Precondition

The airport access facilities described in this section are considered based on the existing and planned roadway/railway network in Metro Manila, for the purpose of comparison of the candidate sites for New Manila Airport in view of accessibility to/from city center and economic efficiency of construction.

Looking at the projected future travel demand at the New Manila Airport, the travel demand seems too large and it would not be able to be catered only with the existing and planned roadway/railway network. Therefore, holistic study for the urban transport network in Metro Manila would be necessary. Once the project site would be selected, the Airport Access Facilities should be reviewed together with a further study for roadway/railway network in Metro Manila.

2) Better Access through Roadway

Airport access road should have good accessibility from city center and neighboring provinces, and it would depend on the strength of road network, consisting of expressways, arterial roads, distributer roads and local roads. For consideration of accessibility and connectivity in the existing and planned roadway network in Metro Manila, hierarchy levels of roadway are assigned based on the functional classification of each roadway as described below.

The 1st hierarchy level roads to be connected with the Airport Access Road should be expressways. In particular, the existing expressways {e.g.: North Luzon Expressway (NLEX), South Luzon Expressway (SLEX), Manila Skyway, and Manila-Cavite Expressway (CAVITEX)} and the proposed expressways {e.g.: Cavite-Laguna Expressway (CALAX), Laguna Lake Shore Expressway, C-6 Expressway} should be the 1st hierarchy level roads in the future road network in Metro Manila.

The 2nd hierarchy level roads to be connected with the Airport Access Road should be arterial ring roads. Considering that most of the major roads in Metro Manila are congested, the Airport Access Road should not be connected to the central area in order not to attract more traffic coming into city center. In particular, EDSA and C-5 would be the preferable arterial ring roads with their radius of approximately 6-10 km and 10-15 km respectively

The 3rd hierarchy level roads to be connected with the Airport Access Road should be distributor roads at the nearest town, which connect arterial roads and local roads. The Airport Access Road would be utilized not only for airport access but also for the access from suburban area to the city center of Metro Manila. Good accessibility from the nearest town would contribute to improve the access from the town to the city center of Metro Manila.

For the purpose of comparison of the candidate sites for New Manila Airport, the distances to/from Rizal Park (as the city center), Makati (as a tourist destination), Balintawak (the beginning of NLEX as the gateway point of North Luzon) and Alabang (the largest city along SLEX near city center of Metro Manila) are measured.

3) Railway Access

Airport Access Rail should also have good accessibility to the railway network in Metro Manila. However, the current railway network in Metro Manila does not have enough capacity to fully cover the travel demand generated in Metro Manila and all the existing lines are currently seriously congested. Even if the Airport Access Rail have good connectivity to the existing railway network, passengers to/from NMIA, who normally have big baggage, would not be able to utilize the existing railway lines. Therefore, upgrading of passenger capacity of the existing railways is necessary to fully utilize the Airport Access Railway.

The Airport Access Rail alternatives proposed in this study are identified as possible shortest railway routes in the future rail system and should therefore be understood to be indicative plan. A comprehensive study should be carried out during the forthcoming feasibility study for development of the rail system for the specific site chosen.

Figure 8.7.1-1 Existing and Planned Road/Railway Network in Metro Manila

8.7.2 Examination of Prospective New Airport Sites on Airport Access

1) Sangley Point Option 1

a) Road Access

The possible route for the Airport Access Road to the candidate site at Sangley Point Option 1 starts from the end of CAVITEX or the beginning of CALAX and pass through the swampy area in Cavite City. The section in the swampy area could be constructed with embankment and the section in the coastal area would be viaduct.

The reason why the beginning point of the Airport Access Road is selected at the location of the interconnection between CAVITEX and CALAX was that these two (2) expressways were expected to be operated by different operators. The expressways in the Philippines are operated by different operators and the toll collection systems are also different depending on the operators. Under current individual toll collection systems, toll plaza on main expressway alignment is needed at an interconnection of expressways. Therefore, connection to the existing interconnection point would be the most preferable for the operators of existing expressways. However, Metro Pacific Investments Corp., who is the operator of CAVITEX, won the bid for CALAX under Public-Private Partnership (PPP) scheme so that the Airport Access Road would be able to be connected with CALAX at anywhere. Further study should be made during the forthcoming feasibility study stage.

The approximate distances to/from Rizal Park, Makati, NLEX (Balintawak) and SLEX (Alabang) are as follows:

- Rizal Park: 32.5 km (47 min without traffic)
- Makati: 32.5 km (35 min without traffic)
- NLEX (Balintawak): 48.5 km (49 min without traffic)
- SLEX (Alabang): 30.5 km (55 min without traffic)

The structural length and construction cost of the routes are roughly estimated as follows:

• Access Road (6-lane):	Embankment:	L = 5 km	Php 2.0 bln
	Viaduct:	L = 5 km	Php 14.0 bln
	Airport Terminal Ramp:	L =3 km	Php 5.0 bln
	Interchange:	2	Php 5.5 bln
	Subtotal:		Php 26.5 bln

b) Railway Access (Indicative only)

The possible route of the Airport Access Rail would be the route along with the abovementioned Access Road, LRT Line 1 south extension (Las Pinas Station – Ninoy

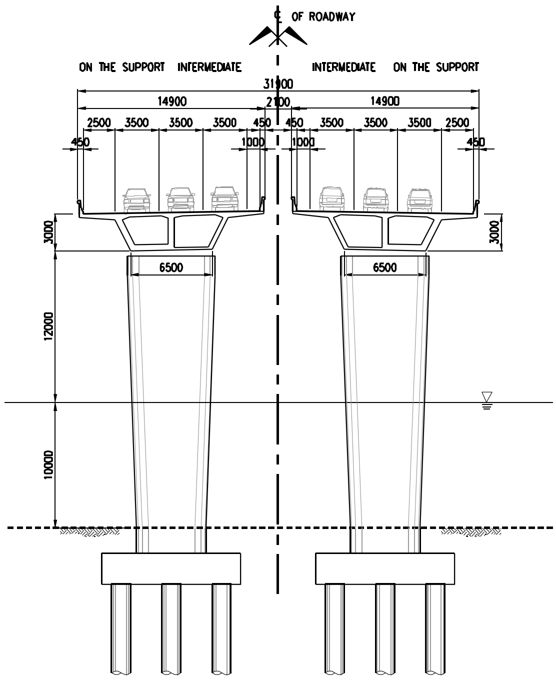
Aquino Station) and existing runway of NAIA. The Access Rail can be connected with LRT Line 1, proposed Mega Manila Subway Line and North-South Railway as well as the proposed FTI Bus Terminal.

The section from airport terminal to Las Pinas Station (18 km) would be constructed with viaduct and the remaining section (8 km) would be underground. The terminal station at the New Airport would also be constructed underground and its tunnel length would be 1 km.

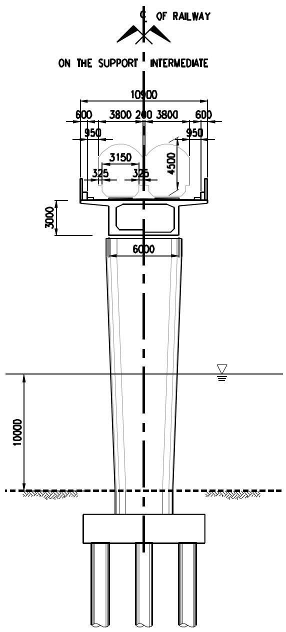
The structural length and construction cost of the routes are roughly estimated as follows:

• Railway Access:	Viaduct:	L = 18 km	Php 17.8 bln
(Subway Subsidiary Line)	Underground:	L = 9 km	Php 20.4 bln
	Station:	7	Php 15.6 bln
	Subtotal:		Php 53.8 bln

Total construction cost is estimated in Php 80.3 billion.



Typical Cross Section
(Viaduct for 6-lane Roadway)



Typical Cross Section
(Viaduct for Railway)

Figure 8.7.2-1 Airport Access Road and Rail Development Concept for Sangley Point Option 1

2) Sangley Point Option 2

a) Road Access

The possible route for the Airport Access Road to the candidate site at Sangley Point 2 starts from CAVITEX Bacoor Interchange and pass through the boundary of the proposed "Three Island" reclamation development area with avoiding the area of Las Pinas-Paranaque Critical Habitat. The whole stretch of this route in Manila Bay will be constructed with viaduct. Through this route, the New Manila Airport will have direct expressway access to NLEX or SLEX through CAVITEX, NAIA Expressway and Manila Skyway. Currently, Bacoor Interchange is a trumpet-type interchange (connecting CAVITEX with Alabang-Zapote Road and Aguinaldo Boulevard) but re-construction of this interchange is necessary from 3-leg interchange to 4-leg interchange. Also, realignment of Alabang-Zapote Road and Aguinaldo Boulevard should be made together with construction of another interchange to this Access Road in order to provide smooth traffic flow at this location.

Direct connection with C-5 is also considered but is not adopted because the possible interconnection point for C-5 would be 1 km north-east side away from Bacoor Interchange of CAVITEX and the location is within the abovementioned environmental protected area. If this environmental issue can be managed or accepted, the Airport Access Road would be able to connect with C-5.

The approximate distances to/from Rizal Park, Makati, NLEX (Balintawak) and SLEX (Alabang) are as follows:

- Rizal Park: 24.5 km (39 min without traffic)
- Makati: 24.5 km (27 min without traffic)
- NLEX (Balintawak): 40.5 km (41 min without traffic)
- SLEX (Alabang): 22.5 km (47 min without traffic)

The structural length and construction cost of the routes are roughly estimated as follows:

• North Route (6-lane):	Embankment:	L = 1.5 km	Php 0.6 bln
	Viaduct:	L = 7.5 km	Php 20.7 bln
	Airport Terminal Ramp:	L =3 km	Php 5.0 bln
	Interchange:	2	Php 5.5 bln
	Subtotal:		Php 31.9 bln

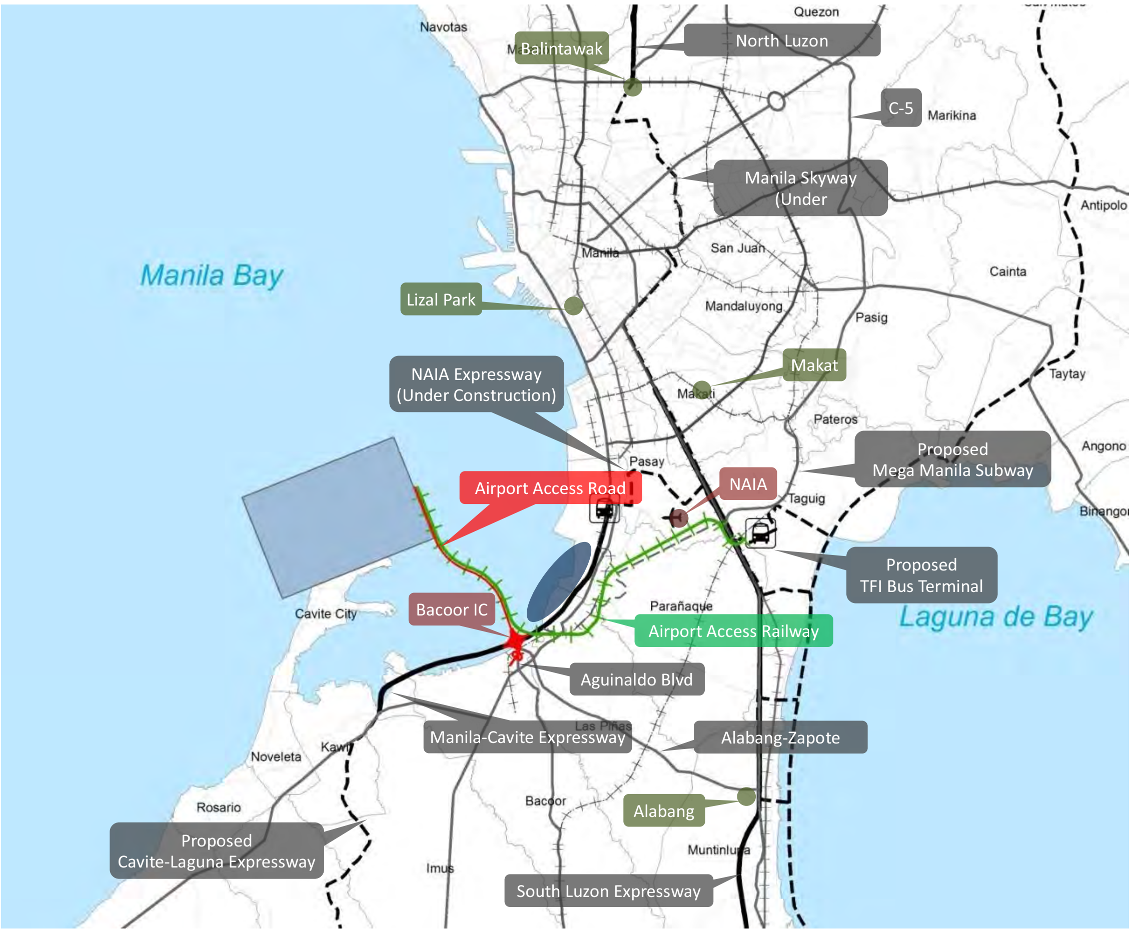
b) Railway Access (Indicative only)

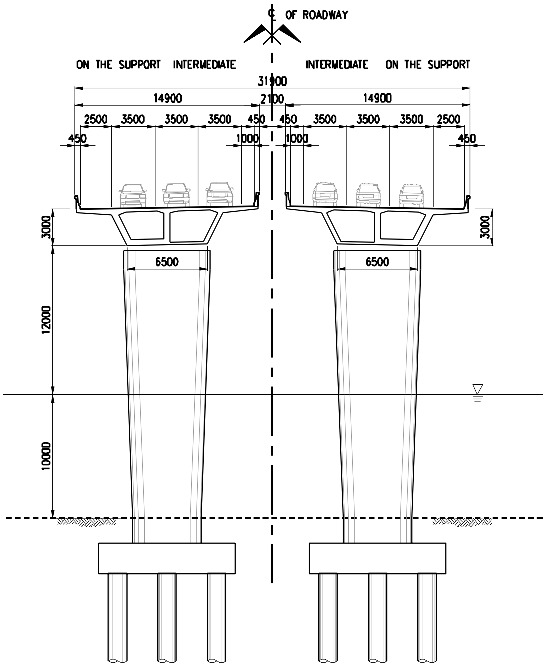
The possible access route for the Airport Access Rail is same as the route for Sangley Point 1 between Bacoor and FTI.

The structural length and construction cost of the routes are roughly estimated as follows:

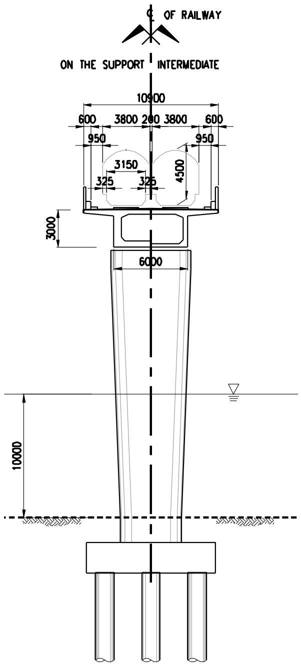
• Railway Access:	Viaduct:	L = 11 km	Php 12.1 bln
(Subway Subsidiary Line)	Underground:	L = 9 km	Php 20.4 bln
	Station:	4	Php 11.3 bln
	Subtotal:		Php 43.8 bln

Total construction cost is estimated in Php 75.7 billion.





Typical Cross Section
(Viaduct for 6-lane Roadway)



Typical Cross Section
(Viaduct for Railway)

Figure 8.7.2-2 Airport Access Road and Rail Development Concept for Sangley Point Option 2

3) Central Portion of Manila Bay

a) Road Access

The possible route for the Airport Access Road to the candidate site at Manila Bay Center is same as the routes for Sangley Point 2.

The approximate distances to/from Rizal Park, Makati, NLEX (Balintawak) and SLEX (Alabang) are as follows:

- Rizal Park: 20.5 km (35 min without traffic)
- Makati: 20.5 km (23 min without traffic)
- NLEX (Balintawak): 36.5 km (37 min without traffic)
- SLEX (Alabang): 18.5 km (43 min without traffic)

The structural length and construction cost of the route are roughly estimated as follows:

• Access Road (6-lane):	Embankment:	L = 1.5 km	Php 0.6 bln
	Viaduct:	L = 3.5 km	Php 9.8 bln
	Airport Terminal Ramp:	L =3 km	Php 5.0 bln
	Interchange:	2	Php 5.5 bln
	Subtotal:		Php 20.9 bln

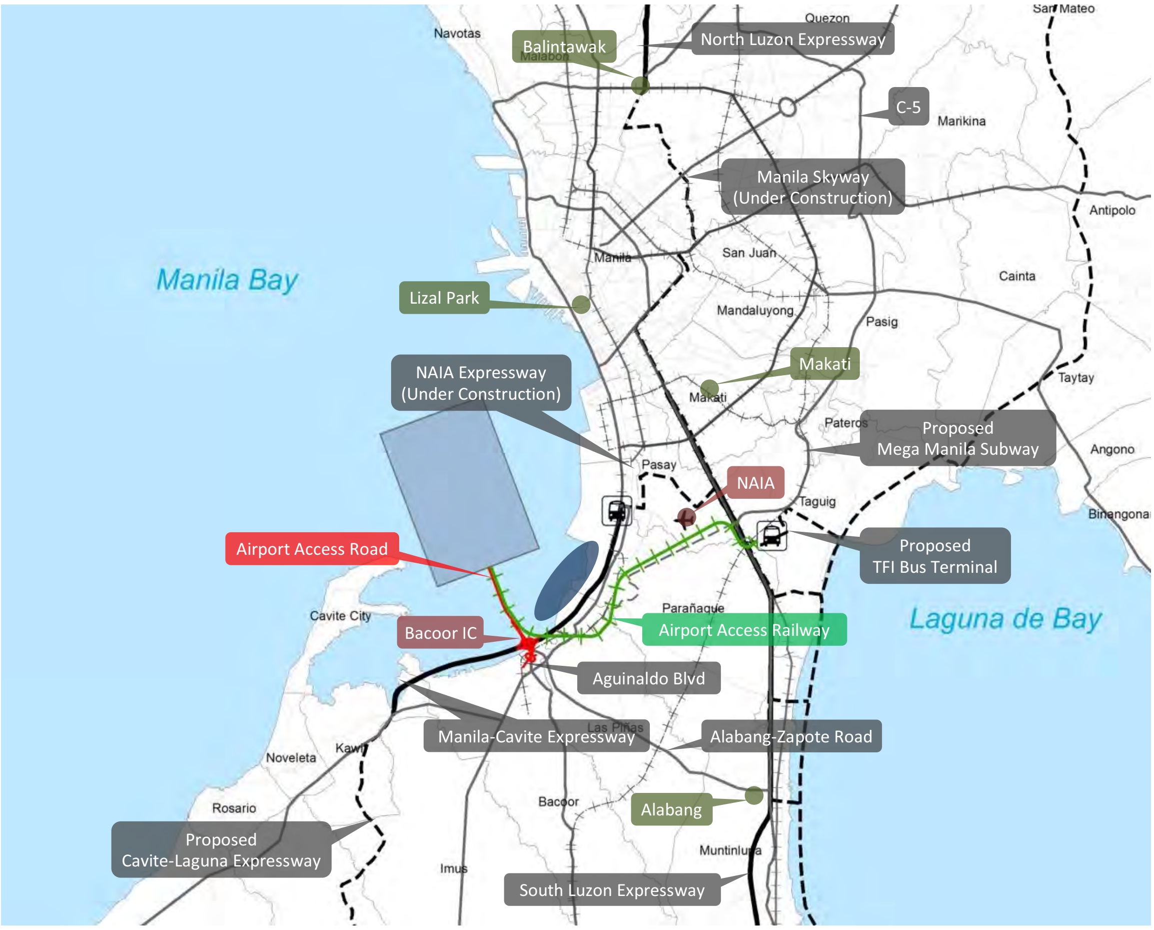
b) Railway Access (Indicative only)

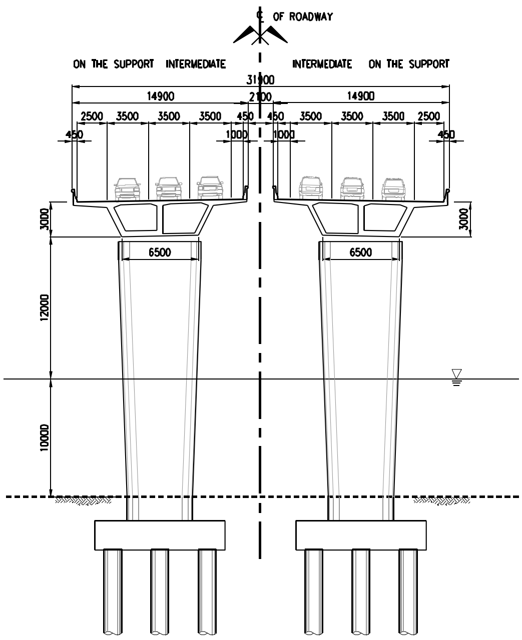
The possible access route for the Airport Access Rail is same as the secondary route for Sangley Point 2.

The structural length and construction cost of the routes are roughly estimated as follows:

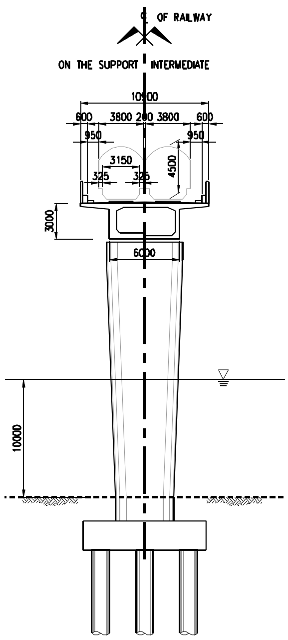
• Railway Access: (Subway Subsidiary Line)	Viaduct:	L = 7 km	Php 7.5 bln
	Underground:	L = 9 km	Php 20.4 bln
	Station:	4	Php 11.3 bln
	Subtotal:		Php 39.3 bln

Total construction cost is estimated in Php 60.2 billion.





Typical Cross Section
(Viaduct for 6-lane Roadway)



Typical Cross Section
(Viaduct for Railway)

Figure 8.7.2-3 Airport Access Road and Rail Development Concept for Central Portion of Manila Bay

4) San Nicholas Shoals

a) Road Access

The possible route for the Airport Access Road to the candidate site at San Nicholas Shoals starts from the end of CAVITEX or the beginning of CALAX and pass through the swampy area in Cavite City. The section in the swampy area could be constructed with embankment and the section in the coastal area would be viaduct.

The approximate distances to/from Rizal Park, Makati, NLEX (Balintawak) and SLEX (Alabang) are as follows:

- Rizal Park: 32.5 km (47 min without traffic)
- Makati: 32.5 km (35 min without traffic)
- NLEX (Balintawak): 48.5 km (49 min without traffic)
- SLEX (Alabang): 30.5 km (55 min without traffic)

The structural length and construction cost of the routes are roughly estimated as follows:

• Access Road (6-lane):	Embankment:	L = 5 km	Php 2.0 bln
	Viaduct:	L = 5 km	Php 14.0 bln
	Airport Terminal Ramp:	L = 3 km	Php 5.0 bln
	Interchange:	2	Php 5.5 bln
	Subtotal:		Php 26.5 bln

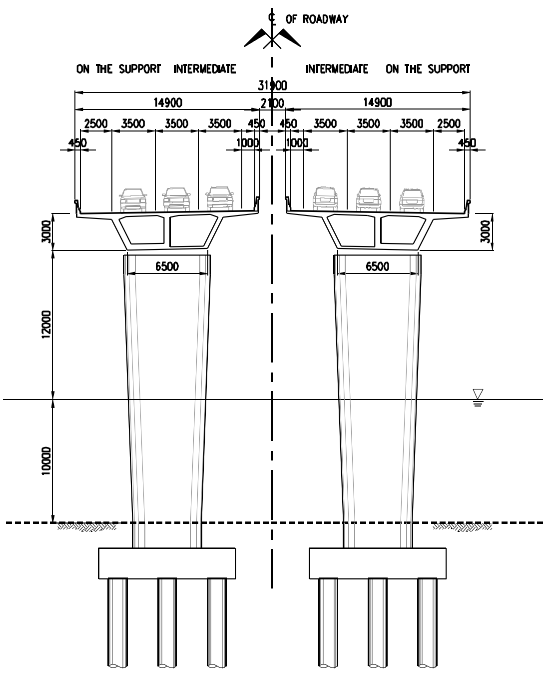
b) Railway Access (Indicative only)

The possible access route for the Airport Access Rail is same as the secondary route for Sangley Point 1.

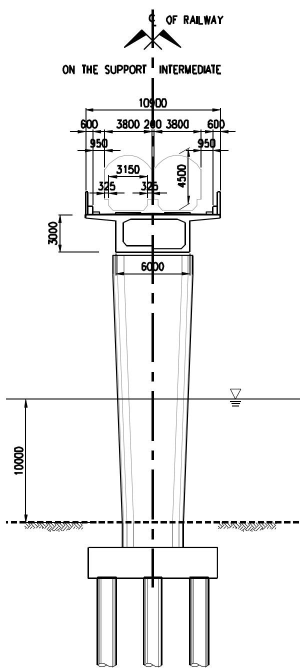
The structural length and construction cost of the routes are roughly estimated as follows:

• Access Rail:	Viaduct:	L = 18 km	Php 17.8 bln
	Underground:	L = 9 km	Php 20.4 bln
	Station:	7	Php 15.6 bln
	Subtotal:		Php 53.8 bln

Total construction cost is estimated in Php 80.3 billion.



Typical Cross Section
(Viaduct for 6-lane Roadway)



Typical Cross Section
(Viaduct for Railway)

Figure 8.7.2-4 Airport Access Road and Rail Development Concept for San Nicholas Shoals

5) Western Portion of Laguna de Bay

a) Road Access

The possible route for the Airport Access Road to the candidate site at Laguna Lake starts from the proposed Sucat Interchange of Laguna Lake Shore Expressway. Sucat Interchange is currently designed as trumpet-type interchange but re-design of this interchange should be necessary to 4-leg interchange.

The approximate distances to/from Rizal Park, Makati, NLEX (Balintawak) and SLEX (Alabang) are as follows:

- Rizal Park: 31.5 km (36 min without traffic)
- Makati: 25.5 km (28 min without traffic)
- NLEX (Balintawak): 41.5 km (42 min without traffic)
- SLEX (Alabang): 17 km (18 min without traffic)

The structural length and construction cost of the routes are roughly estimated as follows:

• Access Road (6-lane):	Embankment:	L = 5 km	Php 2.0 bln
	Viaduct:	L = 4 km	Php 11.2 bln
	Airport Terminal Ramp:	L = 3 km	Php 5.0 bln
	Interchange:	1	Php 4.5 bln
	Subtotal:		Php 22.7 bln

b) Railway Access (Indicative only)

The possible access route for the Airport Access Rail is the route along with the above mentioned Airport Access Road and Dr A. Santos Avenue. Its total length will be 15 km and can be connected with North-South Railway, Mega Manila Subway Line and LRT Line 1.

The structural length and construction cost of the routes are roughly estimated as follows:

• Access Rail:	Viaduct:	L = 14 km	Php 14.5 bln
	Underground:	L = 1 km	Php 2.3 bln
	Station:	5	Php 9.9 bln
	Subtotal:		Php 26.6 bln

Total construction cost is estimated in Php 49.3 billion.

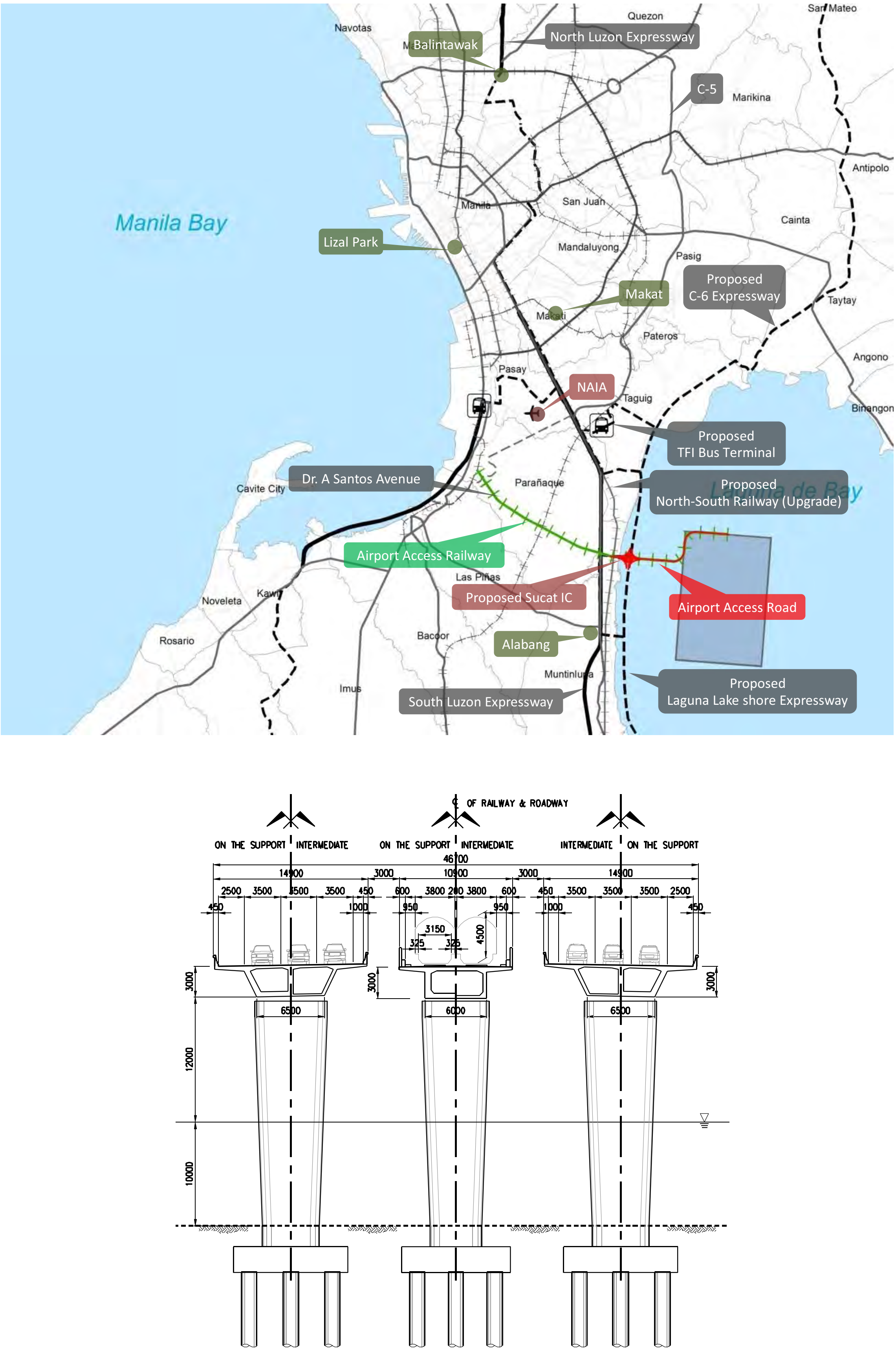


Figure 8.7.2-5 Airport Access Road and Rail Development Concept
for Western Portion of Laguna de Bay
(Viaduct for 6-lane Roadway and Railway)

8.7.3 Impacts on Metro Manila Transport Network

Impacts of new airport access traffic on urban transport network of Metro Manila are analyzed based on the traffic assignment model prepared in the Transport Roadmap Study. The results of the analysis indicate the impact of airport access traffic on overall network of Metro Manila is insignificant mainly due to the fact that a number of new project would have been completed when the new airport is in operation.

However, there is an impact on airport access traffic at the section which connect the new airport and main urban area. On the basis of the data obtained from other airports, the access traffic is estimated to be 92,000 pcu/day as shown in Table 8.7.3-1. Considering the non-airport user traffic such as visitors for pleasure and study purposes depending on additional facilities and functions to be provided with the new airport, required number of lanes for access road will be six (6).

Table 8.7.3-1 Estimated Airport Access Traffic

		2030
Total No. of Airport Users		358,443
Assumed Modal Share (%) [1)]	Public Transport	50
	Private Cars	20
	Others (taxi, tour/hotel bus, etc.)	30
Estimated Access Traffic (pcu)		92,000

Source: worked out by JICA Study Team

1) Modal share of referred airport is shown in the table below;

Airport (Year of Data)	Distance from urban center	Modal Share (%)		
		Public Transport (train and bus)	Private Cars	Others (taxi, tour/hotel bus, transit, etc.)
Narita (2010) [1/]	79km (from Tokyo St. by JR)	**48** - Express Train (JR+Keisei): 11 - Local Train (JR+Keisei): 24 - Limousine Bus: 13	**26**	**26**
Kansai (2005) [2/]	61km (from Shin Osaka St. by JR)	**60** - Train (JR+Nankai): 36 - Limousine Bus: 24	**18**	**22**
Haneda (2008) [3/]	20km (from Tokyo St. by JR and Monorail)	**89** - Monorail: 38 - Train (Keikyu): 35 - Limousine Bus: 16	**4**	**7**
Hong Kong (2005) [4/]	28km (from Central)	**71** - Train (AEL): 24 - Limousine Bus: 47	**7**	**22**

Source:1/ Narita International Airport Corporation
2/MLIT, Japan (excluding airport employees)
3/ MLIT, Japan (air passenger only)
4/ EASTS Journal Vol.6, 2005 (air passenger only)

8.8 Examination on Surrounding Land Use and Urban Development

1) Regional Context

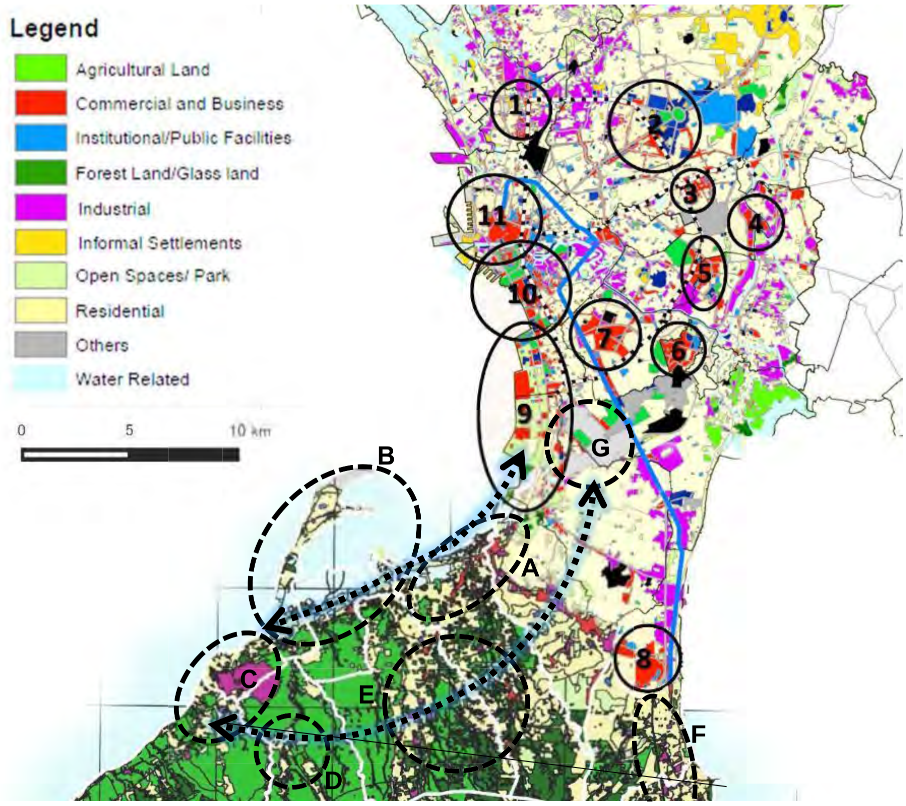
According to the geographical context, NMIA is supposed to mainly accommodate the needs of south Metro Manila (MM), Cavite and Laguna Provinces as shown in Figure 8.8-1. While north of MM includes undeveloped areas (Candaba Swamp, Pampanga River Delta, irrigated rice fields controlled by the Comprehensive Agrarian Reform Program etc.), south of MM becomes highly populated area towards the border of MM and the rapid urbanization extends to the north of Cavite and Laguna Province. Therefore, efficient land use needs to be promoted in these areas.

Source: JICA Study Team

Figure 8.8-1 Current Operating International Airports and Candidate Sites for NMIA

However, formation of urban areas in the north of Cavite and Laguna province are not well organized due to the lack of coordination among provincial plans and plans of MM as well as Comprehensive Land Use Plans (CLUPs) of Local Government Units (LGUs). In these new urban areas, intensification of land use such as introduction of mixed-use development including mid to high residential, commercial, and office buildings needs to be promoted to implement efficient land use and secure sufficient open and green spaces. Also, regional transport system needs to be improved to enhance the connectivity among LGUs towards sustainable urban growth.

As Figure 8.8-2 and Table 8.8-1 show, several emerging Central Business Districts (CBDs) are identified in the north of Cavite and Laguna Province. Unfortunately, currently they're not fully functioned as CBDs due to the lack of connections with the existing CBDs in MM. Regarding the waterfront areas, large scale, holistic reclamation and urban redevelopment needs to be implemented to enhance the linkage among existing and future CBDs along Manila Bay as well as to accommodate sufficient function as urban water front area. For the inland areas, large scale urban redevelopment needs to be implemented in the current densely populated inefficient single family homes including informal settlements to construct an arterial road to connect the existing and future CBDs. Among future CBDs, current NAIA is expected to be an anchor to connect the existing and future CBDs due to its prime location. Therefore, early transition from NAIA to NMIA is desirable.



Source: JICA CBD Study and NAMRIA, 2005

Figure 8.8-2 Land Use and CBDs in MM, Cavite and Laguna Province

Table8.8-1 List of Identified CBDs in MM, Cavite and Laguna Province

No.	Identified CBD by CBD Study	No.	Future CBD identified by NMIA Study
1	Monument Area (Caloocan)	A	Sothern Manila Bay Area (Las Pniãs, Bacoor)
2	Quezon Circle Area (Quezon City)	B	Cavite and Bacoor Bay Area (Cavite, Novelta, Kawit)
3	Cubao (Quezon City)	C	Rosario-Tanza Coastal Area (Rosario, Tanza)
4	Eastwood City (Quezon City)	D	General Trias Area (General Trias)
5	Ortigas Center (Pasig)	E	Bacoor Imus Area (Bacoor, Imus)
6	Bonifacio Global City (Taguig)	F	Southern Muntinlupa and San Pedro Area (Muntinlupa, San Pedro)
7	Makati CBD (Makati)		
8	Alabang Center (Muntinlupa)	G	Current NAIA Area (Post relocation to NMIA) (Pasay, Paranãque)
9	Manila Bay Area (Pasay)		
10	Port Area (Manila)		
11	Central Manila (Manila)		

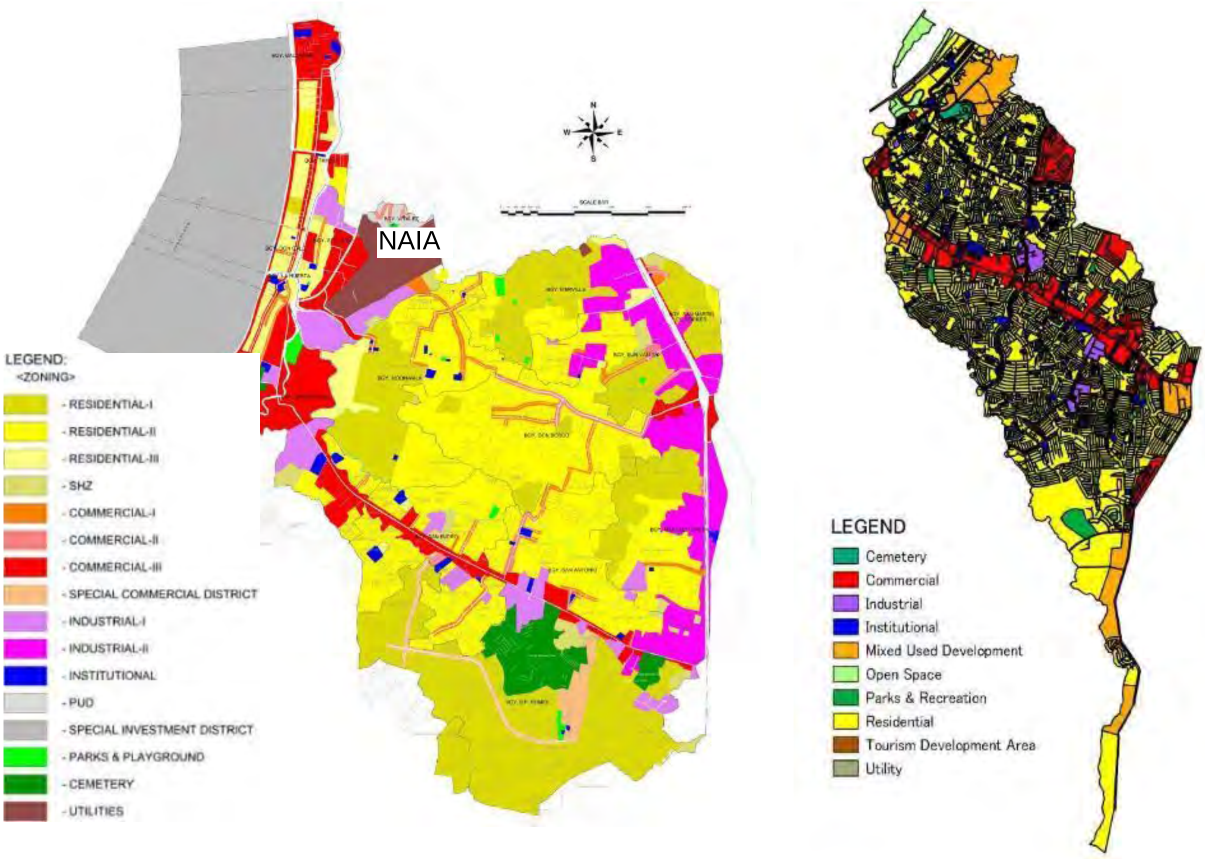
2) Central Portion of Manila Bay

a) Generally

Vicinity of Central Manila Bay site extends along the coast in the cities of Manila, Pasay and Paranãque. The area has been intensively developed since the early stage of urbanization of Manila (see Figure 8.8-3). The area encompasses old city center, port area, tourist area including historic sites, and reclaimed lands where mega developments are in progress.

Figure 8.8-3 Concept Plan of Central Manila (Bay Source: JICA Study Team)

NMIA is to be located offshore of the vibrant coast. From the view point of urban development, there are pros and cons. Advantages include the proximity to the city center which provides airport users with short distance access. As previously described, since NAIA is located in the prime area, prompt relocation from the current NAIA to NMIA is desirable to establish a new CBD. Mixed-use (residential, commercial, public, office etc.) including sufficient open/green area is appropriate for the redevelopment of NAIA due to the scale of the site and surrounding land use as shown in Figure 8.8-4. These CLUPs illustrate the necessity for urban redevelopment to foster future CBDs, enhance the connection between the existing and future CBDs, as well as to secure necessary open/green spaces as previously described. Since these CLUPs do not include the NMIA, they need to be revised including the proposed urban redevelopment to maximize the benefits by the development of NMIA once Central Manila Bay site is selected.



Source: Paranãque City Planning and Development Coordinator's Office, Las-Pinãs City Planning Office

Figure 8.8-4 Proposed CLUP of Paranãque (2007) and Las-Pinãs (2014)

In terms of disadvantages, there are many such as congestion by the airport traffic on Roxas Boulevard and the limited number of main roads which have been already congested. Possible railway connectivity to LRT Line 1 and MRT Line 3 will not be any help because their capacities have also been reached. Therefore, in addition to the proposed airport main access, new local access should be provided as it mitigates the traffic congestion from Roxas Boulevard to

Manila-Cavite Expressway. The new local access road also enhances the benefits by the airport development for the local community and serves as the maintenance access for the airport service vehicular as well. Destruction of waterfront views from Roxas Boulevard which has been inherited in the history and loved by the people will also be another drawback. Opportunities for further development along the coast are scarce because the area has been already developed intensively. Therefore, further reclamation with certain consideration for the environmental impact such as flood prevention is desirable in Baccor Bay in order to maximize the benefit of the airport development. Since the City of Cavite becomes closer to MM by the proposed local access road, value and role of the City of Cavite are expected to be increased and the land expansion will be needed to respond such expectations. While intense urban development is expanding, Manila bay encompasses important natural habitat including LPPECHEA described in Chapter 8.4. In order to protect the vulnerable area along the coast, environmental buffer zone should be designated. Limited land uses (woods, parks, low density single family residential etc.) are supposed to be allowed in the buffer zone to protect the coastal habitat such as mangrove.

b) Conflict with Port of Manila

The proposed layout of Central Portion of Manila Bay was prepared mainly considering the following:

i) RP-P1:Malacanang should not be protruded by the obstacle assessment surfaces for the instrument flight procedures of aircraft approaching/departing NMIA;
ii) Horizontal and vertical limitation on the surrounding cities should be minimized and adequate distances between NMIA and the coastal areas should be provided;
iii) Any tall structures located in the Port of Manila, other than those in the anchorage area, should not infringe the obstacle limitation surfaces of NMIA.

In this case, a part of NMIA physically overlaps the Manila Port Zone as shown in Figure 8.8-5. Some of the ship routes and anchorages are located under the approach/take-off climb surfaces, resulting in strict height limitation as depicted in Figure 8.8-6. Squares shown on the said Figure are the anchorages with identifications of designated areas and numbers. Height limitations are also shown by yellow figures. According to officials of the Philippine Port Authority (PPA), the mast heights sometimes exceed 60 m above sea level. Should such height limitation be enforced, some of the anchorages located in areas B, C and Q would not be usable, resulting in significant reduction of the handling capacity of the Port of Manila. JICA Survey Team had several discussions with officials of PPA, and during the meeting held on 25 January 2016 attended by representatives of PPA, DOTC and the Survey Team, PPA expressed its opinion that such reduction of the handling capacity should not be acceptable for PPA. Therefore, Central Portion of Manila Bay site is to be regarded as less feasible from surrounding land use viewpoint.

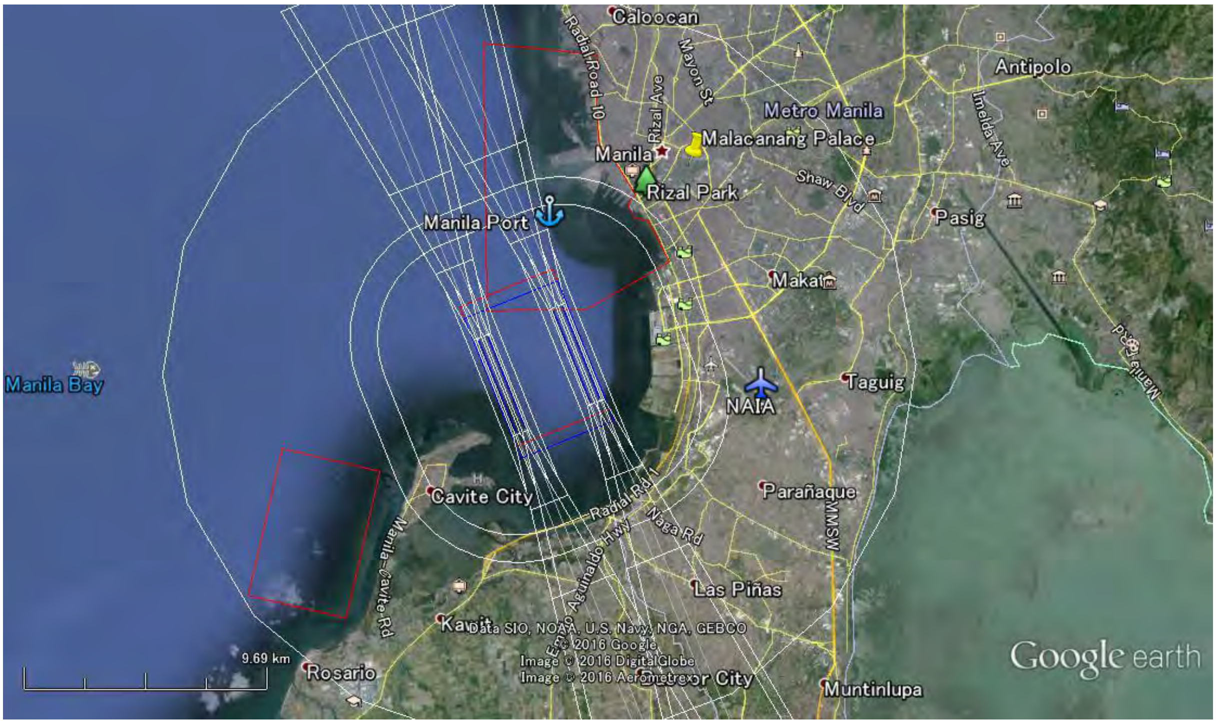


Figure 8.8-5 Overlapping Central Portion of Manila Bay Site and Manila Port Zone

Figure 8.8-6 Anchorages and Ship Routes located under Approach/Transitional/Horizontal Surfaces

c) Alternative Site Location of Central Portion of Manila Bay for Referene

To avoid the site overlapping and height restriction, the runways would need to be rotated anticlockwise to, say 09/27 as depicted in Figure 8.8-7. In this case, land use of Cavite would be significantly adversely affected and a significant number of involuntary resettlement would be necessary. The coastal area of Metro Manila along the CAVITEX would also be significantly disturbed by the height restriction. Additionally, the instrument flight procedures in the case of RWY 09/27 would conflict with RP-R76: LIMAY (Philippine National Oil Corporation) which restricts flights from the surface to unlimited height (see Subsection 8.3.1.2). This alternative location is also considered not practicable.

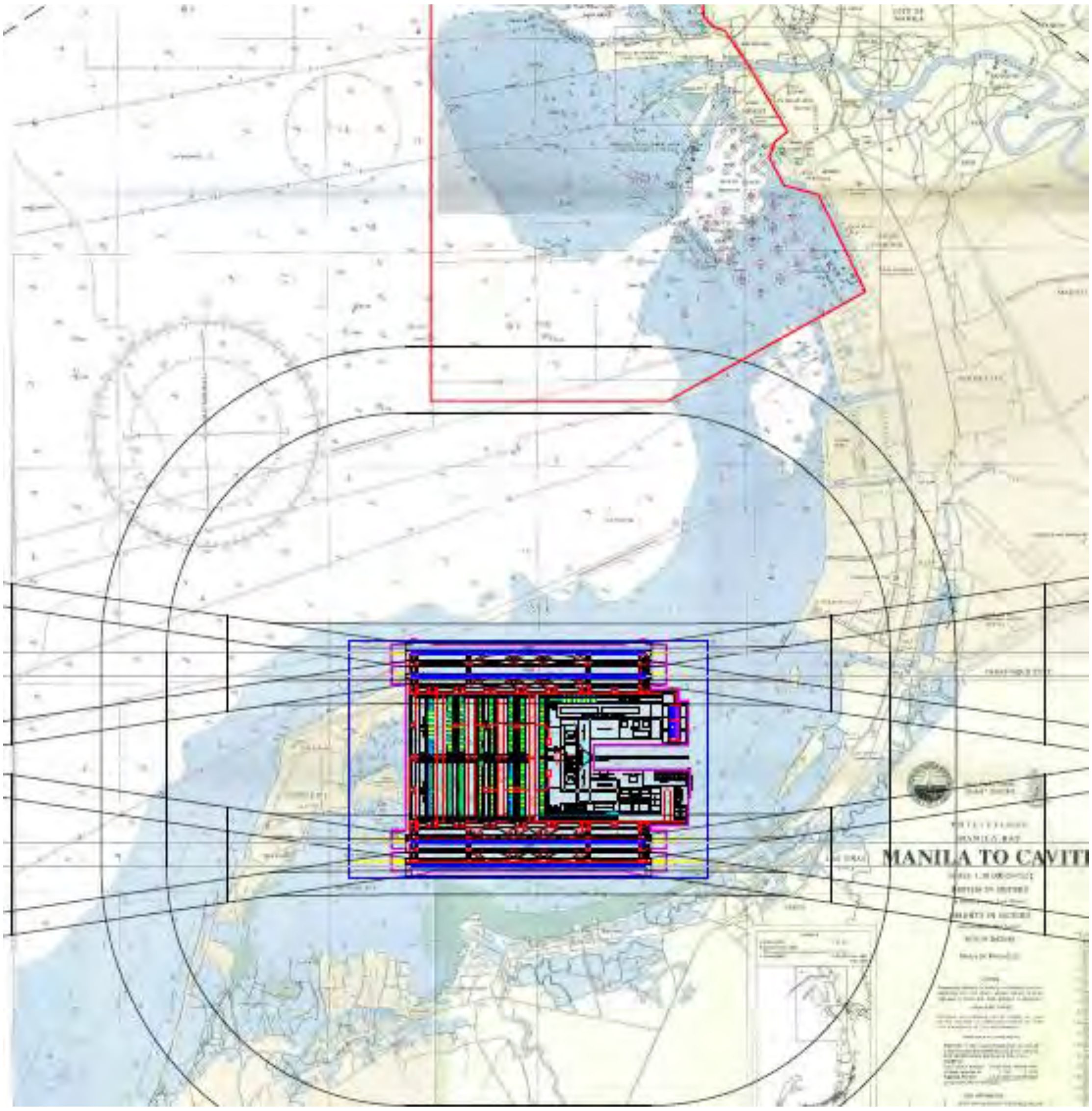
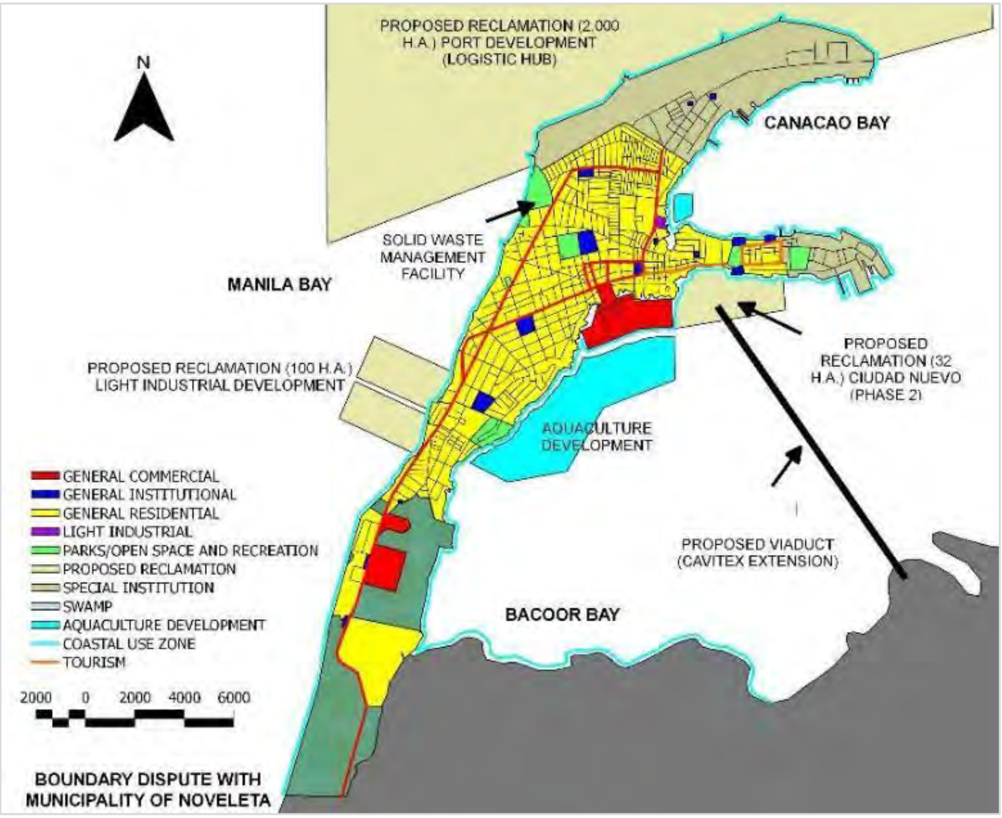


Figure 8.8-7 Alternative Location of Central Portion of Manila Bay Site
(Avoiding Overlapping and Height Restriction Problems)

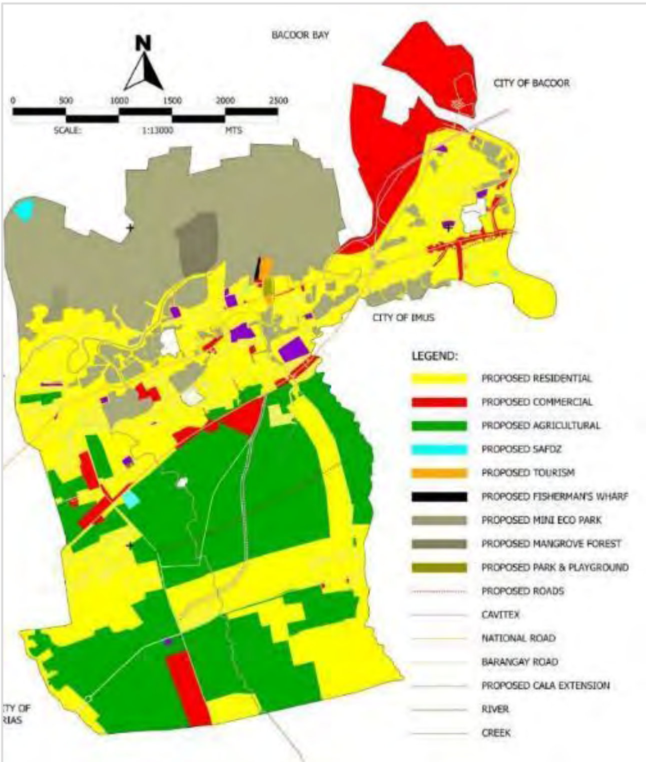
3) Sangley Point Options 1 and 2

Sangley Point Option 1 is in the offshore of Cavite City and Noveleta while Sangley Point Option 2 is in Cavite City. Since the scale of NMIA is so large that other municipalities such as Imus, Bacoor, Las Pinãs, Paranãque, among others, will also be directly and indirectly affected. Directly influenced municipalities including Cavite City, Kawit and Noveleta have their own CLUP as shown in Figures 8.8-8, 8.8-9 and 8.8-10, respectively. Although these current plans do not consider the location of NMIA, there are ample opportunities that three municipalities are significantly benefited by the development of NMIA on conditions that these CLUPs would be updated in a coordinated and integrated manner in terms of socio-economic development, transport connectivity, land use and environmental management. As Figure 8.8-8 illustrates, large-scale (2,000ha) port development has been planned according to the provincial development physical framework plan to construct an international logistic hub. This proposed reclamation project together with the reclamation for light industrial development overlap the sites for Sangley Point Options 1 and 2, and proper coordination should be done among agencies and authorities concerned. When planning the airport access road and rail network, necessary integration with the proposed port and other developments as well as the existing industrial areas (Cavite Economic Zones 1 and 2) designated by the Philippine Economic Zone Authority (PEZA) should be carefully examined in order to maximize the benefits by the airport development. In response to such needs, local access shown in Figures 8.8-11 and 8.8-12 has been proposed in addition to the proposed airport main access. The local access also provides the benefits for both local community and NMIA since it mitigates the traffic congestion and serves as the maintenance access for the airport service vehicular as well.



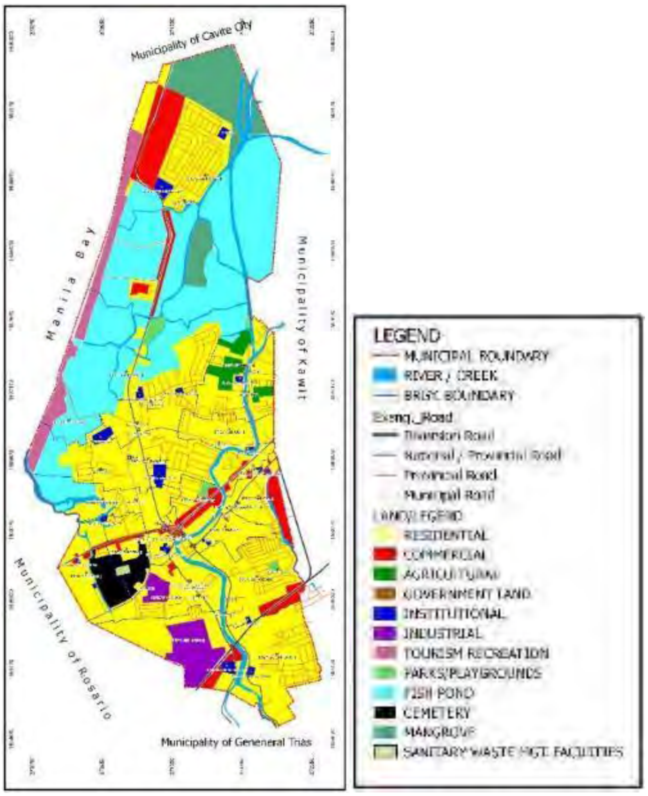
Source: CLUP of Cavite City

Figure 8.8-8 Proposed CLUP of Cavite, 2012-2022



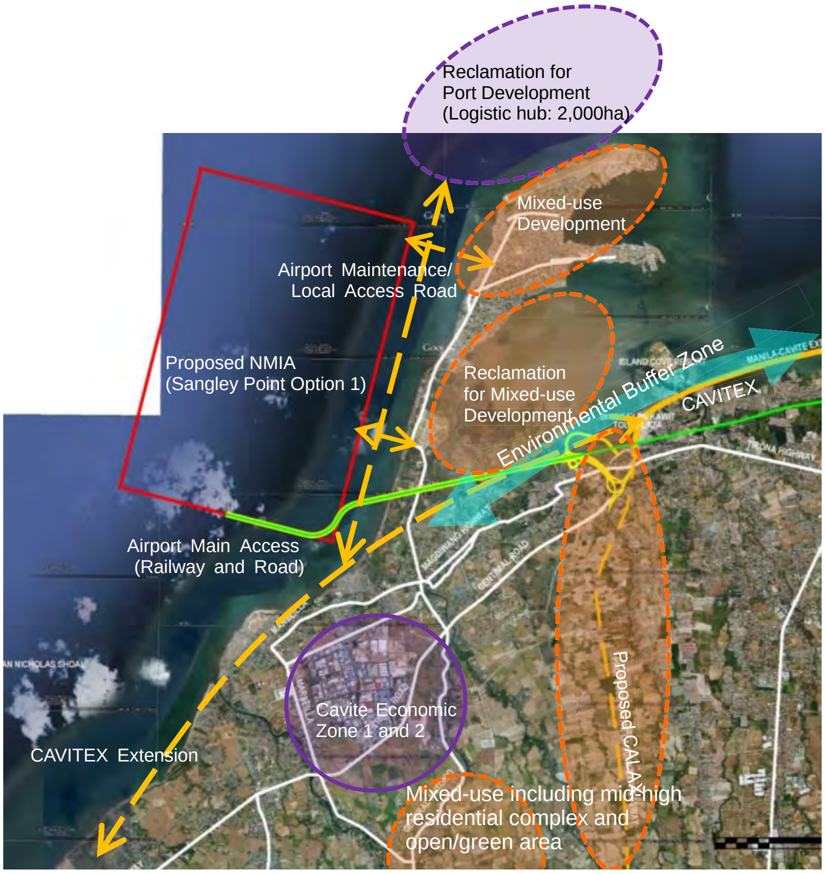
Source: CLUP of Kawit

Figure 8.8-9 Proposed CLUP of Kawit, 2012-2020



Source: CLUP of Noveleta

Figure 8.8-10 Proposed CLUP of Noveleta, 2012-2022



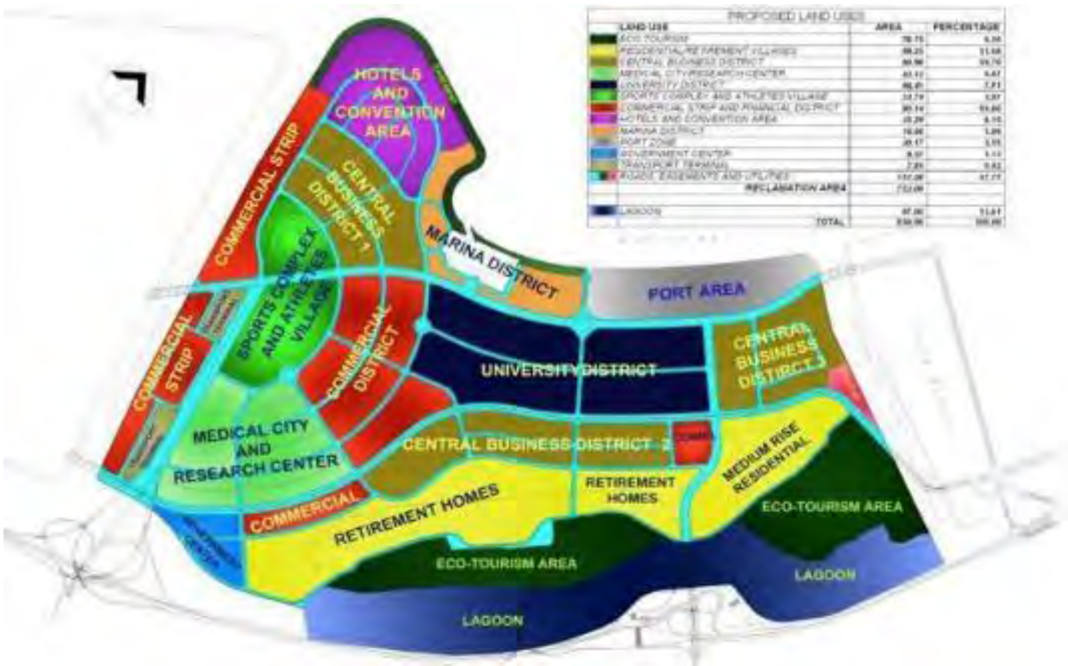
Source: JICA Study Team

Figure 8.8-11 Concept Plan of Sangley Point Option 1

Source: JICA Study Team

Figure 8.8-12 Concept Plan of Sangley Point Option 2

In order to maximize the benefit of the development of NMIA and logistic hub, further reclamation is desirable in Baccor Bay. Considering the large scale reclamation projects (NMIA: 2,400ha, Proposed logistic hub: 2,000ha), value and role of the City of Cavite are expected to be increased and the land expansion will be needed to respond to such expectations. While new reclamation project in Bacoor bay will be implemented, current reclamation projects along Manila Bay need to be revised to enhance environmental integration as a buffer zone of coastal area. The fact that all major current reclamation projects are suspended due to the environmental issues such as LPPECHEA implies the necessity for the revision. One of the major reclamation project is Paranãque-Las Pinãs Coastal Bay Project. Since the project area includes LPPCHEA planned as lagoon and eco-tourism area in Figure 8.8-13, the project is currently on hiatus due to the strong opposition from the civil society although Memorandum of Agreement was signed among PRA, City of Paranãque and Las Pinãs. Manila-Cavite Toll Expressway Reclamation Project located adjacent to west side of Paranãque-Las Pinãs Coastal Bay Project is also currently suspended due to the environmental issues. Another reclamation project has been formulated on the south side of CAVITEX named Cavite Reclamation Project (Figure 8.8-14). Although it has been listed as one of the 10 priority development projects by Cavite Province, it has not been approved by PRA yet.



Source: Las Pinãs-Paranãque Coastal Bay Project
(http://www.slideshare.net/jay_c/las-piasparaaque-coastal-bay-reclamation-project-para-saan-para-kanino)

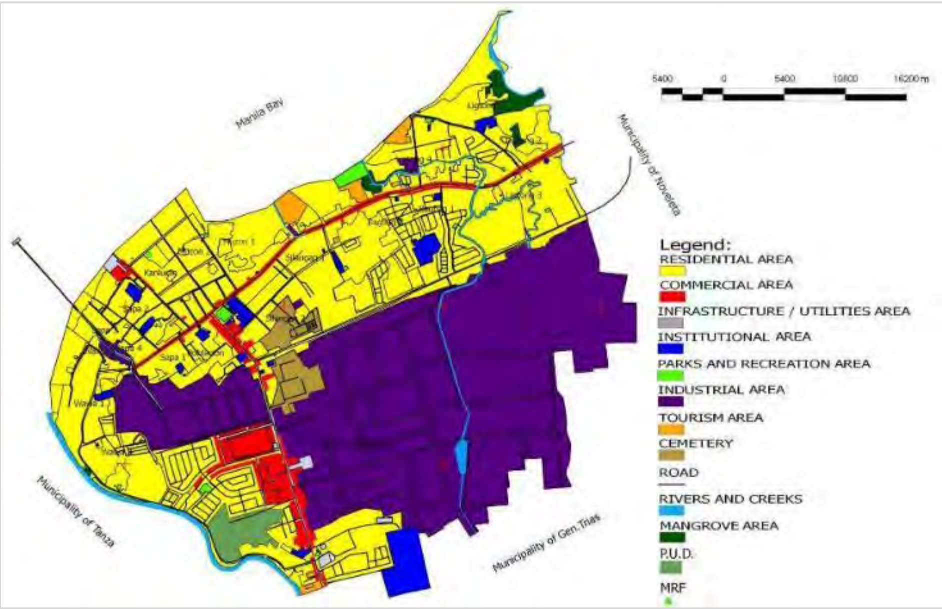
Figure 8.8-13 Proposed Land Use Plan of Paranãque-Las Pinãs Coastal Bay Project

Source: Cavite Province Development Strategy

Figure 8.8-14 Cavite Reclamation Project

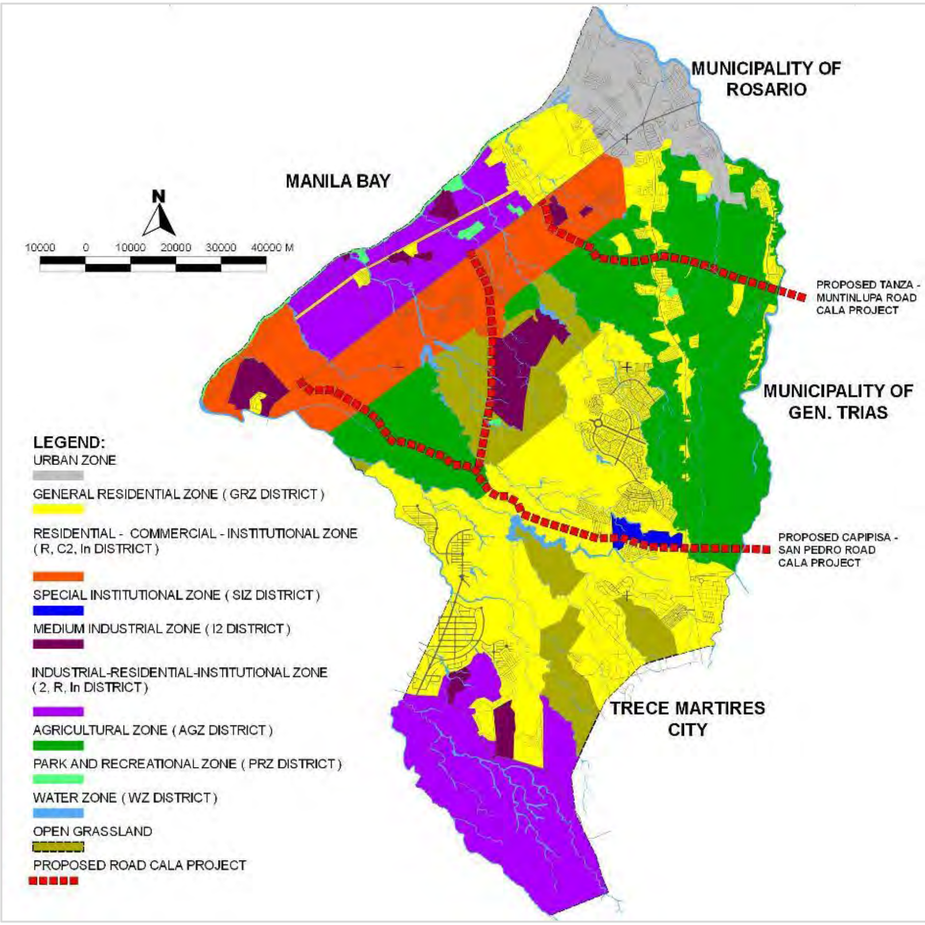
4) San Nicholas Shoal

San Nicholas Shoal site is located offshore of the municipalities of Rosario and Tanza. While Rosario is highly developed as shown in Figure 8.8-15, developed areas in Tanza are sporadic even in the proposed CLUP (Figure 8.8-16). Since there are no noteworthy projects within the immediate influenced area by NMIA except for some industrial areas, development of NMIA and relevant infrastructure may not provide the significant positive impacts comparing to the other candidate sites. In order to foster a new CBD as shown in Figure 8.8-2, integration of these municipalities and NMIA needs to be enhanced.



Source: MPDC Municipality of Rosario

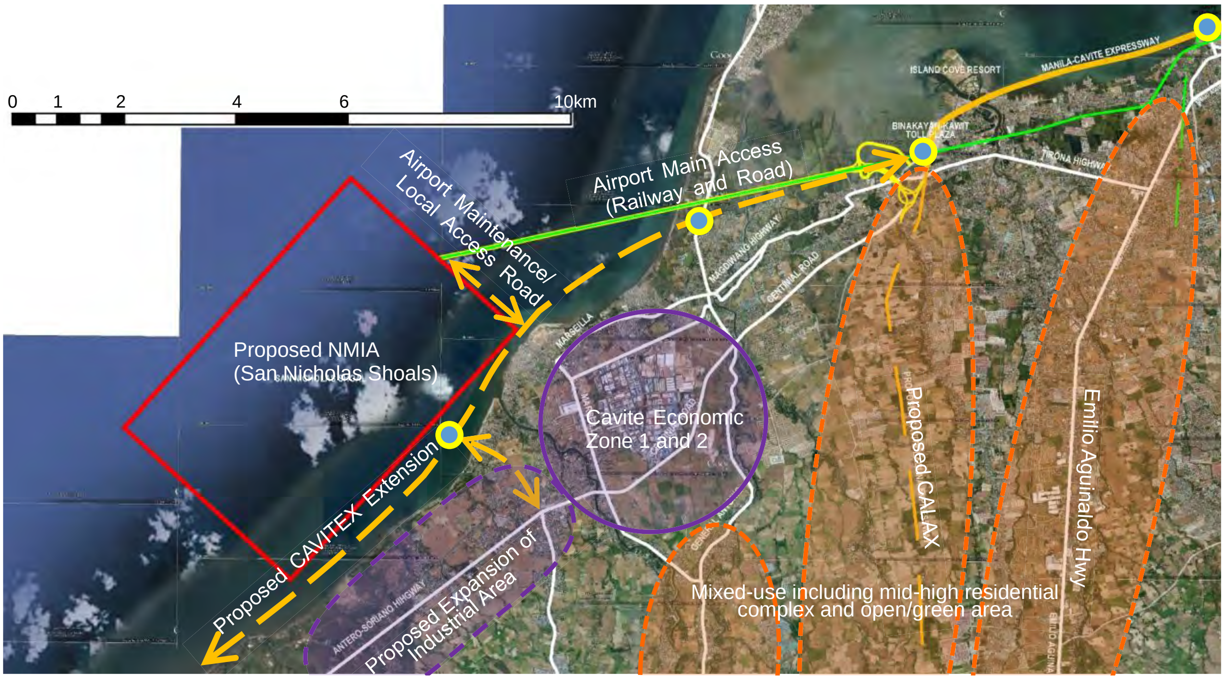
Figure 8.8-15 Proposed CLUP of Rosario, 2011-2020



Source: MPDC Municipality of Tanza

Figure 8.8-16 General Zoning Map of Tanza, 2011-2020

In order to enhance the integration and maximize the benefits of the development of NMIA, the access for the local community and the existing industrial areas as well as for the maintenance should be considered as shown in Figure 8.8-17 in addition to the main access. Extension of CAVITEX is desirable not only for the better local access but also for the better regional access to the western coastal area in Cavite province including some major resort areas such as Ternate. Since large scale residential development is not identified in the vicinity of San Nicholas Shoals due to its fragmented and relatively small-scale land ownership, consolidated and efficient land use needs to be promoted to accommodate the influx of population from MM. Therefore, large scale residential and mixed-use development is desirable along major roads such as Emilio Aguinald Highway and proposed CALAX as illustrated in Figure 8.8-17.



Source: JICA Study Team

Figure 8.8-17 Concept Plan of San Nicholas Shoals

5) Western Laguna Lake

Western Laguna Lake area is located along main urban and transport corridors connecting the north and south as well as the east and west of Metro Manila. In response to the rapid urbanization toward the southern MM, number of large-scale transport infrastructure and urban development projects are planned and under implementation. They include, among others; C6 Extension, Laguna Lakeshore Expressway, Calamba – Los Baños Expressway, and North-South Railway Project (Malolos-Calamba). As Laguna Lakeshore Expressway Project involves development of flood free urban land, integration with the development of NMIA will stimulate the multiplier effects on socio-economic especially in terms of urban development. In order to enhance the linkage with the emerging CBD in Alabang, local access including maintenance access for the airport service vehicular is desirable to be developed in addition to the airport main access as shown in Figure 8.8-18.

Source: JICA Study Team

Figure 8.8-18 Concept Plan of Western Laguna Lake

8.9 Summary Results of Examination

Table 8.9-1 shows summary results of examination on five prospective new airport sites and Table 8.9-2 shows the breakdown of the estimated construction costs. It should be noted that the preliminary construction costs are for the opening day (platform size of about 1500ha). However the compensation for the affected fisherfolk was estimated for the long-term required platform size of 2400ha. For reference purpose, the preliminary cost for the long-term platform development (2400ha) is also presented assuming that the platform would be constructed at one time.

Result of the examination is summarized below.

[From the airspace utilization and aircraft operation viewpoints]

In case of the Ultimate Phase Option 1 (two sets of widely spaced close parallel runways), Sangley Point Option 2 and San Nicholas Shoals are considered very difficult as the establishment of the instrument flight procedures would not be possible unless the height restriction of RP-P1: Malacanang could be removed or significantly relaxed to approximately 700 FT (Sangley Point Option 2) or 2600 FT (San Nicholas Shoals). In case of Sangley Point Option 2, the instrument flight procedures would also protrude RP-R74: Antenna Farm, RP-R75: Tall Structure in Makati and RP-R76: Philippine National Oil Corporation facility. Although the instrument flight procedures for Western Portion of Laguna de Bay would penetrate RP-R73: Barbados Airstrip, this airspace is for skydiving, aerobatic flying, ultra-light and aero-model operations and successful coordination could be expected. Instrument flight procedures could be established for Sangley Point Option 1 and Central Portion of Manila Bay without conflict with the existing major restricted/prohibited air spaces. It should be noted that a reclamation project exists in close proximity to Central Portion of Manila Bay site and development of high rise buildings and structures should be properly controlled in case NMIA is to be developed in the site. It should also be noted that if removal or relaxation of the prohibited/restricted airspaces mentioned above could be successfully coordinated by the Government of the Philippines, the instrument flight procedures could be established for five prospective new airport sites.

In case of the Ultimate Phase Option 2 (three open parallel runways), in addition to Sangley Point Option 2 and San Nicholas Shoals, Central Portion of Manila Bay site is also considered difficult as the IFP for the three runways would inevitably protrude RP-P1. Sangley Point Option 1 and Western Portion of Laguna de Bay are the only options for which IFP could be established without conflict with RP-P1.

It should be noted that for both Ultimate Phase Options 1 and 2, there would exist an oil terminal operated by PETRON near RWY 02R of Sangley Point Option 1. The oil terminal itself does not constitute any obstacle for the aircraft operation but could be regarded as a potential hazard for neighboring area in case of aircraft crash into the terminal, and coordination with relevant authorities would be required.

[From the environmental and social consideration viewpoint]

Significant number of involuntary resettlement would be expected in cases of Sangley Point Options 1 and 2, Central Portion of Manila Bay and San Nicholas Shoals for development of the airport access road. Western Portion of Laguna de Bay would necessitate much less number of involuntary resettlement. Concern over siltation is an issue inherent in development of NMIA by reclamation at all sites and should properly be addressed in the determination of the size and dimension of the platform.

[With respect to the risks of natural hazard]

With regard to the natural hazard, excessively high peak ground acceleration could be anticipated for Western Portion of Laguna de Bay in case magnitude 7.2 earthquake is caused by West Valley Fault. In case of Central Portion of Manila Bay, as the site is closely located to LPPCHEA (Ramsar Site), higher risk of bird strike would be anticipated.

[From the platform development viewpoint]

With regard to the technical feasibility of reclamation, no significant difficulty would be anticipated for the sites located in Manila Bay. In case of Western Portion of Laguna de Bay, however, the sub-surface soils at the lake bed, consisting of very soft silty soils, would need to be utilized as the reclamation material and need to be chemically stabilized. In addition, the sub-surface soils at the site need to be improved to facilitate consolidation settlement. As a consequence, the cost for platform development at this site would be excessive. However this analysis is based on the secondary data collected during the Survey, and confirmation based on actual boring data during the next feasibility study stage should preferably be made.

[Airport access and urban development viewpoint]

For the airport access, an access time of more or less 30 minutes between the prospective new airport sites and Makati would be achievable.

The prospective new airport sites, except for the Central Portion of Manila Bay as well as the San Nicholas Shoals, would offer good opportunity for urban development with surrounding areas. In case of the Central Portion of Manila Bay, the new airport site would overlap the Manila Port Zone and the obstacle limitation requirements would impose significant height restriction on the anchorage area of Manila Port, resulting in reduction of its handling capacity. Officials of the Philippine Port Authority (PPA) confirmed that such reduction of handling capacity should not be acceptable. In case of San Nicholas Shoals, due to its less availability of basic infrastructure and services, urban development would require more cost than the other sites.

[In terms of the development cost]

With regard to the cost implication, the platform and access road construction as well as the land acquisition and compensation for Western Portion of Laguna de Bay site would require much more excessive level of cost due to the unfavorable sub-surface soil condition and unavailability of proper reclamation materials. However, this preliminary conclusion was based on the secondary data of the sub-surface soil condition of Wester Portion of Laguna de Bay, and confirmation thereof based on actual boring data in the next feasibility study phase would preferably be required. Among the other four sites, San Nicholas Shoals offer the least cost for the platform and access road development as well as the land acquisition and compensation as it is closely located to the anticipated quarry site and the water depth is less than the others. Sangley Point Option 1 offers the second least cost for such, followed by Sangley Point Option 2 and Central Portion of Manila Bay.

[Summary]

In summary following are the key findings based on the technical examination on the five prospective new airport sites.

a) Sangley Point Option 1 is feasible option as:

i) The instrument flight procedures can be established without conflict with the existing major restricted/prohibited airspaces for both the Ultimate Phase Options 1 and 2. Coordination with relevant authorities regarding risks of aircraft crash into the PETRON oil terminal in Rosario might be required.

ii) Although number of the involuntary resettlement is significant, the other sites also would require significant number of the involuntary resettlement except for Western Portion of Laguna de Bay. As Western Portion of Laguna de Bay site would require excessive level of the cost for the platform development, it is considered less feasible option and cannot be an alternative to Sangley Point Option 1, subject to the proposed confirmation based on the actual boring data in the next feasibility study stage.

iii) Sangley Point Option 1 can be regarded feasible in terms of the risk of natural hazard and the airport accessibility as well as surrounding land use and urban development as it offers at least a similar level of feasibility to the other sites.

iv) The cost for the platform and access road development as well as land acquisition and compensation of Sangley Point Option 1 is the second lowest after San Nicholas Shoals. In order for San Nicholas Shoals to be an alternative to Sangley Point Option 1, the conflict issue between the instrument flight procedures and RP-P1 must be resolved.

b) Sangley Point Option 2 is less feasible option as:

i) The instrument flight procedures for both Ultimate Phase Options 1 and 2 would conflict with RP-P1, RP-R74, RP-R75 and RP-R76. Coordination to remove or relax these airspace limitations could be very difficult, subject to decision by the Government of the Philippines.

ii) The required cost for platform and access road development as well as and acquisition and compensation is more than Sangley Point Option 1.

iii) No significant advantage has been recognized from the other examination aspects compared with Sangley Point Option 1.

c) Although there are several advantages for development of NMIA at Central Portion of Manila Bay, this site is less feasible option as the expected reduction of the handling capacity of the Port of Manila mainly due to the height limitation for safe aircraft operations should not be acceptable for the Philippine Port Authority. Alternative runway orientation of 09/27 to avoid the height limitation on the port zone would result in another problem; significant negative impact on the land use of Cavite City as well as the coastal area of Metro Manila along CAVITEX. Conflict between the instrument flight procedure and RP-R76 is another issue inherent to the alternative Runway 09/27. In conclusion this site is to be regarded less feasible.

d) San Nicholas Shoals is less feasible option unless the conflict between its instrument flight procedures and RP-P1 is successfully coordinated as:

i) The instrument flight procedures would conflict with RP-P1 for both the Ultimate Phase Options 1 and 2. Coordination to remove or relax the airspace limitations could be very difficult, subject to decision by the Government of the Philippines.

ii) This site would require significant number of involuntary resettlement for development of the access road.

iii) San Nicholas Shoals can be regarded feasible in terms of the risk of natural hazard and the cost implication.

iv) From the airport accessibility as well as surrounding land use and urban development viewpoints, this site is moderate to less feasible level.

v) However, the cost for platform and access road development as well as land acquisition and compensation of this site is the least among five prospective new airport sites.

e) Western Portion of Laguna de Bay is less feasible, subject to the proposed confirmation based on the actual boring data in the next feasibility study stage, as:

i) Although the instrument flight procedures for Western Portion of Laguna de Bay would penetrate RP-R73: Barbados Airstrip, this airspace is for skydiving, aerobatic flying, ultra-light and aero-model operations and successful coordination could be expected. For both the Ultimate Phase Options 1 and 2, overlapping with RP-P1 can be avoided.

ii) This site would offer the least number of involuntary resettlement.

iii) A risk of excessively high peak ground acceleration could be anticipated in case of magnitude-7.2 earthquake to be caused by West Valley Fault.

iv) From the airport accessibility as well as surrounding land use and urban development viewpoints, this site is feasible.

v) However, the cost for platform development of this site is excessively large due to the poor sub-soil condition and non-availability of proper reclamation materials.

Table 8.9-1 Summary Result of Examination on Five Prospective New Airport Sites

Item	Sangley Point Option 1	Sangley Point Option 2	Central Portion of Manila Bay	San Nicholas Shoals	Western Portion of Laguna
Airspace Utilization and Aircraft Operations	Possible for both options.	Very difficult for both options. Conflict with RP-P1, RP-R73, RP-R75.	Possible for option1 only. Control of surrounding developments required.	Very difficult for both options. Conflict with RP-P1.	Possible for both options. Conflict with RP-R73 could be coordinated.
Environmental and Social Considerations	Significant Involuntary resettlement 4,100 people	Significant Involuntary resettlement 6,200 people	Significant Involuntary resettlement 6,200 people	Significant Involuntary resettlement 4,100 people	Less Involuntary resettlement 300 people
Risk of Natural Hazard	Feasible	Feasible	Moderate Migrant birds could be cause of bird strike.	Feasible	Less feasible Excessively high peak ground acceleration anticipated
Reclamation for Platform Development	Feasible	Feasible	Feasible	Feasible	Not Feasible Stabilization of dredged fill material and lake bed.
Airport Access: Travel time from Makati	Moderate About 35 min.	Feasible About 27 min.	Feasible About 23 min.	Moderate About 35 min.	Very good as connectable with LLED and PNR. About 28 min.
Surrounding Land Use and Urban Development	Feasible	Feasible	Conflict with port zone not acceptable for PPA	Less Feasible	Feasible
Cost for Opening Day *2	Million US$ 10,860	Million US$ 11,645	Million US$ 13,482	Million US$ 10,065	Million US$ 22,146 *4
Overall	Feasible	Less feasible	Less feasible *3	Less feasible *1	Less feasible *4

Notes for Table 8.9-1

*1: In case of San Nicholas Shoals site, if the airspace utilization issue is successfully coordinated, overall rating should be regarded as Feasible.

*2: The "Cost for Opening Day" includes costs for the platform development (approximately 1500 ha), access road, land acquisition for the access road construction, compensation (for ultimate phase 2400 ha) as well as the airport facilities for the opening day but exclude the costs for the engineering, contingencies, taxes and duties and other incidental costs. See Table 8.9-2.

*3: A part of PPA port zone would overlap the airport property. The ships anchored in the port zone would infringe the obstacle limitation surfaces of NMIA. The handling capacity of the Port of Manila would be significantly restricted by the overlapping and height limitation, which should not be acceptable for PPA.

*4: The cost estimate and hence overall examination result for this site should be reviewed based on actual boring data to be conducted in the next master plan and feasibility study.

Table 8.9-2 Breakdown of Preliminary Construction Costs

(Million US$)

Items	Sangley Option 1	Sangley Option 2	Central Manila Bay	San Nicholas Shoals	Western Laguna
A. Platform Development (1500 ha)	**5,716**	**6,354**	**8,379**	**4,942**	**16,774**
Seawall	1,218	1,429	1,485	1,112	2,704
Reclamation	3,529	3,847	4,437	2,950	13,767
Acceleration of Consolidation Settlement	428	528	1,910	348	303
Liquefaction Prevention	541	550	546	533	0
B. Airport Access Development (Opening Day)	**588**	**705**	**464**	**588**	**504**
Expressway	588	705	464	588	504
Rail	0	0	0	0	0
C. Land Acquisition and Compensation (2400 ha)	**41**	**48**	**48**	**42**	**24**
D. Subtotal (A+B+C)	**6,344**	**7,107**	**8,890**	**5,573**	**17,301**
E. Airport Facilities Development (Opening Day)	**4,200**	**4,200**	**4,200**	**4,200**	**4,200**
Airfield/Landside Civil Facilities	707	707	707	707	707
Buildings	2,689	2,689	2,689	2,689	2,689
Utilities	646	646	646	646	646
CNS/ATM & AGL	159	159	159	159	159
F. General Requirement	**315**	**338**	**391**	**292**	**644**
G. Total for Opening Day (D+E+F)	**10,860**	**11,645**	**13,482**	**10,065**	**22,146**

Reference: Platform Development (2400 ha)	8,501	9,418	10,580	7,326	25,314

Note. Cost estimate was done based on the platform size of 1500ha and airport facilities on the opening day. However the cost of compensation for affected fisherfolk was estimated for the required platform size of 2400ha for the long-term. The cost does not include engineering, contingencies, taxes and duties and other incidental costs.