APPENDIX FOR

CHAPTER 7

Appendix 7.1 Hydrology

A.1 Objectives and Work Flow

Taking account of the goals of the recommended project, the objectives of the hydrological and hydraulic studies are set as follows:

(i) To clarify the current conditions of river channel and riparian areas, where are subject to proposed road network

(ii) To estimate the flood discharges of the rivers in various return periods through statistical approach at crossings along proposed road alignment

(iii) To recommend betterment of drainage system along the proposed alignment, where deterioration of present drainage conditions due to implementation of the project is predicted, if any

In order to accomplish the objectives above mentioned, the work flow of sectoral studies has been set up as follows:

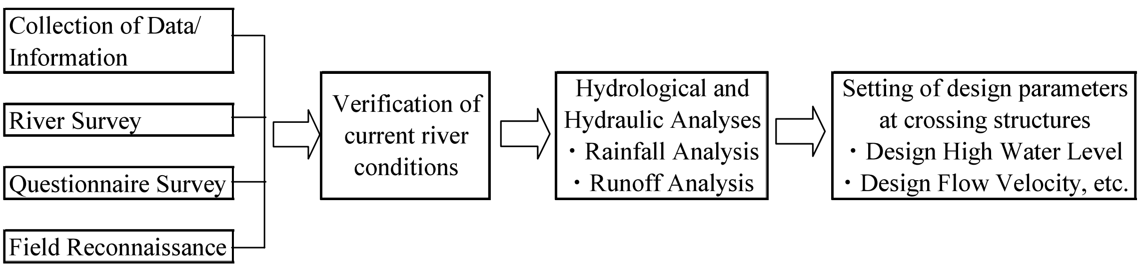

Figure A.1.1 General Work Flow of Hydrological Analysis

A.2 Available Data, Maps and Documents

(1) Topographic Maps

Topographic maps of the Study Area were obtained from NAMRIA Map Sales Office in Fort Bonifacio, Manila. These maps of scale 1:50,000 and 1:10,000 were utilized to confirm the watershed boundaries of river basins and road crossings, which are concerned to the road/bridge design of three routes, i.e. CALA Expressway, North-South Road and Daang Hari Extension. The maps collected for the Study is schematically shown with index numbers in **Figure A.2.1**.

On the other hand, the cross sections with 50 m intervals and plan along the proposed road alignment with 100 m wide became available exclusively for the present study together with the aerial photographs. Consistency of river cross sections at bridges sites and topographic conditions in the vicinity was duly checked by means of the new survey outcome.

Scale 1:50,000

Scale 1:10,000

3129 I Cavite City	3229 IV Muntinlupa City
3219 II Mendez	3229 III Calamba

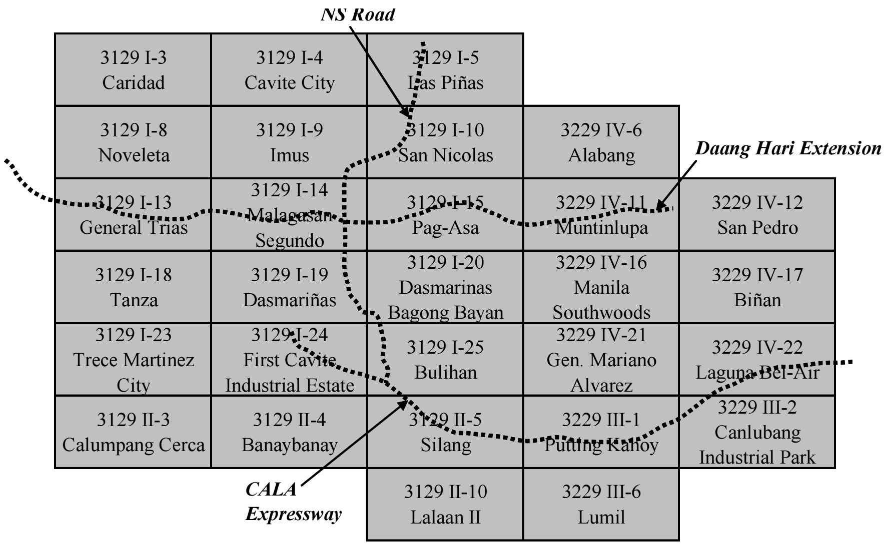

Figure A.2.1 Available Topographic Maps in the Study Area

(2) Rainfall Record

Daily rainfall records at total six gauging stations (Sangley Point, Ambulong, Amadeo, Bacoor, San Pedro and Tagaytay) in and around the Study Area were collected at the Climate Data Center of PAGASA, Quezon City. The longest duration of daily record is available from 1951 to date at Ambulong, Laguna. The name of gauging station, location (longitude and latitude) and duration are presented in **Table A.2.1** and location of these stations is shown in **Figure A.2.2**.

(3) Discharge Record

Mean daily discharge records at total ten gauging stations in and around the Study Area were collected from Hydrological Division, Bureau of Research and Standards, DPWH. The records are divided into two categories, i.e. old and new coding system. The available data of the old and new systems cover the period from 40's to 1979 and from 1983 to date, respectively, since there was a suspension of discharge measurement by DPWH between 1979 and 1983. Two gauging stations have been operated in the Study Area namely at Alapan in Ylang-Ylang River and at Palubluban in Panaysayan River (Pasong Cama Chile River, a tributary of Ylang-Ylang River). However, those were all closed and stopped measurement in 1979 and 1984 respectively. Available duration and other related information is shown in **Table A.2.2** and location of water level gauging stations is marked on **Figure A.2.2**.

(4) Land Use Maps

The future land use pattern is required to estimate flood peak discharge at arbitrary points of crossing structures such as bridge, viaduct and culvert. As for the flood runoff analysis, which is scheduled to be carried out in the subsequent feasibility study period, the land use map created on GIS format prepared though the present study is available.

(5) Satellite Imagery

Geographical information of the Study Area can be extracted at free-access web site of Google Earth. A satellite imagery taken in 2005 can provide the latest information of ground cover in the Study Area. The imagery was utilized to examine relationship between proposed road alignment and river channels concerned.

(6) Related Study Reports and Guidelines

Among the related reports, documents and guidelines related to the hydrology, hydraulics and river engineering issues, in particular, following are to be referred for the Study:

(i) The Feasibility Study of the Proposed Cavite Busway System, JICA, November 2002
Among the volumes of the Final Report of the Feasibility Study, Appendix A – Natural Conditions involves useful information for hydrological analysis. Since the study of Busway System covers same target area of the present Study, the methodology shall be referred.

(ii) Specific Discharge Curve Rainfall Intensity Duration Curve Isohyet of

Probable 1-day Rainfall, JICA, March 2003

This Report was prepared under the Project for the Enhancement of Capabilities on Flood Control and Sabo Engineering of DPWH, a Project Type Technical Cooperation from JICA. Specific discharge curves and rainfall intensity curves in short and long duration curves at synoptic stations of PAGASA are available in the Report.

(ii) Design Guidelines, Criteria and Standards for Public Works and Highways, Volume II (Part 2- Hydraulic Design, Part 3-Hgihway Design, Part 4-Bridge Design), DPWH (to be hereinafter referred as to “DPWH Design Guideline”)

Design procedure and key factors for hydraulic design are presented with miscellaneous design data and standard drawings.

(iii) Technical Guidelines of River and Sabo Engineering (Draft), Ministry of Infrastructure and Transport, Japan

Details on methodology of rainfall and flood runoff analyses are included with key design parameters such as runoff coefficient by deferent land cover and traveling time of flood flow, etc.

A.3 River Cross Section Survey

In order to obtain the sectional data at rover crossing points along the proposed three routes, river cross section survey was carried out from February to May 2006. The survey works were sublet to RASA Surveying, Quezon City, through procurement procedure as specified by JICA. Total 22 sites, where the proposed routes cross over major rivers, were selected as follows:

(i)	CALA Expressway	: 9 sites	
(ii)	North-South Road	: 6 sites	
(iii)	East-West Road	: 7 sites	Total 22sites

The location of major crossing points is shown in **Figure A.3.1** as well as the sites for river cross section survey. Related information at each crossing point is tabulated in **Table A.3.1.** The measured cross sections are compiled in **Annex A.1**.

A.4 Current Conditions of River Channels along Proposed Road Network

A.4.1 General

The Study Area is located at south of Tagaytay mountain ridge, where situated at perimeter of Lake Taar at south, in Provinces of Cavite and Laguna. In terms of watershed areas related to the road network, the Study Area falls in 40 km from north to south and 25 km from east to west, namely, in around 1,000 km^2. The altitude of the watershed varies from EL 680 m at Tagaytay City to the sea level at the coastal area facing to Manila Bay.

The watershed area is characterized by a number of rivers originating at Tagaytay Ridge and running in parallel, which flows into Manila Bay and Laguna de Bay with feeding valuable water resources in the area. Relatively narrow strips of watershed from south to north (Manila Bay) and to northeast (Laguna de Bay) forms such unique topography. The major river basins emptying toward Manila Bay are Zapote, Imus, San Juan and Canas (from east to west), and those toward Laguna de Bay are Tunasan, San Pedro, Binan and Santa Rosa (from north to south) as shown in **Figure A.2.1**. The size of catchment areas approximately varies between 20 and 120 km^2. The length of river course is around 50 km for the longest. The longitudinal profiles of major nine rivers such as Santa Rosa, Binan, San Pedro, Imus, Dasmariñas, Ylang-Ylang, Baluctot, Rio Grande and Canas Rivers, in which the proposed road alignment traverses.

It is noted that in the Study Area, more than 70 small scale ponds/reservoirs with under 10 m high dams are located. Most of them were constructed by National Irrigation Administration (NIA) or Local Government Units (LGUs) for irrigation purposes. In accordance with the interview to the local people, most of them were constructed 20 to 40 years ago and its function has been deteriorated due to lack of proper maintenance and appropriate repair of gate facilities. As urbanization progressed in Cavite, the necessity of the pond has been declined due to drastic decrease of irrigation water demand. In fact, agricultural land is rapidly changing to residential areas in the Study Area. The approximate location of the pond can be confirmed on the General Layout that was obtained at the "Cavite Friar Lands Irrigation System Office" (Branch of NIA regional office), Naic.

Further detailed conditions on the rivers running through the Study Area are presented dividing into three routes in the subsequent sub-sections. Principal feature of the crossings along the proposed routes is summarized in **Table A.3.1**.

A.4.2 CALA Expressway

The proposed CALA Expressway starts at South Luzon Expressway at Santa Rosa, Laguna, and is connected with Dasmariñas - Naic Road at west of First Cavite Industrial Estate (FCIS), Dasmariñas. Total length is 22.9 km. From the starting point (Sta.0+000), it runs to eastward in parallel with the Cabuyao River for about 6 km. After crossing the existing Santa Rosa-Tagaytay Road, it will cross a tributary of the Banava River, and then will enter into Municipality of Silang, Cavite. As going toward west, the alignment will cross the several rivers and rise altitude up to EL.300m at around Sta.12+000. These rivers flow down to Laguna de Bay. The channel section is mostly covered by thick vegetation and formed moderately deep valley. The river bed is outcropped at many places and seems relatively stable against turbulence of flow. At Sta.13+700, the alignment runs in the watershed of the Baluctot River, which is one of major tributaries of the Imus River system flowing to Manila Bay.

Based on the field reconnaissance, shifting of the original alignment of about 100 m to 150 m toward north (crossing at more downstream section) is recommended due to possible reduction of bridge span at around Sta.13+400. It is advantageous from topographical point view. After crossing Aguinaldo Highway at Sta.14+700 most likely by flyover, the CALA Expressway will cross over three rivers. After passing Sta.19+400, the alignment will run in the narrow strip area between the Rio Grade and the Ylang-Ylang Rivers.

The typical river conditions at crossings are shown as follows:

		
River channel at Sta.8+400	Land undulation between Sta.9+000 and Sta.10+000	River channel at Sta.14+200

A.4.3 North-South Road

The North-South Road (NS Road) will be linked with the existing Coastal Road at the right-angle curve, where the Coastal Road is separating from the costal line at Talaba, Municipality of Bacoor and after running to south it will be connected with the proposed CALA Expressway in Municipality of Silang. Total length is 26.7 km, which is the longest among the proposed three routes. It should be crossed over the fishpond area developed in Barangay Talaba II within first 1.0 km stretch from start point. In next 8.0 km length, the NS Road will run in the most urbanized residential area among the proposed road section in the Study. The proposed alignment is located to pass by the Citta Iatlia Estate at Sta.8+500. Up to the point several, the NS Road will cross over several creeks.

In terms of risk of inundation in the Study Area, as far as along the proposed road network, this section will be most susceptible considering rapid land reclamation and insufficient drainage system in the lowly lying area. Further, according to the interview to the villagers residing nearby the newly development area connected with Citta Italia Estate, his house located at Sta.8+900 is threatening by flood flow overtopping parapet wall almost every rainy season. In the channel area beside his residence, an old irrigation weir with spillway gate exists. Since the gate seems closed permanently due to lack of maintenance, the water stagnated at upstream will rise by inflow and overtop occasionally.

The inundation problem along the coastal area of particularly Municipalities of Bacoor, Imus, Kawit, Noveleta and Rasario, where the population and industries has been concentrated, is aware by DPWH and such LGUs as well. The improvement of drainage system cannot catch up the rapid land use changes that will cause acute rising of flood peak discharge and serious inundation. Comprehensive master plan for flood control of three principal rivers of Imus, San Juan and Canas is indispensable. In fact, most of all municipalities located at the lowland areas were inundated for 8 hours when the typhoon Reming has hit the area on October 28, 2000. The situation in the area becomes worse after then as such urbanization is remarkably progressive.

At Sta.12+700, the NS road crosses the East-West Road (EW Road) and crosses the Aguinaldo Highway at Sta.19+200 where the elevation is approximately EL.100 m. Then, the NS Road runs almost in parallel with the Dasmariñas River, a tributary of the San Juan River system. It will cross near Bucal Bridge at Dasmariñas town proper, Sta.21+500. The shape of river is formed by deep valley and steep slope with 30 to 50 m height from riverbed and risk of flood damage will be limited as far as the present land use last. Following pictures show the typical conditions as described above:

Upstream of irrigation weir (water is contaminated by domestic waste water) , Sta.17+250

Upstream view from the suspension bridge, Sta.14+000

Disposed solid waste in the river channel and heavily contaminated water, Sta.8+750

A.4.4 Daang Hari Extension

The East-West Road (EW Road) will start from the border between Muntinlupa City (National Capital Region) and Municipality of Imus, Cavite, where it will be connected with the Daang Hari Road under construction presently. The EW Road will end the Coastal Road in Municipality of Tanza. Total length is 21.0 km.

Since the proposed alignment is located at lowland between EL.10m to EL.30m and crosses over many rivers flowing down from south to north into Manila Bay, due consideration will be required to decide the design flood levels appropriately. The EW Road is can be divided mainly into two parts, namely east and west sections by Aguinaldo Highway. Within the eastern part, the Road will cross seven rivers, which are moderately small creeks with 15 m to 25 m of width. It will cross with the proposed NS Road at Sta.8+500. At Sta.8+650, a new bridge is under construction along the proposed alignment.

At western part stretching from Aguinaldo Highway to the end point at the Coastal Road, total five rivers cross the alignment. Paddy and pasture land is predominant land use in this area to the contrary those in the eastern part. It is noted that future urbanization and land use change shall be taken into account to estimate flood discharge at crossings where the catchments varies between 50 to 100 km^2 approximately.

Typical conditions of river channel along the proposed alignment are presented as follows:

		
Temporary coffer at downstream side, Sta.8+650	Near crossing at Sta.15+400downstream view)	Paddy and pasture land (looking at east) between Sta.17+000 and Sta.18+000

A.5 Questionnaire Survey on Flooding Conditions

In order to confirm the flooding conditions such as flood prone area, information on severe floods, notable inundation damage and river improvement plans/on-going works, etc., questionnaire survey to 15 municipalities (11 in Cavite and 4 in Laguna Provinces) was conducted in February 2006. The questionnaire sheets were distributed to Engineering Department of each municipality and were retrieved after filled up. The questionnaire is divided into five sections, namely, (I) General Information, (II) Record of Flood Event, (III) Existing Water Impounding Pond, (IV) Discharge Measurement Record and (V) River Improvement Plans. The answers on questionnaire from each municipality is summarized in **Table A.5.1**. Some important issues confirmed through the survey are described as follows:

<u>Section I: General Information</u>

(1-1) In the coastal area facing to Manila Bay, in particular, Bacoor, Imus, Kawit, Noveleta, and in lakeshore municipalities of Carmona, San Pedro and Biñan, flood prone area is identified in the low lying Barangays. Extraordinary high tide in addition to the insufficient inland drainage system is major reason of flood occurrence.

(1-2) A total of 974 ha (approximately 10 km^2) flood prone area in Bacoor, Minus, Kawit and Noveleta was identified with some particular barangays suffering from frequent inundation, where are the most susceptible zone to heavy storm in monsoon seasons. Among those, the largest area of 801 ha (82 %) falls in Kawit. Nonexistence of major river outlet in Kawit might be one of the main reasons.

Section II: Record of Flood Event

(2-1) Severest flood in each municipality is summarized as below:

Nov. 1995 : Carmona
Nov.1998 : Bacoor
Jun.1999 : Silang
Sep.1999 : Gen. Mariano Alvalez
Oct.-Nov.2000 : Imus, Kawit, Noveleta, General Trias
Nov.2001 : Naic, Biñan
Oct.-Nov.2002 : San Pedro

(Rosalio, Tanza, Dasmariñas and Trece martinez answered "None" or blank)

(2-2) According to the answers, due to the flood in Nov. 2000, relatively wide area was inundated at Imus, Kawit and Neveleta, in particular, Manila Bay coastal area. The inundation depth reached about 1.0 m above the ground surface and inundation lasted 4 hours (Noveleta) to 3days (Imus), which caused serious damage to houses, other properties and livestock. No description regarding inundation is found in the questionnaire sheets from Bacoor. Since the origin of the North-South Road will be located in Bacoor, careful treatment of flood water in Bacoor is required.

Section III: Existing Water Impounding Pond

(3-1) Three municipalities of Dasmariñas, Trece Martinez and Carmona reported information on impounding ponds. Dasmariñas described information on five dams with 6m to 10m high. Agriculture is predominant function of small scale reservoirs in the Study Area. Most of them were constructed in 40 to 20 years ago.

Section IV: Discharge Measurement Records

(4-1) Among 15 municipalities, only Gen. Mariano Alvalez answered "Yes", but no technical document is available fort the records.

Section V: River Improvement Plan

(5-1) Only four municipalities of Bacoor, General Trias, Carmona and Biñan responded that they have river improvement plans. For instance, Bacoor has a plan to dredge the NIA's Creek (L=3.4 km) near Molino Highway for enhancement of cultivation. In other municipalities there is no river improvement plan/activities.

A.6 Methodology of Hydrological Analysis

In order to set appropriate methodology of hydrological analysis to determine the probable flood discharge and other design parameters at arbitrary crossings where structures are to be designed, following factors were examined:

(i) Basin parameters : size of catchments, channel length, riverbed gradient (traveling time of discharge)
Relatively small catchments (> 200 km^2), short river length (> 50 km) and 1/80 to 1/100 of average riverbed gradient

(ii) Existing structures for flood control
No major control structures, which can retard and store flood discharge and no inter-basin connection or floodways

(iii) Availability of rainfall and discharge record
Fairly reliable daily rainfall records (sufficient duration and coverage of area) but no flood discharge measurement record in the subject river basin (no measured hydrograph)

(iv) Requirement for design parameters of structure (bridge, culvert, revetment and embankment, etc.)
Flood peak discharge can be converted to the flood water level based on the channel geometry by means of appropriate runoff model.

(v) Future flood control/drainage improvement plan
No major flood control/drainage improvement plan to be taken account to estimate flood discharges is not identified in DPWH except minor channel improvement managed by LGUs

As the result of examination, flood runoff analysis by rational formula and uniform flow theory will be applied to estimate probable peak discharges and associated water levels at arbitrary locations in the Study Area.

A7. Hydrological Analysis

A.7.1 Characteristics of Rainfall Pattern

Monthly rainfall amount at six stations is tabulated in **Table A.7.1** and illustrated in **Figure A.7.1.** It is distinct that August and July are predominant rainy period and January to April is very dry in the Study Area. Although the monthly pattern is similar among six stations, the rainfall amount at Amadeo is rather high compared with others. According to the record from PAGASA, in fact, annual rainfall in most of years are extraordinary high, which shows equal or more than 2.5 to 2.8 times of the amount at Sangley Point and Bacoor.

Because the reliability of the daily rainfall record at Amadeo seemed low, the Study Team wrote a letter to confirm the issue to the Chief of Climate Data Division, PAGASA, before starting hydrological analysis. As the results of the consultation, PAGASA informed to the Study Team by their letter dated on February 28, 2006 that the records at Amadeo should not be included in any analysis. PAGASA recognized that it was entirely their mistake on data processing. Therefore, the records at Amadeo were omitted in the subsequent analysis in the present Study. A chronological annual rainfall fluctuation is shown in **Figure A.7.2.**

Table A.7.1 Monthly Rainfall Amount at Six Stations

Year	Sangley	Ambulong	Bacoor	San Pedro	Tagaytay	Year	Sangley	Ambulong	Bacoor	San Pedro	Tagaytay
1951	-	1,885	-	-	-	1979	1,345	2,107	1,803	2,001	-
1952	-	2,123	-	-	-	1980	1,265	2,135	1,743	1,786	-
1953	-	1,669	-	-	-	1981	1,518	1,870	1,683	1,206	-
1954	-	1,322	-	-	-	1982	1,009	1,651	1,508	573	-
1955	-	1,190	-	-	-	1983	1,367	1,280	702	523	-
1956	-	2,022	-	-	-	1984	2,179	1,799	2,103	648	-
1957	-	1,166	-	-	-	1985	1,956	2,034	2,351	1,291	-
1958	-	1,348	-	-	-	1986	2,955	2,458	2,623	2,597	-
1959	-	1,678	-	-	-	1987	1,705	1,370	1,409	1,603	-
1960	-	2,252	-	-	-	1988	1,986	1,971	1,826	1,406	-
1961	-	2,184	-	-	-	1989	2,117	2,085	1,654	2,605	-
1962	-	2,514	-	-	-	1990	2,599	2,284	2,220	-	-
1963	-	1,379	-	-	-	1991	2,441	1,946	1,858	-	-
1964	-	1,740	-	-	-	1992	2,242	1,587	1,692	-	-
1965	-	1,179	-	-	-	1993	1,852	2,121	1,488	1,359	-
1966	-	2,038	-	-	-	1994	1,924	1,578	1,649	775	1,689
1967	-	1,943	-	-	-	1995	2,299	2,001	1,721	1,118	2,048
1968	-	1,380	-	-	-	1996	1,657	1,608	1,446	1,548	1,802
1969	-	1,264	-	-	-	1997	2,048	1,269	1,325	783	1,492
1970	-	1,854	-	-	-	1998	2,019	1,679	1,812	1,043	2,111
1971	-	2,299	-	1,620	-	1999	2,430	2,364	1,937	-	2,268
1972	-	2,427	-	2,441	-	2000	3,116	2,457	2,286	-	1,546
1973	-	1,745	-	1,717	-	2001	1,930	1,643	1,462	-	2,022
1974	1,296	2,328	-	2,090	-	2002	2,682	1,486	1,952	-	1,808
1975	1,137	1,549	1,522	1,704	-	2003	1,915	1,334	1,310	-	1,748
1976	1,877	2,601	1,964	1,966	-	2004	1,591	1,520	1,254	-	1,553
1977	1,944	1,675	1,963	1,594	-	2005	1,673	1,544	1,424	-	2,175
1978	2,086	2,009	2,399	2,005	-	Ave.	1,942	1,817	1,745	1,520	1,855

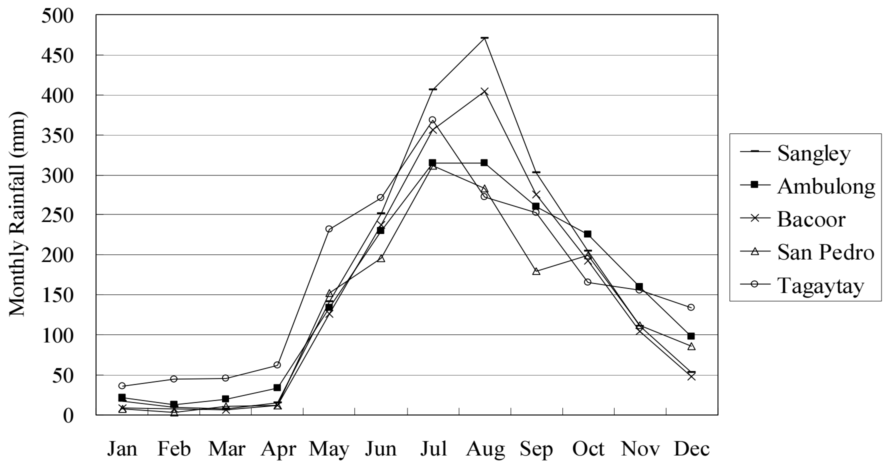

Figure A.7.1 Monthly Variation of Rainfall

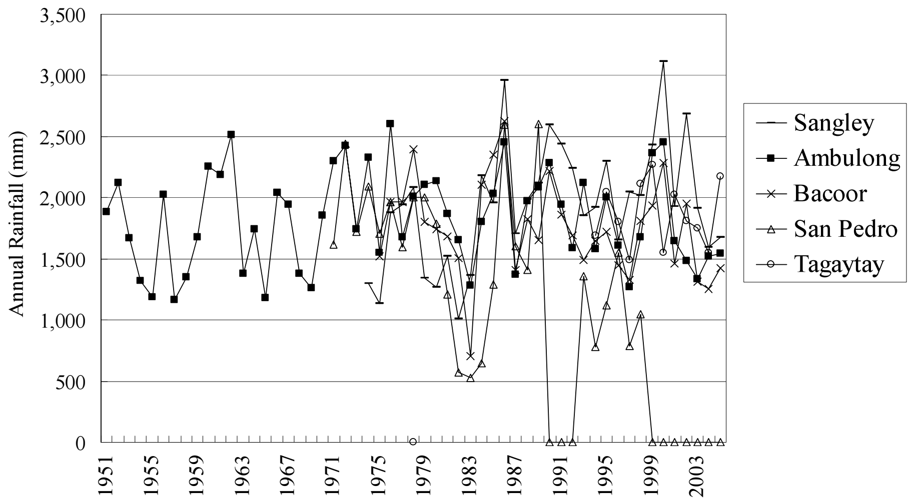

Figure A.7.2 Chronological Annual Rainfall Pattern

A.7.2 Probable Rainfall

Annual maximum 1-day rainfall at four stations (point rainfall) are tabulated in **Table A.7.2**. Based on the series of records, probable 1-day rainfall was estimated by Gumbel Method and as summarized in **Table A.7.3**.

Table A.7.2 Annual Maximum 1-day Rainfall

Year	Sangley Point		Ambulong		Bacoor		San Pedro		Tagaytay	
	Amount (mm)	Date	Amount (mm)	Date	Amount (mm)	Date	Amount (mm)	Date	Amount (mm)	Date
1951	-	-	117.1	Nov.21	-	-	-	-	-	-
1952	-	-	134.6	Dec.21	-	-	-	-	-	-
1953	-	-	84.3	Jun.03	-	-	-	-	-	-
1954	-	-	59.7	Aug.09	-	-	-	-	-	-
1955	-	-	59.9	Sep.23	-	-	-	-	-	-
1956	-	-	120.1	Sep.07	-	-	-	-	-	-
1957	-	-	85.3	Oct.11	-	-	-	-	-	-
1958	-	-	261.1	Jun.02	-	-	-	-	-	-

Year	Sangley Point		Ambulong		Bacoor		San Pedro		Tagaytay	
	Amount (mm)	Date	Amount (mm)	Date	Amount (mm)	Date	Amount (mm)	Date	Amount (mm)	Date
1959	-	-	84.3	Dec.31	-	-	-	-	-	-
1960	-	-	144.8	May 27	-	-	-	-	-	-
1961	-	-	301.5	Jun.27	-	-	-	-	-	-
1962	-	-	270.8	Sep.05	-	-	-	-	-	-
1963	-	-	84.3	Sep.09	-	-	-	-	-	-
1964	-	-	233.0	Jun.29	-	-	-	-	-	-
1965	-	-	90.7	Sep.08	-	-	-	-	-	-
1966	-	-	127.0	Sep.07	-	-	-	-	-	-
1967	-	-	202.5	Nov.04	-	-	-	-	-	-
1968	-	-	60.3	Oct.15	-	-	-	-	-	-
1969	-	-	80.3	Jul.26	-	-	-	-	-	-
1970	-	-	175.6	Oct.13	-	-	-	-	-	-
1971	-	-	141.5	Jun.15	-	-	101.8	Jun.15	-	-
1972	-	-	188.3	Jul.20	-	-	327.7	Jul.20	-	-
1973	-	-	112.3	Nov.21	-	-	151.9	Nov.21	-	-
1974	159.3	Aug.17	152.0	Oct.16	-	-	164.9	Aug.17	-	-
1975	56.6	Oct.02	97.8	Sep.05	91.7	Dec.25	101.6	Nov.01	-	-
1976	185.7	Aug.10	499.2	Jun.21	224.3	Aug.10	224.8	May 19	-	-
1977	235.8	Aug.19	129.0	Sep.11	233.5	Aug.19	101.6	Sep.11	-	-
1978	157.1	Aug.12	155.2	Oct.09	185.1	Aug.12	134.6	Aug.11	-	-
1979	238.8	Aug.14	194.9	Aug.15	158.0	Aug.14	105.1	Aug.11	-	-
1980	95.5	Jul.25	135.2	Oct.28	131.6	Jul.25	96.6	Jul.24	-	-
1981	128.8	Jul.17	165.6	Sep.20	91.7	Nov.24	54.8	Jun.28	-	-
1982	62.2	Sep.09	204.0	Sep.09	126.6	Jul.01	40.4	Sep.09	-	-
1983	101.7	Jul.15	196.6	Jul.15	90.0	Aug.14	119.1	Jul.15	-	-
1984	99.4	Jun.22	140.2	Oct.21	98.5	Jun.22	37.1	Oct.24	-	-
1985	172.4	Jun.27	242.6	Jun.27	439.2	Jun.27	108.0	Jun.27	-	-
1986	260.7	Oct.05	185.4	Sep.02	229.2	Oct.05	259.1	Jul.08	-	-
1987	102.3	Aug.18	78.8	Aug.18	144.2	Sep.07	164.9	Aug.17	-	-
1988	108.1	Oct.24	129.4	Oct.24	114.8	Oct.24	120.6	Oct.24	-	-
1989	83.7	Aug.19	131.4	May 17	143.0	Jul.26	168.6	May 17	-	-
1990	307.8	Aug.24	283.6	Aug.24	178.8	Aug.24	-	-	-	-
1991	176.5	Aug.21	154.2	Jul.09	98.5	Aug.20	-	-	-	-
1992	160.4	Oct.25	155.0	Jul.20	115.0	Jul.20	-	-	-	-
1993	168.0	Jun.25	155.2	Aug.09	192.0	Jun.25	60.0	Dec.05	-	-
1994	119.4	Jun.22	119.0	Jul.25	122.0	Jul.18	40.0	Oct.21	93.2	Jun.04
1995	230.9	Aug.29	277.2	Nov.03	185.8	Aug.29	84.0	Sep.30	87.9	Dec.26
1996	106.3	Jul.29	197.3	Jul.25	160.5	Jul.29	104.0	Jul.23	126.6	Jul.24
1997	272.0	Aug.18	209.3	Aug.18	173.5	Aug.18	97.0	May 25	71.6	May 25
1998	141.2	Sep.18	135.2	Oct.23	123.3	Oct.23	85.8	Dec.11	113.1	Oct.23
1999	182.3	Oct.16	150.7	Oct.16	108.9	Oct.16	-	-	113.4	Sep.11
2000	193.2	Oct.28	183.2	Oct.28	214.5	Oct.28	-	-	113.2	Jul.07
2001	114.2	Aug.23	69.2	May 10	64.8	Jul.05	-	-	126.5	Jun.26
2002	231.4	Jul.20	104.4	Jul.20	188.8	Jul.12	-	-	125.8	Jul.20
2003	166.8	Sep.02	82.9	Nov.14	128.1	May 26	-	-	133.9	May 27
2004	116.4	Nov.29	96.4	Sep.15	84.2	Nov.29	-	-	51.6	Aug.08
2005	103.4	Sep.15	88.6	Oct.27	100.2	Sep.15	-	-	93.7	Oct.27
Nos of years	32	-	55	-	31	-	25	-	12	-
Max	307.8	-	499.2	-	439.2	-	327.7	-	133.9	-

Source: Edited by the Study Team based on the data obtained from PAGASA

Table A.7.3 Probable 1-day Rainfall (point rainfall)

(Unit: mm)

Return Period (Year)	Sangley Point	Ambulong	Bacoor	San Pedro
1.01	41.6	38.8	24.4	11.5
2	147.8	138.8	144.4	105.5
5	211.3	198.6	215.4	161.7
10	253.3	238.2	262.8	198.9
25	305.3	287.1	321.3	244.9
50	345.8	325.3	366.9	280.8
100	385.0	362.1	411.0	315.4
200	423.9	398.8	454.8	349.8
Years of data available	32	55	31	25

Source: Analyzed based on the rainfall record from PAGASA

As seen in **Table A.7.2**, the significant rainfall (193.2mm at Sangley Point and 214.5 mm at Bacoor) was recorded on October 28, 2000, which caused serious inundation along the coastal area. The municipalities at coastal area answered to the questionnaire that most serous flooding has occurred in November 2000. Although no available direct measurement record of flood discharges is available, the magnitude of the flood of November 2000 might be approximately 10-year recurrence 1-day rainfall probability based on the probable rainfall tabulated above.

A.7.3 Runoff Analysis

(1) Runoff Record

Based on the available daily discharge records, annual peak discharges at eight gauging stations are summarized in **Table A.7.4**. The table shows the specific discharges per one km^2 of catchment as well. In the Study Area at Alapan (CA=60 km^2: Ylang-Ylang River) and Palubluban (CA=29 km^2: Panaysayan River), maximum value of annual peak discharge is 346.5 m^3/s and 227.7 m^3/s respectively. In terms of specific discharge, both are 5.8 $m^3/s/km^2$ and 7.9 $m^3/s/km^2$. Since the reliability of the records could not be justified based on the actual discharge measurement and/or rating curves, etc. at gauging stations concerned, statistical analysis to estimate probable discharges was not conducted based on the discharge data. Therefore, those were handled as a guide of magnitude of flood peak discharges.

Table A.7.4 Annual Peak Discharge Records

	1		2		3		4		5		6		7		8	
Station Name	Alapan		Mabacao		Bukal		Palubluban		Palangue		Calamias		San Cristobal		Porac	
Name of River	Ylang-Ylang		Maragondon		Maragondon		Panaysayan		Balsahan		Arangilan		San Cristobal		San Juan	
Catchment Area (km^2)	60		260		260		29		22		87		106		185	
	m^3/s	$m^3/s/km^2$	m^3/s	$m^3/s/km^2$	m^3/s	$m^3/s/km^2$	m^3/s	$m^3/s/km^2$	m^3/s	$m^3/s/km^2$	m^3/s	$m^3/s/km^2$	m^3/s	$m^3/s/km^2$	m^3/s	$m^3/s/km^2$
1946	-	-	1,667.0	6.41	-	-	-	-	-	-	-	-	-	-	-	-
1947	-	-	3,387.0	13.03	-	-	-	-	-	-	-	-	-	-	-	-
1948	-	-	1,093.0	4.20	-	-	-	-	-	-	-	-	-	-	-	-
1949	-	-	367.2	1.41	-	-	-	-	-	-	-	-	-	-	-	-
1950	-	-	1,204.9	4.63	-	-	-	-	-	-	-	-	-	-	-	-
1951	-	-	631.5	2.43	-	-	-	-	-	-	-	-	-	-	-	-
1952	-	-	1,387.5	5.34	-	-	-	-	-	-	-	-	-	-	-	-
1953	-	-	1,044.0	4.02	-	-	-	-	-	-	-	-	-	-	-	-
1954	-	-	399.9	1.54	-	-	-	-	17.2	0.78	-	-	-	-	-	-
1955	-	-	193.8	0.75	-	-	-	-	4.3	0.20	-	-	-	-	-	-
1956	-	-	1,234.5	4.75	-	-	-	-	315.0	14.32	181.0	2.08	-	-	-	-
1957	-	-	1,364.1	5.25	-	-	149.0	5.14	76.9	3.50	12.3	0.14	-	-	-	-
1958	-	-	1,911.0	7.35	-	-	92.5	3.19	17.8	0.81	68.5	0.79	-	-	-	-
1959	-	-	334.0	1.28	-	-	32.8	1.13	24.8	1.13	16.8	0.19	-	-	-	-
1960	-	-	1,507.0	5.80	-	-	171.6	5.92	56.5	2.57	60.6	0.70	-	-	-	-
1961	-	-	1,161.0	4.47	-	-	206.3	7.11	80.9	3.68	215.3	2.47	-	-	-	-
1962	-	-	2,667.0	10.26	-	-	227.7	7.85	187.1	8.50	215.0	2.47	-	-	-	-
1963	-	-	922.5	3.55	-	-	92.5	3.19	36.0	1.64	4.6	0.05	-	-	-	-
1964	-	-	3,495.0	13.44	-	-	146.3	5.04	46.9	2.13	17.4	0.20	-	-	-	-
1965	-	-	149.2	0.57	-	-	6.5	0.22	49.7	2.26	5.4	0.06	-	-	-	-
1966	-	-	1,234.5	4.75	-	-	72.1	2.48	104.5	4.75	34.7	0.40	-	-	-	-
1967	-	-	3,987.0	15.33	-	-	85.4	2.94	95.4	4.34	53.5	0.61	-	-	-	-
1968	-	-	502.5	1.93	-	-	75.2	2.59	118.9	5.40	10.6	0.12	-	-	-	-
1969	-	-	320.5	1.23	-	-	16.0	0.55	90.1	4.10	8.4	0.10	-	-	-	-
1970	-	-	-	-	-	-	-	-	-	-	180.8	2.08	-	-	-	-
1971	52.9	0.88	938.0	3.61	-	-	148.5	5.12	30.4	1.38	-	-	-	-	-	-
1972	52.9	0.88	726.0	2.79	-	-	85.4	2.94	11.4	0.52	-	-	-	-	-	-
1973	171.0	2.85	806.5	3.10	-	-	85.4	2.94	6.0	0.27	-	-	-	-	-	-
1974	346.5	5.78	3,167.0	12.18	-	-	-	-	10.9	0.50	-	-	-	-	-	-
1975	301.5	5.03	1,072.0	4.12	-	-	166.3	5.73	0.6	0.03	-	-	-	-	-	-
1976	157.5	2.63	3,607.0	13.87	-	-	65.9	2.27	11.0	0.50	-	-	-	-	-	-
1977	-	-	-	-	-	-	0.7	0.02	-	-	-	-	-	-	-	-
1978	-	-	122.4	0.47	-	-	4.0	0.14	6.5	0.29	-	-	-	-	-	-
1979	310.5	5.18	809.2	3.11	-	-	85.4	2.94	14.5	0.66	-	-	-	-	-	-
1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1981	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1982	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1983	18.7	0.31	-	-	127.2	0.49	-	-	-	-	-	-	-	-	-	-
1984	0.5	0.01	-	-	319.6	1.23	-	-	-	-	-	-	29.3	0.28	-	-
1985	-	-	-	-	375.5	1.44	-	-	-	-	-	-	91.9	0.87	-	-
1986	-	-	-	-	823.4	3.17	-	-	-	-	-	-	1,068.8	10.08	85.0	0.46
1987	-	-	-	-	412.0	1.58	-	-	-	-	-	-	34.5	0.33	63.5	0.34
1988	-	-	-	-	184.3	0.71	-	-	-	-	-	-	606.1	5.72	124.1	0.67
1989	-	-	-	-	293.4	1.13	-	-	-	-	-	-	192.5	1.82	-	-
1990	-	-	-	-	62.8	0.24	-	-	-	-	-	-	538.1	5.08	-	-
1991	-	-	-	-	46.8	0.18	-	-	-	-	-	-	-	-	34.2	0.18
1992	-	-	-	-	50.7	0.19	-	-	-	-	-	-	-	-	4.8	0.03
1993	-	-	-	-	107.0	0.41	-	-	-	-	-	-	-	-	26.7	0.14
1994	-	-	-	-	39.9	0.15	-	-	-	-	-	-	-	-	14.5	0.08
1995	-	-	-	-	67.3	0.26	-	-	-	-	-	-	-	-	74.4	0.40
1996	-	-	-	-	108.6	0.42	-	-	-	-	-	-	-	-	10.3	0.06
1997	-	-	-	-	67.3	0.26	-	-	-	-	-	-	-	-	4.3	0.02
1998	-	-	-	-	81.1	0.31	-	-	-	-	-	-	-	-	24.5	0.13
1999	-	-	-	-	9.9	0.04	-	-	-	-	-	-	-	-	4.1	0.02
2000	-	-	-	-	124.4	0.48	-	-	-	-	-	-	-	-	-	-
Average	156.9	2.61	1356.7	5.22	183.4	0.71	95.9	3.31	58.9	2.68	72.3	0.83	365.9	3.45	39.2	0.21
Max	346.5	5.78	3987.0	15.33	823.4	3.17	227.7	7.85	315.0	14.32	215.3	2.47	1068.8	10.08	124.1	0.67
Min	0.5	0.01	122.4	0.47	9.9	0.04	0.7	0.02	0.6	0.03	4.6	0.05	29.3	0.28	4.1	0.02

Source: Hydrological Division, Bureau of Research and Standards, DPWH

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(2) Probable Flood Peak Discharge

As mentioned in Section A.6, the flood peak discharge was calculated by means of Rational Formula. The formula of the theory is represented as follows:

$$Q = \frac{1}{3.6} * C * I * A$$

where, Q: Peak discharge (m^3/s)

I: Intensity of rainfall for a duration equal to the time of concentration (mm/hr)

A: Drainage area or catchment contributing to storm flow (km^2)

C: Runoff coefficient depending on catchment characteristics

(a) Runoff coefficient

Runoff coefficient (C) shall be decided taking account of land cover, vegetation, shape of catchment and land development, etc. Different figures recommended in guidelines commonly applied in sewerage design and land development are introduced in the Technical Guidelines of River and Sabo Engineering, Ministry of Infrastructure and Transport, Japan.

On the other hand, future land use plan targeted in year 2020 was prepared in the current Study. Based on the presumed built-up conditions in the Study Area versus the criteria as above, 0.6 was applied to estimate the peak discharges at crossing points.

(b) Time of concentration

Time of Concentration in the Rational Formula is usually defined as required time for reaching of the flow in the channel from the most remote point to the outlet of the catchment concerned. Three methodologies by Kraven's formula, Rziha's formula and Ven Ti Chows formula were tested. The one developed by Ven Ti Chow is recommended to apply in the Design Guidelines, Criteria and Standards for Public Works and Highways Volume II, DPWH (Page 696). Those formulas cited above are described as follows:

① <u>Kraven's formula</u>

T = L/W

I	I > 1/100	1/100 < I <1/200	I< 1/200
W	3.5 m/s	3.0 m/s	2.1 m/s

where, I: Slope of channel, W: Flow velocity (m/s)

L: Length of channel, T: Time of concentration

② Rziha's formula

$T = L/W$

$W = 20\ (h/L)^{0.6}$

where, W: Flow velocity (m/s), h: Elevation gap (m)

L: Channel length (m) T: Time of concentration (s)

③ Ven Ti Chow (DPWH's Guideline)

$$Tc = \frac{L^{1.15}}{51H^{0.385}}$$

where, Tc: Time of concentration (min)

L: Length of watershed along the mainstream (m)

H: Difference in elevation between the most distant ridge in the watershed and point under review (m)

The results of calculation by three methods are compared as tabulated in **Table A.7.5.** As the results of examination, Ven Ti Chow's formula was applied to estimate the time of concentration, because that tends to give moderate figures between other two methods. Especially as for the small catchments with short channel length, Kraven and Rziha formula return comparatively short time concentration, which would cause too large rainfall intensity and overestimate of flood discharge.

Longitudinal profiles of major ricers subject to design of proposed road network are illustrated **Figure A.7.3**.

Table A.7.5 Calculation of Time of Concentration

	Section No.	River Length (km)	Bed slope	Elevation Gap (m)	Flow Velocity (m/s)		Time of Concentration (min)		
					Kraven	Rziha	Kraven	Rziha	Ven Ti Chow
CALA Expressway	CE-R1	16.53	0.01724	505	3.5	2.5	79	112	127
	CE-R2	5.67	0.02564	195	3.5	2.6	27	36	53
	CE-R3	5.56	0.02857	155	3.5	2.3	26	40	57
	CE-R4	1.38	0.03846	65	3.5	3.2	7	7	16
	CE-R5	12.12	0.01020	315	3.5	2.2	58	90	106
	CE-R6	16.43	0.00746	355	3.0	2.0	91	137	144
	CE-R7	15.16	0.01714	375	3.5	2.2	72	116	129
	CE-R8	4.60	0.01724	125	3.5	2.3	22	33	50
	CE-R9	13.25	0.01429	325	3.5	2.2	63	102	116
North-South Road	NS-R1	11.07	0.00562	195	3.0	1.8	62	104	115
	NS-R2	1.21	0.00926	12	3.0	1.3	7	16	26
	NS-R3	19.83	0.00524	235	3.0	1.4	110	237	210
	NS-R4	30.50	0.00714	585	3.0	1.9	169	273	242
	NS-R5	1.53	0.01538	25	3.5	1.7	7	15	26
	NS-R6	12.04	0.00833	255	3.0	2.0	67	101	114
Daang Hari Extension	DH-R1	5.64	0.00444	115	2.1	1.9	45	49	65
	DH-R2	8.19	0.00588	155	3.0	1.9	46	74	89
	DH-R3	32.54	0.00532	605	3.0	1.8	181	296	257
	DH-R4	6.55	0.00436	55	2.1	1.1	52	96	103
	DH-R5	27.70	0.00735	465	3.0	1.7	154	268	237
	DH-R6	35.33	0.00311	635	3.0	1.8	196	328	278
	DH-R7	38.08	0.00130	645	3.0	1.7	212	367	301

Source: JICA Study Team

In order to decide the rainfall intensity applying to the rational Formula, analyzed data of rainfall (intensity-duration-frequency) in short duration at Sangley Point in Cavite was collected from Hydrometeorological Investigations and Special Studies Section, Flood Forecasting Branch, PAGASA. The computed extreme values of rainfall and equivalent average intensity of computed extreme values are available as shown in **Tables A.7.6**. The table was prepared by hourly rainfall records for 11 years from 1978 to 1988.

On the other hand, probable annual maximum 1-day rainfall at Sangley Point was estimated based on 32-year records till 2005 as presented in Sub-section A.7.3. However, since the probable values were estimated in the basis of 1-day rainfall not 24-hour data, an adjustment to 24-hour by adding 5% was conducted. The adjusted intensity-duration-frequency values are tabulated in **Table A.7.7** with graphs corresponded.

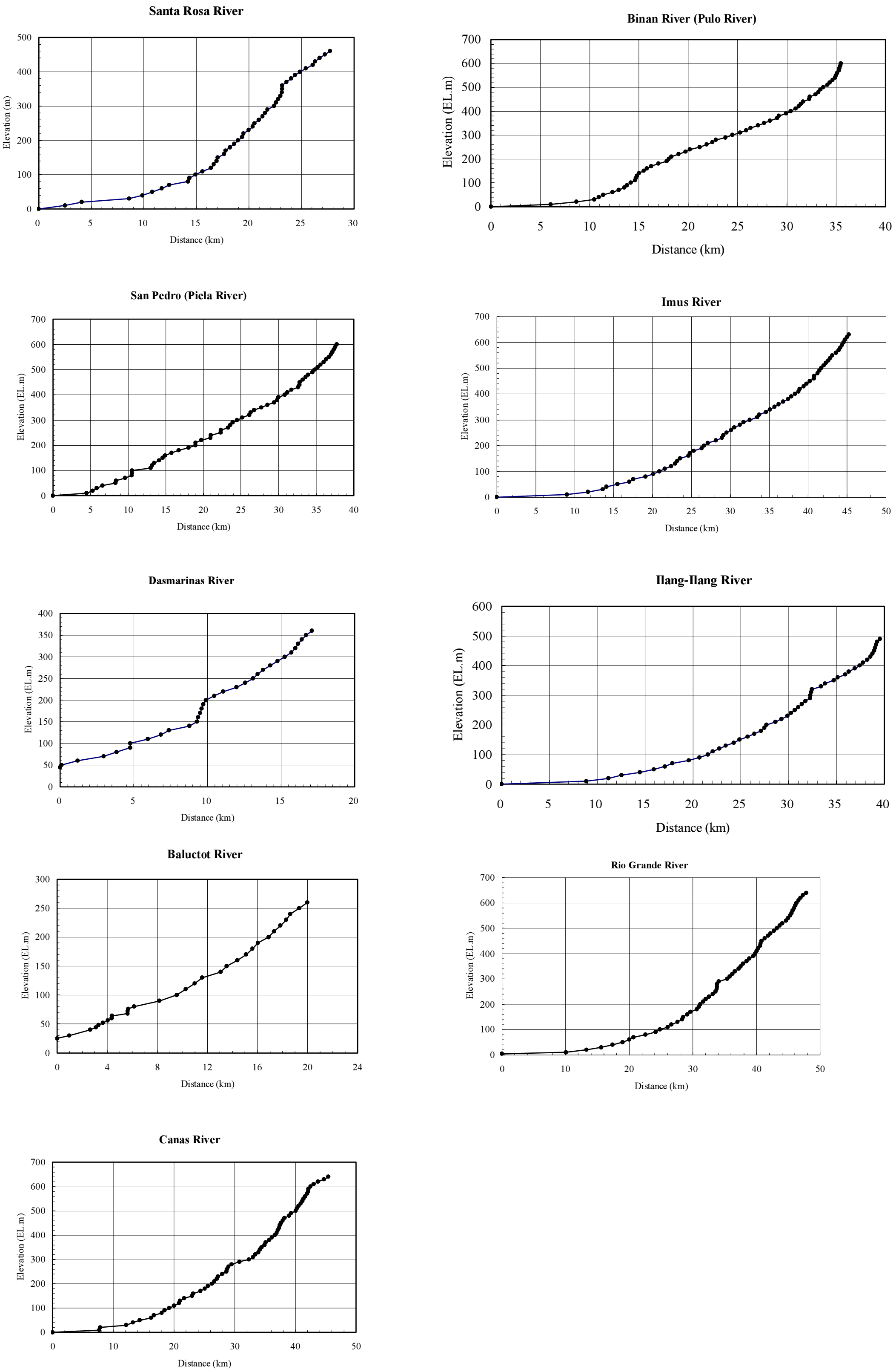

Figure A.7.3 Longitudinal Profiles of Major Rivers

(c) Rainfall intensity

Table A.7.6 Rainfall Intensity - Duration - Frequency Data at Sangley Point, Cavite

Computed extreme value (in mm)

Return period (year)	Duration														
	5 min	10 min	15 min	20 min	30 min	45 min	60 min	80 min	100 min	120 min	150 min	3 hrs	6 hrs	12 hrs	24 hrs
2	11.0	17.7	22.9	26.3	31.8	37.4	41.3	48.1	53.7	58.6	65.0	71.4	93.1	117.1	135.8
5	16.8	26.9	34.6	39.7	48.8	58.4	65.0	76.4	86.5	94.6	105.1	114.3	151.2	185.9	217.5
10	20.6	33.0	42.4	48.6	60.1	72.3	80.8	95.1	108.2	118.4	131.7	142.7	189.6	231.5	271.7
15	22.8	36.4	46.8	53.6	66.4	80.2	89.7	105.7	120.5	131.8	146.7	158.8	211.3	257.3	302.2
20	24.3	38.8	49.9	57.1	70.9	85.7	95.9	113.1	129.0	141.2	157.1	170.0	226.5	275.3	323.6
25	25.5	40.7	52.2	59.8	74.3	89.9	100.7	118.8	135.7	148.4	165.2	178.7	238.1	289.1	340.0
50	29.1	46.4	59.5	68.2	84.9	102.9	115.4	136.4	156.0	170.7	190.1	205.3	274.2	331.9	390.8
100	32.6	52.1	66.8	76.5	95.3	115.9	130.1	153.8	176.2	192.9	214.8	231.8	309.9	374.3	441.1

Equivalent average intensity of computed extreme values (in mm/hr)

Return period (year)	Duration														
	5 min	10 min	15 min	20 min	30 min	45 min	60 min	80 min	100 min	120 min	150 min	3 hrs	6 hrs	12 hrs	24 hrs
2	132.0	106.2	91.6	78.9	63.6	49.9	41.3	36.1	32.2	29.3	26.0	23.8	15.5	9.8	5.7
5	201.6	161.4	138.4	119.1	97.6	77.9	65.0	57.3	51.9	47.3	42.0	38.1	25.2	15.5	9.1
10	247.2	198.0	169.6	145.8	120.2	96.4	80.8	71.3	64.9	59.2	52.7	47.6	31.6	19.3	11.3
15	273.6	218.4	187.2	160.8	132.8	106.9	89.7	79.3	72.3	65.9	58.7	52.9	35.2	21.4	12.6
20	291.6	232.8	199.6	171.3	141.8	114.3	95.9	84.8	77.4	70.6	62.8	56.7	37.8	22.9	13.5
25	306.0	244.2	208.8	179.4	148.6	119.9	100.7	89.1	81.4	74.2	66.1	59.6	39.7	24.1	14.2
50	349.2	278.4	238.0	204.6	169.8	137.2	115.4	102.3	93.6	85.3	76.0	68.4	45.7	27.7	16.3
100	391.2	312.6	267.2	229.5	190.6	154.5	130.1	115.3	105.7	96.5	85.9	77.3	51.6	31.2	18.4

Source: Hydrolometeorological Investigations and Special Studies Section, Flood Forecasting Branch, PAGASA
(The results above were estimated based on 11 years record from 1978 to 1988.)

Table A.7.7 Adjusted Rainfall Intensity - Duration - Frequency Curve for Sangley Point, Cavite

Computed extreme value (in mm)

Return Period (Year)	5	10	15	20	30	45	60	80	100	120	150	180	360	720	1440
2	12.6	17.7	22.9	26.3	31.8	37.4	41.3	48.1	53.7	58.6	65.0	71.4	93.1	117.1	135.8
5	17.1	27.4	35.3	40.5	49.8	59.6	66.3	77.9	88.2	96.5	107.2	116.6	154.3	189.7	221.9
10	20.2	32.3	41.5	47.6	58.8	70.8	79.1	93.1	105.9	115.9	128.9	139.7	185.6	226.6	266.0
25	24.0	38.4	49.2	56.4	70.1	84.8	95.0	112.0	128.0	139.9	155.8	168.5	224.5	272.6	320.6
50	27.0	43.1	55.3	63.4	78.9	95.6	107.2	126.7	144.9	158.6	176.6	190.7	254.8	308.4	363.1
100	29.9	47.8	61.2	70.1	87.3	106.2	119.2	141.0	161.5	176.8	196.9	212.5	284.0	343.1	404.3

Equivalent average intensity of computed extreme values (in mm/hr)

Return Period (Year)	5	10	15	20	30	45	60	80	100	120	150	180	360	720	1440
2	150.9	121.4	104.7	90.2	72.7	57.0	47.2	41.2	36.8	33.5	29.7	27.2	17.7	11.2	6.5
5	205.7	164.7	141.2	121.5	99.6	79.4	66.3	58.5	52.9	48.3	42.9	38.9	25.7	15.8	9.2
10	242.0	193.8	166.0	142.7	117.7	94.4	79.1	69.8	63.6	58.0	51.6	46.6	30.9	18.9	11.1
25	288.5	230.3	196.9	169.2	140.1	113.0	95.0	84.0	76.8	70.0	62.3	56.2	37.4	22.7	13.4
50	324.4	258.7	221.1	190.1	157.8	127.5	107.2	95.0	87.0	79.3	70.7	63.6	42.5	25.7	15.1
100	358.6	286.5	244.9	210.4	174.7	141.6	119.2	105.7	96.9	88.4	78.8	70.8	47.3	28.6	16.8

Source: Prepared by JICA Study Team based on the processed data obtained from PAGASA

(d) Probable Flood Peak Discharge

All data required for estimate of the flood peak discharge at 22 sites, where cross sections are available, have been set up to the above item (c). The results of computation divided into three routes such as CALA Expressway, Daang Hari Extension and North – South National Highway are summarized in **Table A.7.8**.

Table A.7.8 Adjustment of Probable Rainfall at Sangley Point

Return Period (Year)	A	B
	Probable 1-day Rainfall (32 years from 1974 to 2005) (mm)	Adjusted Probable 24-hour Rainfall (mm)
1.01	41.6	43.7
2	147.8	155.2
5	211.3	221.9
10	253.3	266.0
25	305.3	320.6
50	345.8	363.1
100	385.0	404.3

Source: JICA Study Team

(3) Flood Water Level

Based on the flood peak discharge at 22 sites, flood water levels were estimated by uniform flow theory with Manning's Formula as shown below:

$$Q = V \times A$$

$$V = \frac{1}{n} I^{1/2} R^{2/3}$$

where, V: Flow velocity (m/s), Q: Discharge (m^3/s)

n: Roughness coefficient, I : Slope of channel bed

R: Hydraulic radius (m)

The roughness coefficient of 0.040 for "n" was applied to entire perimeter of all cross sections considering the current channel conditions. The flood water levels are shown under the cell of the 50-year peak discharge (Q) in **Table A.7.8.** New river cross sections were utilized to estimate the water levels. In accordance with the DPWH Design Guideline (Page 697), design storm frequency is specified for different type of structures as below:

Kind of Structure	Design Storm Frequency
Bridges	1 in 50 years
Box Culverts	1 in 25 years
Pipe Culverts	1 in 10 years
Embankments	1 in 10 years
Ditches and Road Surface	1 in 2 years

Source: DPWH Design Guideline (Page 697)

(4) Evaluation of Results

In the Feasibility Study of the Cavite Busway System carried out by JICA in 2002, runoff analysis to estimate flood peak discharges at 12 crossing point along the proposed busway. The proposed route is corresponded with the North-South road in the present Study. Estimated peak discharge and specific discharge at the subject points is tabulated in **Table A.7.9.** The specific discharge for 50-year return period varies between 2.7 and 14.9 $m^3/s/km^2$. On the other hand, those estimated by the current study fall into between 9 and 36 $m^3/s/km^2$ based on the figures in **Table A.7.8**. Therefore, it is noted that the current study resulted larger values in terms of specific discharges compared with those estimated by Busway System Study.

On the other hand, Specific Discharge Curves in different return periods are available in the Report of "Specific Discharge Curve, Rainfall Intensity Duration Curve, Isohyet of Probable 1-day Rainfall", which was prepared in the Project for the Enhancement of Capabilities in Flood Control and Sabo Engineering of the DPWH under JICA in March 2003. As **Figure A.7.4** illustrates, three curves in each region, such as Luzon, Visayas and Mindanao were developed based on the peak flood discharges estimated in 14 major river basins in the country. The distributed range of the specific discharges becomes closer to the envelope curve of Luzon.

Therefore, it is proved that the results of runoff analysis were preliminarily justified in the feasibility study level. However, further verification and updating of the design discharges and flood water levels should be conducted during the detailed design stage. Discharge rating curves at 22 cross sections are attached in **Annex B.**

Table A.7.9 Flood Peak Discharges Estimated by Busway Study

Station No.	River Name	Area (km^2)	Peak Discharge (m^3/s)			Specific Discharge (m^3/s)		
			25 yr	50yr	100 yr	25 yr	50yr	100 yr
1	Imus-Tributary	10.73	25.4	29.2	33.0	2.4	2.7	3.1
1a	Zapote	56.14	184.9	207.9	230.6	3.3	3.7	4.1
1b	Zapote	53.22	177.8	199.7	221.4	3.3	3.8	4.2
2	Zapote-Tributary	2.32	13.0	14.9	16.9	5.6	6.4	7.3
3	Imus-Tributary	1.15	11.0	12.7	14.3	9.6	11.0	12.4
4	Imus-Tributary	3.07	19.6	22.6	25.5	6.4	7.4	8.3
5	Imus-Tributary	0.69	6.6	7.6	8.6	9.6	11.0	12.5
6	Imus	8.53	35.0	40.7	45.3	4.1	4.8	5.3
7	Imus-Tributary	0.72	8.8	10.1	11.5	12.2	14.0	16.0
8	Imus-Tributary	0.74	9.6	11.0	12.5	13.0	14.9	16.9
9	Imus-Tributary	1.44	17.4	20.0	22.7	12.1	13.9	15.8
10	Imus-Tributary (Baluctot River)	5.92	61.1	67.3	73.4	10.3	11.4	12.4
11	Imus	39.75	135.5	155.7	175.5	3.4	3.9	4.4
12	Imus-Tributary	3.30	34.0	39.0	44.1	10.3	11.8	13.4

Source: Final Report, Feasibility Study of the Cavite Busway System, JICA

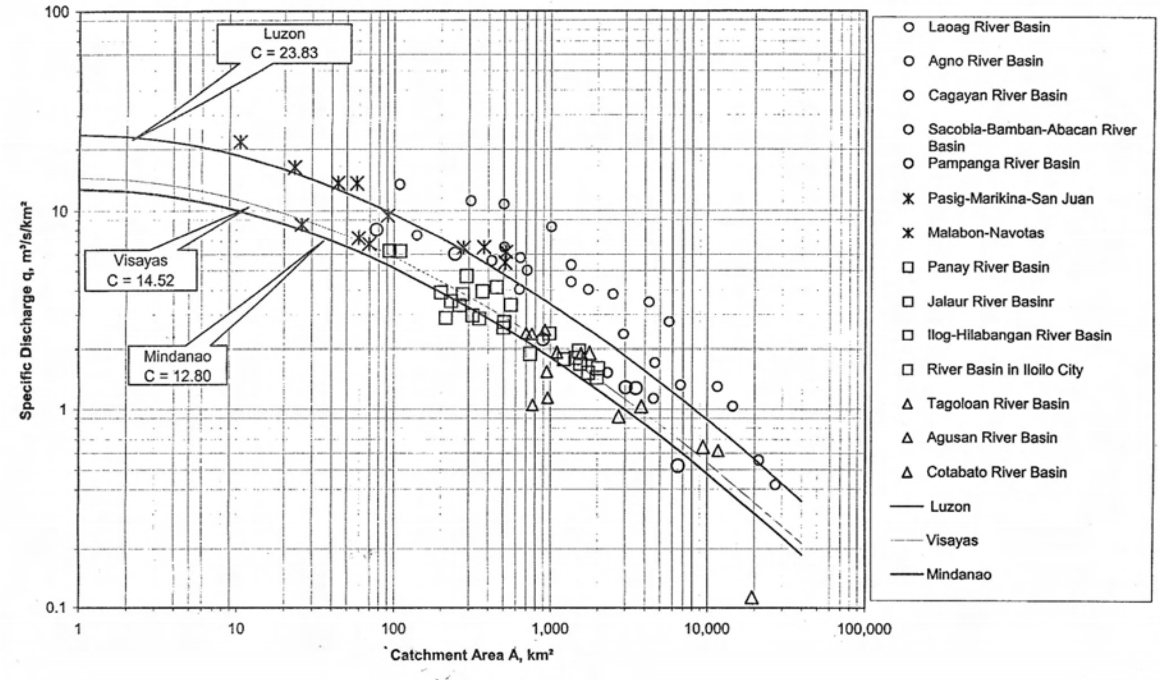

Figure A.7.4 Specific Discharge Curve (1:50-Year Return Period)

A.8 Particular Issues on River Engineering related to the Proposed Alignment

A.8.1 CALA Expressway from Sta.1+000 to Sta.1+500

The alignment of CALA Expressway near connection with the SLEX near Santa Rosa will cross the small creek of the Santa Rosa River. Since the proposed alignment will run along the creek, appropriate alignment not to deteriorate of the local drainage conditions considering the drainage system in the new residential estates, where are under developing in the vicinity will be required.

Although flood discharge will not make influence to the vertical design of the proposed expressway, it is recommended to confirm existing outlet connected with the creek should be further investigated in the feasibility design stage.

A.8.2 Daang Hari Extension from Sta.14 +000 to Sta. 15+000

Near the starting point in Bacoor of the North-South Road, interchange (and/or service area) is planned on the ground level. In order to decide appropriate elevation of land reclamation and required related structures in the coastal area considering high tide (storm serge) of Manila Bay, probable maximum tide levels were studied.

In Manila Bay, tide levels are observed at Pier No.7 of Manila South Harbor (14°37′N, 120°58′) by the Coast and Geodetic Survey Department, National Mapping and Resource Information Authority (NAMRIA), DENR. The maximum tide levels were collected from NAMRIA Binondo Office as tabulated in **Table A.8.1.** Based on the historical records, probable maximum high tide of 50-year return period was estimated at EL.2.42m by

Gumbel Method. In order to protect the structure extraordinary high tide, it is recommended that this tide level should considered in structural design of road facilities.

A.8.3 North-South Road from Sta.0+000 to Sta.3+000

Along the proposed alignment of Daang Hari Extension in Citta Italia estates in Municipality of Imus, NIA's irrigation canal is running in parallel. Considering the availability of the limited space of right-of-way, encasing is one of the possible solution to keep the required width of the road design.

The Study Team wrote an official letter to confirm the opinion to NIA. Discussion with the Chief Engineer of the NIA's Operation Office in Municipality of Naic as well as joint filed inspection was made on May 30, 2006.

As the result of the discussion with NIA, they basically accepted to encase (or to cover) the irrigation canal, since it has been already abandoned due to decrease of irrigation water demand in their command area. In fact, it seems no maintenance of the canal is currently provided and confirmed spotted water stagnation in the canal. However, the NIA staff requested to remain the flow space, because presently the canal has a function of drainage in the neighboring area of the sub-division.

Based on the findings and recognition by NIA, in order to fit the road alignment within the right-of-way, it is recommended to encase the canal to keep present flow area tentatively. In the detailed design stage, appropriate drainage network should be studied.

A.8.4 North-South Road from Sta.21+000 to Sta.21+500

Proposed alignment of NS-Road will cross the Dasmariñas River at around 100 m to 200 m upstream of Bucal Bridge, where construction of widening span is progressed. A river cross section (NS-R6) is available at this section. Based on the runoff analysis, the 50-year probable flood water level will reached a little higher the right bank. It is recommended that the proper protection for the side slope of embankment at bridge pier will be required. In particular, as for the vertical formation of the proposed alignment crossing this point, due care shall be paid.

A.9 Bank Erosion

No serious erosion or local scour of river bed and/or river bank may become realize under the current conditions as far as at the crossing site along the proposed alignment of three routes. However, appropriate treatment to stabilize the slope of river bank in association with construction of bridge and other crossing structures will be required.

Sediment deposition along the channel is rather small considering steep river bed gradient and relatively thick vegetation cover of the watershed. Further, the river bed and foot of bank slopes are formed with hard rock and thus these are less susceptible to erosion by strong current under the current conditions.

However, specific consideration of countermeasures at crossing points shall be made if present channel geometry is remarkably changed due to construction works of new road and related structures.

Table A.2.1 Available Daily Rainfall Record in and around the Study Area

Code No.	Name of Station	Province	Munisipality	Location North	Location East	Year (1951–05)	Available Years
Synoptic Station							
428	Sangley Point	Cavite	Cavite City	14° 30'	120° 55'	■ 74–04	31
432	Ambulong	Batangas	Tanauran	14° 05'	121° 03'	■ 1951–04	54
Climatic Station							
74 - 0406	Barrio Maintim, Amadeo	Cavite	Amadeo	14° 10'18"	120° 57'00"	■ 85–86, 88–99, 01–04	18
75 - 0407	Mabolo Elem. School, Bacoor	Cavite	Bacoor	14° 27'00"	120° 56'00"	■ 75–04	30
79 - 0408	San Pedro, Laguna	Laguna	San Pedro	14° 22'00"	121° 02'18"	■ 71–89, 93–98	25
Agromat Station							
424	Tagaytay	Cavite	Tagaytay City	14° 07'18"	120° 58'00"	■ 94–04	11
						Total	138

Source: Prepared by the Study Team based on daily rainfall records from PAGASA

Table A.2.2 Available Mean Daily Discharge Record in and around the Study Area

Code No.	Name of River	Location	Catchment Area (km^2)	Altitude of zero gauge (EL.m)	Location North	Location East	Year (45, 46, ..., 54, 55, 56, ..., 65–05)	Available Years
04SW142205PW022	Ilang-Ilang	Alapan, 2nd Imus, Cavite	60	5.558	14° 24'30"	120° 54'20"	▨ 71–79; ■ 83–85	12
04SW141204PW025	Maragondon	Mabacao, Maragondon, Cavite	260	17.730	14° 16'20"	120° 44'20"	▨ 45–79	30
04SW141204BRS068	Maragondon	Bukal, Maragondon, Cavite	260	2.288	14° 16'20"	120° 44'20"	■ 83–00	18
04SW142205PW023	Panaysayan	Palubluban, General Trias	29	28.970	14° 22'22"	120° 52'55"	▨ 71–73, 75–79	20
04SW141204PW024	Balsahan	Palangue, Naic, Cavite	22	34.662	14° 16'59"	120° 48'30"	▨ 54–69, 71–76, 78–79	24
04SW141204BRS062*	Alemang	Makina, Naic, Cavite	42	Not established	14° 19'06"	120° 46'28"	■ 85–99	15
04SW141210PW013	Arangilan	Calamias,Cabuyao, Laguna	87	19.950	14° 14'10"	121° 07'30"	▨ 55–70	15
04SW141212BRS071*	Pagsanjan	San Isidro, Pagsanjan, Laguna	247	4.980	14° 16'41"	121° 27'25"	■ 84–99	16
04SW141210BRS074	San Cristobal	San Cristobal, Calamba, Laguna	106	Not established	14° 13'06"	121° 09'19"	■ 84–90	7
04SW141210BRS075	San Juan	Porac, Calamba, Laguna	185	Not established	14° 12'38"	121° 09'10"	■ 86–99	14
							Total	171

Note: *, Only mean daily gauge height is available.

▨ Only annual discharge characteristics and mean monthly discharge are available instead of daily discharge record.

■ Daily discharge or mean daily gauge height are available.

Source: Hydrological Division, Bureau of Research and Standards, DPWH

Figure A.2.2 Watershed Boundaries with Rainfall and Water Level Gauging Stations

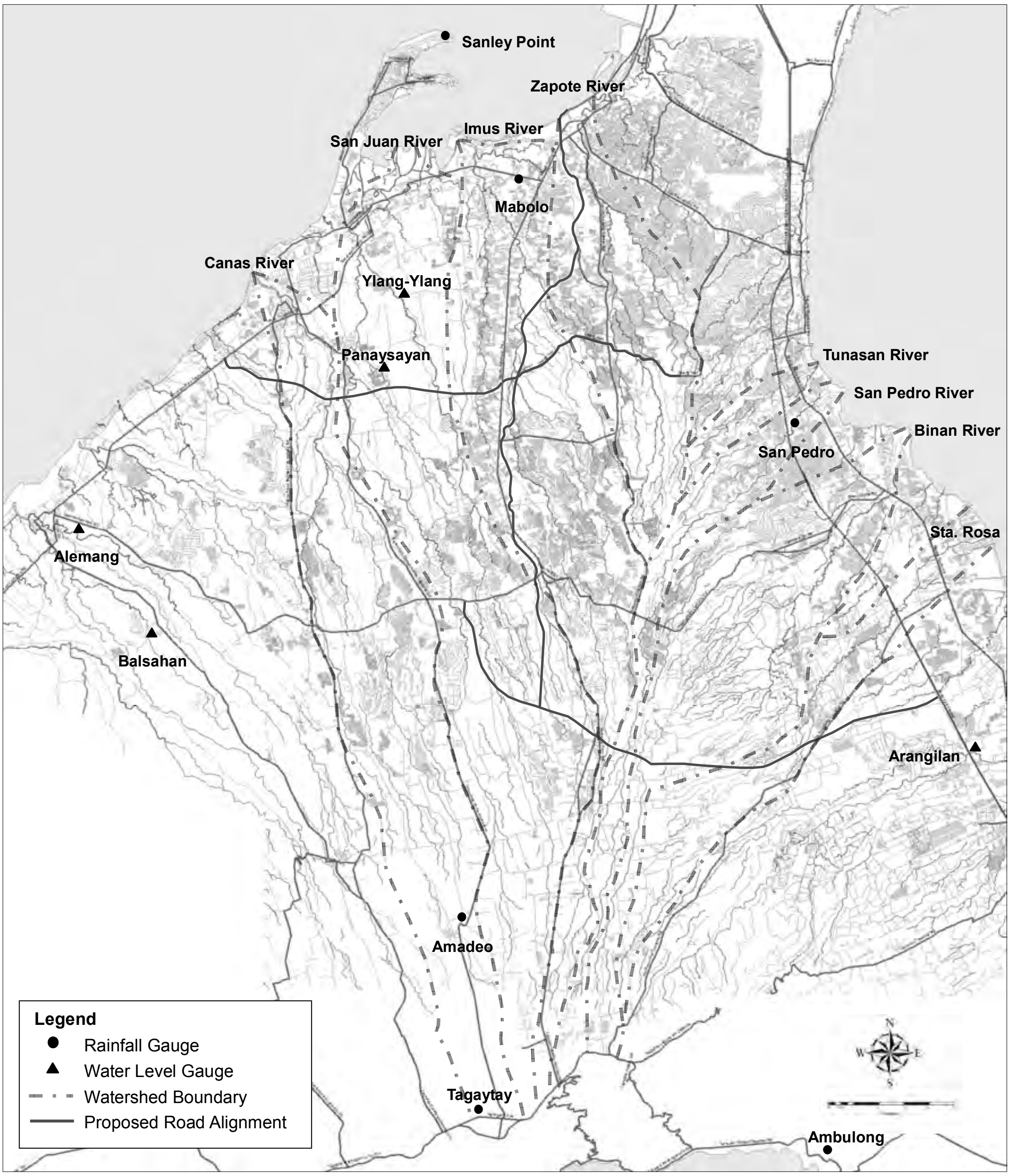

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Figure A.2.3 Location Map of Crossing with River along Proposed Roads

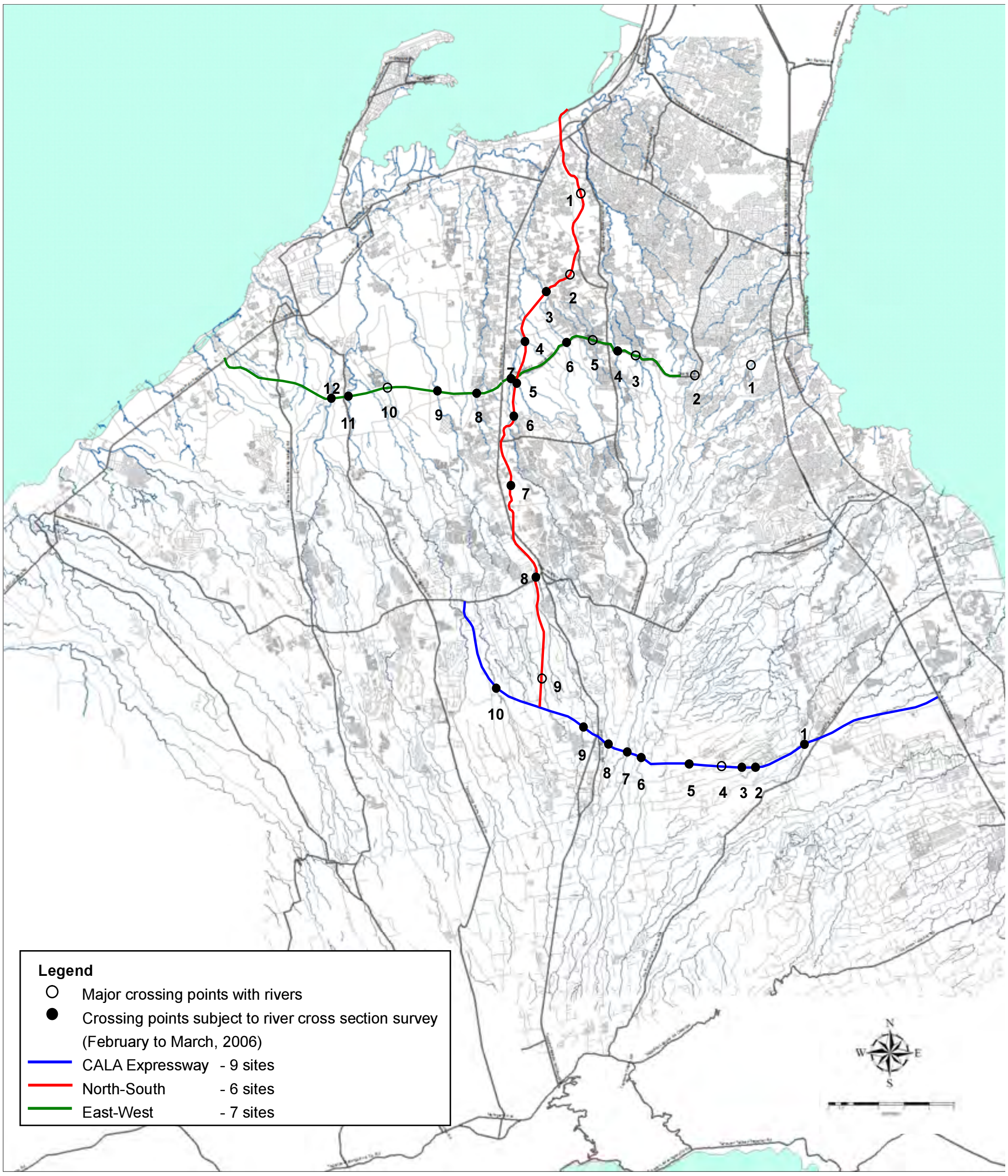


Table A.3.1 River Crossings along Proposed Three Routes

Ref. No.	Crossing Points [1]	Name of River	Name of Tributary	Municipality	Drainage Area (km^2)	Proposed Structure (Tentative)	Notable Existing Conditions	Cross section survey
I.	**CALA Expressway (CE)**							
Start	Sta.0+000			Santa Rosa			SLEX	
CALA1	Sta.5+820	Banava	-	Silang	12.3	Bridge		CE-R1
CALA2	Sta.7+200	Banava	-	Silang	1.6	Bridge	moderately deep	CE-R2
CALA3	Sta.7+720	Banava	-	Silang	4.5	Bridge	moderately deep	-
CALA4	Sta.8+500	Banava	-	Silang	2.2	Bridge		CE-R3
CALA5	Sta.9+200	Biñan	-	Silang	1.4	Bridge		CE-R4
CALA6	Sta.10+840	Biñan	-	Silang	8.8	Bridge		CE-R5
CALA7	Sta.13+250	San Pedro	-	Silang	12.7	Bridge	Downstream of confluence, deep valley with thick vegetation	CE-R6
CALA8	Sta.15+320	Imus	-	Silang	13.2	Bridge	deep valley	CE-R7
CALA9	Sta.16+800	Dasmariñas	-	Silang	4.9	Bridge		CE-R8
CALA10	Sta.19+300	San Juan	Ylang Ylang	Silang	8.8	Bridge		CE-R9
End	Sta.22+881			Silang			Dasmarinas - Naic Road	
								9 sites
II.	**Daang Hari Extension (DH)**							
Start	Sta.0+000			Muntinlupa City	-	-	Boundary of Muntinlupa City and Municipality of Imus	
EW1	Sta.3+200	-	-	Muntinlupa City	-	Bridge	moderately deep valley	-
EW2	Sta.3+420	-	-	Imus	3.4	Bridge		-
EW3	Sta.6+100	Zapote	Don Cella	Imus	10.9	Bridge		-
EW4	Sta.7+100	Zapote	-	Imus	4.6	Bridge		DH-R1
EW5	Sta.8+100	-	-	Imus	1.3	Bridge		-
EW6	Sta.9+300	Imus	-	Imus	7.7	Bridge		DH-R2
EW7	Sta.12+050	Imus	-	Imus	54.6	Bridge	near new bridge under construction	DH-R3
EW8	Sta.13+640	Imus	-	Imus	8.7	Bridge		DH-R4
EW9	Sta.15+220	San Juan	-	Imus	52.0	Bridge		DH-R5
EW10	Sta.17+300	San Juan	Pasong Cama Chili	General Trias	11.4	Bridge		-
EW11	Sta.17+400	San Juan	Rio Grande	General Trias	51.1	Bridge	near existing suspension bridge	DH-R6
EW12	Sta.18+960	Cañas	Cañas	General Trias	95.8	Bridge		DH-R7
End	Sta.24+268			Tanza			Coastal Road	
								7 sites
III.	**North-South Road (NS)**							
Start	Sta.0+000			Imus			Coastal Road	
NS1	Sta.4+150	-	-	Imus	-	-	small creek	-
NS2	Sta.7+950	-	-	Imus	4.9	Bridge		-
NS3	Sta.8+750	Imus	-	Imus	9.9	Bridge	near new bridge already constructed, land reclamation is on-going for expansion of Citta Italia estate	NS-R1
NS4	Sta.11+300	Imus	-	Imus	1.8	Bridge		NS-R2
NS5	Sta.12+900	Imus	Baluctot	Imus	20.9	Bridge	moderately deep	NS-R3
NS6	Sta.14+000	Imus	-	Imus	34.7	Bridge	near suspention bridge	NS-R4
NS7	Sta.17+250	Imus	-	Dasmariñas	3.0	Bridge	near existing irrigation weir	NS-R5
NS8	Sta.21+500	San Juan	Dasmariñas	Dasmariñas	11.8	Bridge	near Bucal Bridge under construction of widening	NS-R6
NS9	Sta.25+500	San Juan	Ylang Ylang	Silang	2.9	Bridge		-
End	Sta.26+700			Silang			Proposed CALA Expressway	
								6 sites

Note: [1], Tentative figures to be further veirfied through finalization of alingment in the feasibility study

Source: JICA Study Team

Table A.8.1 Recorded Maximum Tide Levels at Manila South Harbour

Station: Pier No.7, Manila South Harbour
Location: 14°35'N, 120°58'E

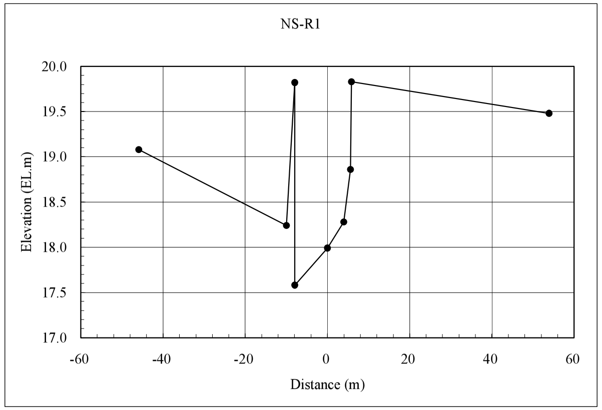
Year	Date	Elevation (m)	Year	Date	Elevation (m)
1946	Sep.06,11,24	1.27	1976	Jun.29,30	1.85
1947	Jun.20	1.63	1977	Jul.18	1.76
1948	Sep.01	1.63	1978	Oct.12	1.79
1949	Jun12,15 27,28,29	1.33	1979	Aug.09	1.75
1950	Jul.27	1.57	1980	Aug.26,28	1.67
1951	Aug.16,17	1.63	1981	Jul.04, Aug.01	1.82
1952	Jun.11	1.57	1982	Jun.24	1.91
1953	Jun.28,29	1.60	1983	Aug.11	1.71
1954	Jul.01, Dec.10	1.45	1984	Aug.27,29	2.09
1955	Jul.19	1.45	1985	Jun.22	2.12
1956	Jun.10	1.45	1986	Jul.09	2.01
1957	Jun.29	1.36	1987	Jul.12,13	1.95
1958	Jul.17	1.33	1988	Jul.30	1.98
1959	Aug.05,18	1.33	1989	Jun.05	1.95
1960	Aug.07	1.60	1990	Jun.24,25	1.94
1961	Jul.29	1.48	1991	Oct.25	1.95
1962	Aug.01	1.57	1992	Aug.29	1.95
1963	Jul.21	1.48	1993	Oct.06	1.99
1964	Aug.07	1.82	1994	Jun.23, Jul.10	2.00
1965	Jul.14,28	1.57	1995	Oct.01	2.03
1966	Aug.15	1.60	1996	Jul.31	2.19
1967	Jul.19, Aug.19	1.60	1997	Aug.18	2.04
1968	Jul.25, 26	1.69	1998	Aug.09	1.91
1969	Jun.30	1.60	1999	Apr.22	2.15
1970	Aug.17	1.72	2000	Jul.04	2.25
1971	Oct.11	1.72	2001	Aug.19	1.49
1972	Jul.12	1.91	2002	Jul.11	1.63
1973	Oct.15	1.79	2003	-	-
1974	Jul.20	1.91	2004	Dec.14	1.52
1975	Aug.07	1.47	2005	Jun.24	1.62
				Max	2.25
				Average	1.73

Note: The records above are in meters and referred to Mean Lower Low Water (MLLW)
Source: NAMRIA Binondo Office

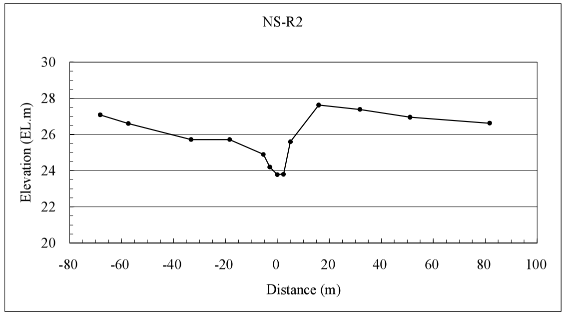
ANNEX A

1	104.15	19.57
2	53.93	19.48
3	5.83	19.83
4	5.64	18.86
5	3.97	18.28
6	0.00	17.99
7	-7.93	17.58
8	-7.95	19.82
9	-9.97	18.24
10	-45.86	19.08
11	-77.08	19.76
12	-95.99	19.60

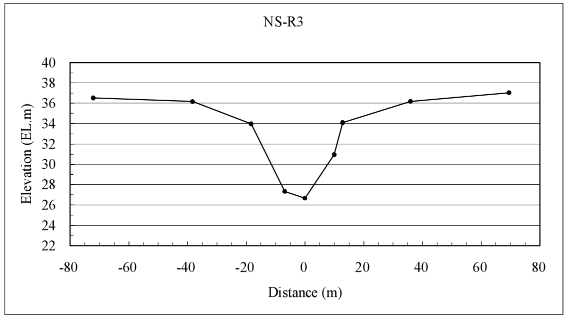
Only this section is enough



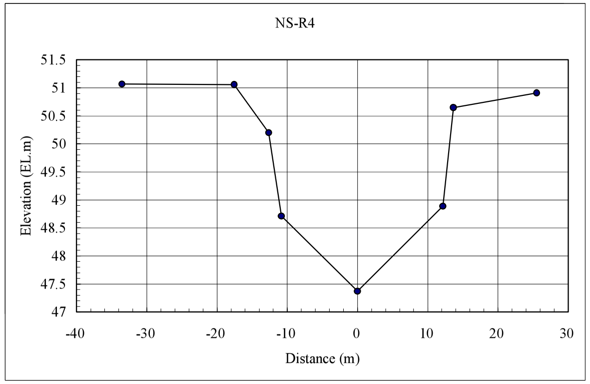
1	81.70	26.63
2	51.08	26.96
3	31.78	27.39
4	15.89	27.63
5	4.99	25.60
6	2.38	23.80
7	0.00	23.79
8	-2.90	24.20
9	-5.38	24.90
10	-18.35	25.72
11	-33.20	25.72
12	-57.37	26.61
13	-68.20	27.09



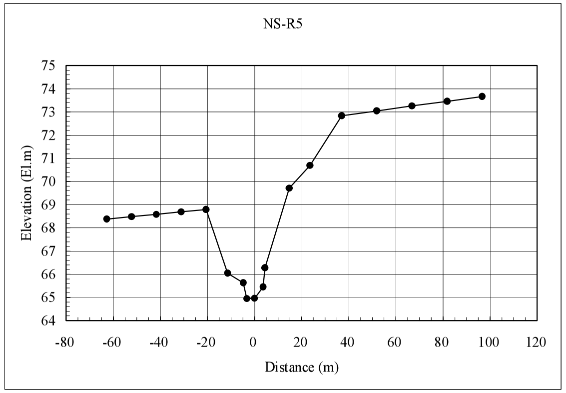
1	69.47	37.03
2	35.92	36.17
3	12.79	34.10
4	9.98	30.94
5	0.00	26.66
6	-6.85	27.32
7	-18.33	33.97
8	-38.30	36.16
9	-72.12	36.52



1	117.48	51.73
2	81.67	51.45
3	25.50	50.91
4	13.66	50.65
5	12.16	48.89
6	0.00	47.37
7	-10.84	48.71
8	-12.64	50.2
9	-17.57	51.06
10	-33.54	51.07
11	-51.58	50.77
12	-73.69	50.51
13	-88.50	49.98

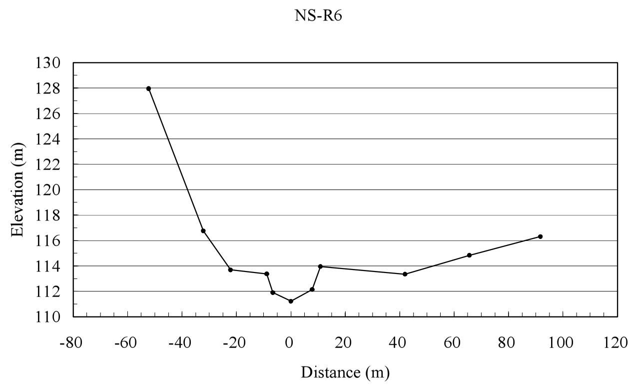


1	96.71	73.67
2	81.78	73.46
3	66.84	73.26
4	51.91	73.05
5	36.97	72.84
6	23.51	70.69
7	14.69	69.71
8	4.40	66.28
9	3.61	65.45
10	0.00	64.96
11	-3.26	64.95
12	-4.80	65.63
13	-11.45	66.05
14	-20.61	68.79
15	-31.16	68.69
16	-41.71	68.58
17	-52.26	68.48
18	-62.80	68.38

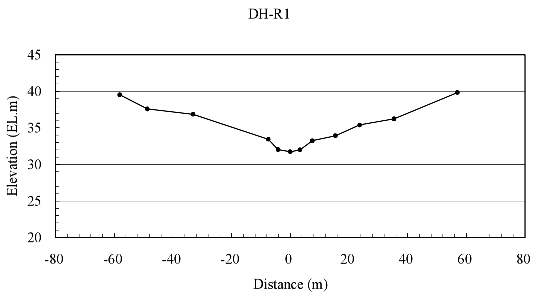


1	91.70	116.303
2	65.62	114.833
3	41.94	113.353
4	10.87	113.953
5	7.87	112.143
6	0.00	111.223
7	-6.62	111.903
8	-8.84	113.373
9	-22.17	113.693
10	-32.18	116.763
11	-52.25	127.953

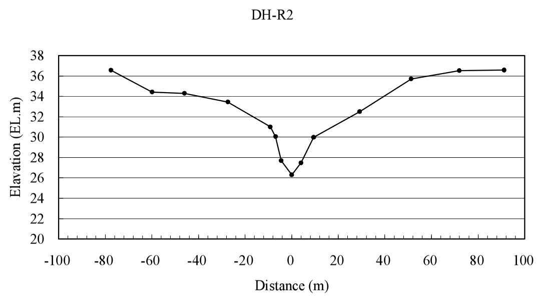
Distance 8 to 9
13.33279
Distance 4 to 5
3.503786



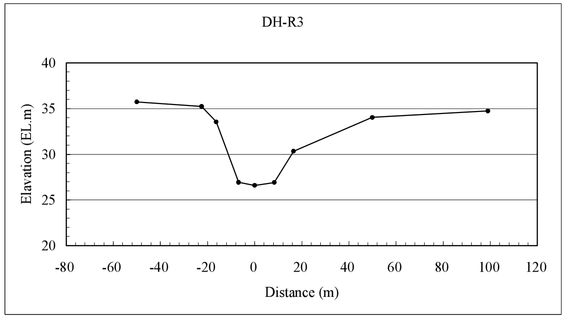
1	56.99	39.82
2	35.39	36.22
3	23.65	35.38
4	15.39	33.92
5	7.55	33.23
6	3.33	32.00
7	0.00	31.72
8	-4.14	32.01
9	-7.49	33.44
10	-33.10	36.86
11	-48.76	37.59
12	-58.17	39.52



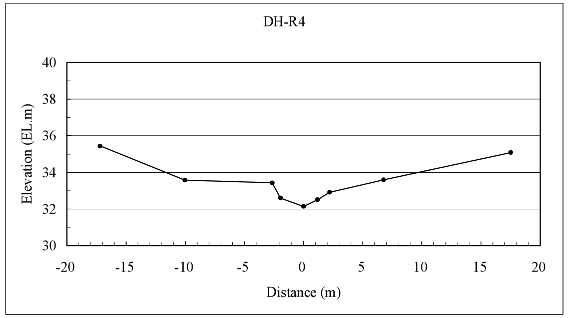
1	91.19	36.58
2	71.93	36.53
3	51.24	35.72
4	29.19	32.50
5	9.44	29.99
6	3.98	27.48
7	0.00	26.30
8	-4.51	27.69
9	-6.92	30.06
10	-9.18	31.00
11	-27.37	33.45
12	-46.04	34.31
13	-59.91	34.43
14	-77.56	36.57



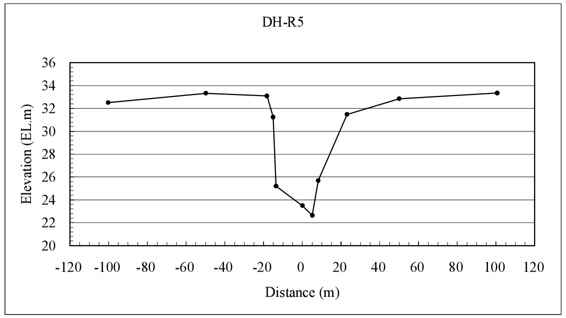
1	98.98	34.73
2	49.99	34.02
3	16.46	30.33
4	8.29	26.91
5	0.00	26.60
6	-6.87	26.93
7	-16.28	33.53
8	-22.49	35.22
9	-50.06	35.72



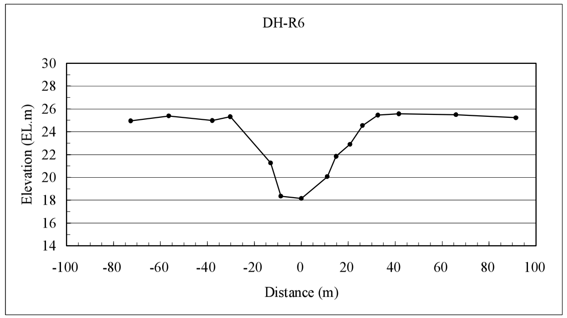
1	17.51	35.08
2	6.77	33.59
3	2.20	32.91
4	1.18	32.5
5	0.00	32.14
6	-1.95	32.6
7	-2.64	33.42
8	-10.03	33.57
9	-17.20	35.44



1	100.60	33.34
2	50.05	32.85
3	23.13	31.48
4	8.23	25.69
5	5.18	22.64
6	0.00	23.50
7	-13.54	25.20
8	-15.08	31.24
9	-18.29	33.09
10	-49.82	33.33
11	-100.30	32.51

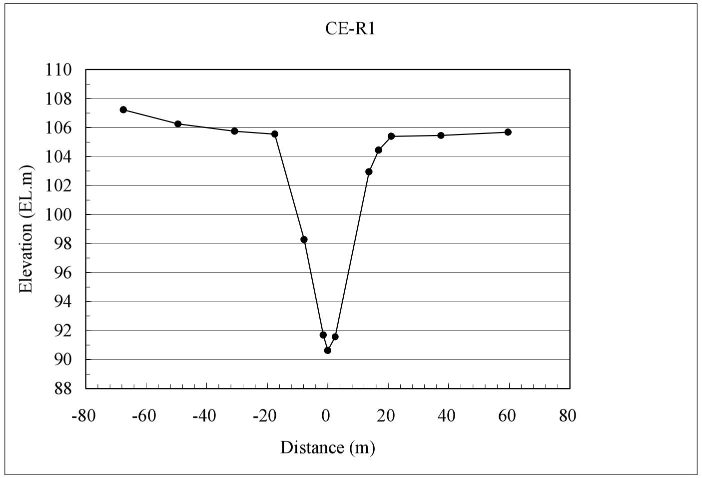


1	91.48	25.23
2	65.97	25.49
3	41.58	25.57
4	32.66	25.46
5	26.14	24.55
6	20.81	22.9
7	14.83	21.84
8	11.03	20.07
9	0.00	18.15
10	-8.70	18.36
11	-13.09	21.26
12	-30.25	25.32
13	-37.91	24.98
14	-56.46	25.39
15	-72.69	24.95

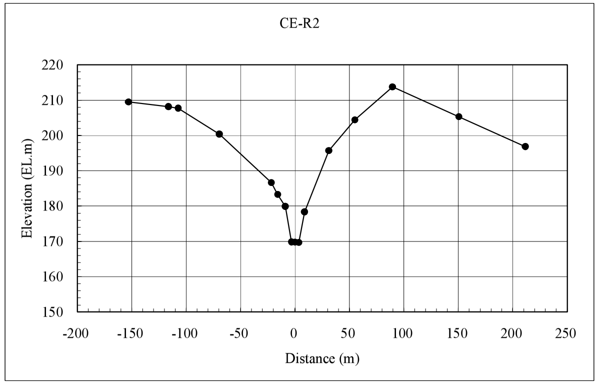


1	178.83	23.68
2	142.33	23.21
3	112.09	23.62
4	97.58	23.62
5	96.28	15.10
6	90.72	15.25
7	87.33	23.81
8	83.01	23.92
9	53.43	17.72
10	42.40	14.72
11	27.12	11.71
12	14.21	8.68
13	4.73	5.93
14	0.00	5.65
15	-3.48	5.81
16	-11.42	8.29
17	-30.55	13.11
18	-65.78	12.95
19	-76.34	14.50
20	-97.74	12.83
21	-129.22	15.53
22	-139.62	13.76
23	-149.76	17.98
24	-185.10	20.98
25	-247.33	25.59
26	-269.67	24.68
27	-277.26	24.76
28	-294.14	23.72

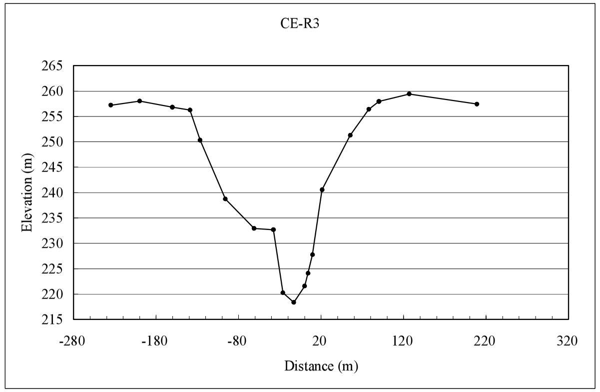
1	59.55	105.68
2	37.43	105.45
3	21.02	105.4
4	16.78	104.45
5	13.60	102.95
6	2.48	91.56
7	0.00	90.62
8	-1.47	91.69
9	-7.83	98.27
10	-17.53	105.55
11	-30.76	105.75
12	-49.49	106.25
13	-67.55	107.23



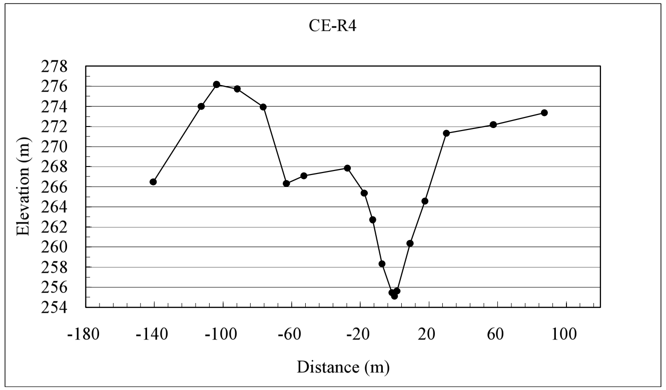
1	211.58	196.85
2	150.59	205.28
3	89.60	213.71
4	55.12	204.37
5	31.03	195.70
6	8.72	178.34
7	3.42	169.66
8	0.00	169.76
9	-3.27	169.83
10	-8.89	179.91
11	-15.83	183.27
12	-21.75	186.63
13	-69.46	200.36
14	-107.23	207.72
15	-116.14	208.17
16	-152.95	209.49



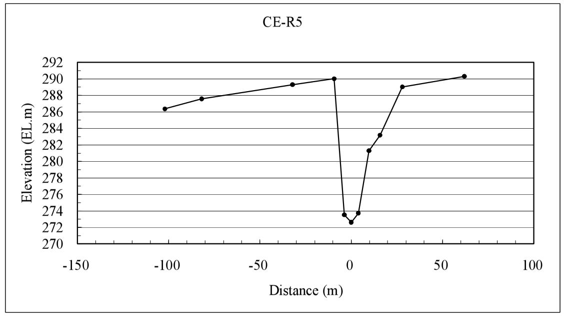
208.87	257.42
126.77	259.42
90.16	257.92
77.81	256.4
55.30	251.25
21.30	240.52
9.49	227.76
4.09	224.1
0.00	221.58
-13.03	218.36
-26.22	220.25
-37.69	232.69
-61.32	232.92
-96.04	238.71
-126.69	250.3
-138.90	256.25
-160.26	256.78
-200.03	257.99
-234.90	257.21



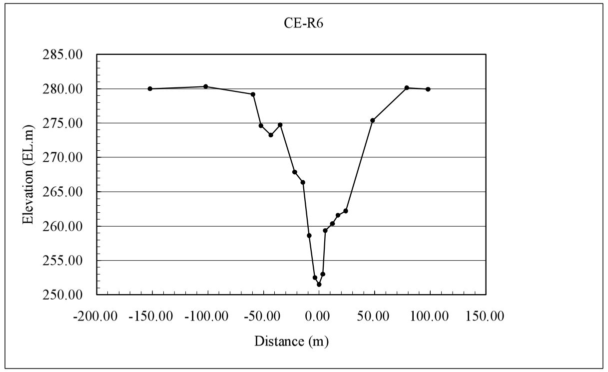
87.37	273.36
57.50	272.17
30.18	271.32
17.70	264.57
9.02	260.34
1.30	255.60
0.00	255.10
-1.58	255.44
-7.32	258.30
-12.74	262.70
-17.71	265.37
-27.52	267.85
-52.88	267.08
-63.04	266.31
-76.55	273.92
-91.69	275.73
-103.71	276.18
-112.69	274.00
-140.63	266.48



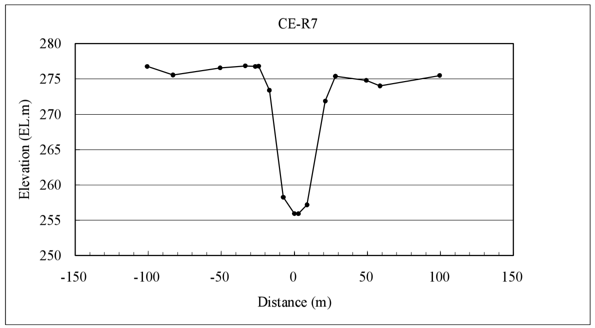
61.99	290.30
28.05	289.03
15.77	283.18
9.78	281.29
3.97	273.72
0.00	272.62
-3.75	273.51
-9.31	290.01
-32.15	289.30
-81.91	287.57
-102.04	286.35



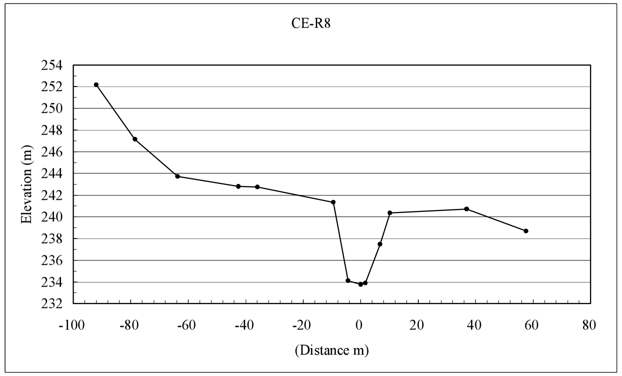
1	97.93	279.91
2	78.80	280.12
3	48.15	275.39
4	23.90	262.21
5	16.99	261.58
6	12.07	260.35
7	5.60	259.35
8	3.34	253.00
9	0.00	251.49
10	-3.79	252.50
11	-8.90	258.63
12	-14.46	266.35
13	-21.94	267.86
14	-34.97	274.74
15	-43.40	273.24
16	-52.25	274.61
17	-59.47	279.17
18	-101.90	280.32
19	-151.97	279.98



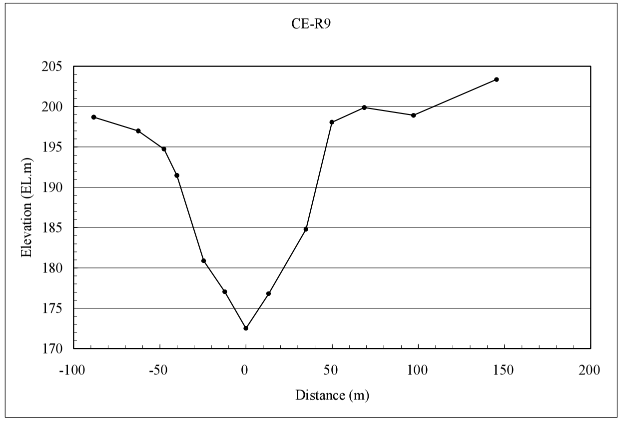
1	99.52	275.49
2	58.66	274.00
3	49.32	274.80
4	28.19	275.39
5	21.15	271.86
6	8.69	257.15
7	2.84	255.90
8	0.00	255.92
9	-7.52	258.24
10	-17.03	273.40
11	-24.46	276.81
12	-26.68	276.77
13	-33.56	276.84
14	-50.83	276.56
15	-82.99	275.55
16	-100.77	276.76



57.52	238.7
36.87	240.72
10.15	240.36
6.75	237.48
1.62	233.9
0.00	233.78
-4.39	234.12
-9.51	241.34
-35.95	242.75
-42.57	242.8
-63.72	243.73
-78.54	247.16
-92.04	252.17



145.36	203.36
97.20	198.91
68.66	199.88
49.82	198.06
34.73	184.8
13.13	176.81
0.00	172.51
-12.28	177.05
-24.48	180.89
-40.05	191.46
-47.59	194.74
-62.42	196.98
-88.29	198.69

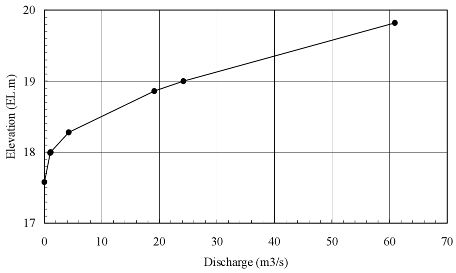


ANNEX B

HYDRAULIC PROPERTIES AT NS-R1

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	5.83	19.83	19.82	0.82	0.84	16.90	1.481	11.23	25.02	0.82	2.24	0.040	0.0056	0.0750	1.299	2.4	25.0	60.9
2	5.64	18.86	19.00	0.14	0.14	15.24	0.905	1.90	13.79	0.14	1.42	0.040	0.0056	0.0750	0.935	1.8	13.8	24.2
3	3.97	18.28	18.86	0.58	1.77	14.96	0.795	7.39	11.89	0.58	1.28	0.040	0.0056	0.0750	0.858	1.6	11.9	19.1
4	0.00	17.99	18.28	0.28	3.85	12.61	0.357	2.79	4.50	0.28	0.70	0.040	0.0056	0.0750	0.503	0.9	4.5	4.2
5	-7.93	17.58	18.00	0.01	0.14	8.48	0.201	0.08	1.70	0.01	0.42	0.040	0.0056	0.0750	0.343	0.6	1.7	1.1
6	-7.95	19.82	17.99	0.41	7.92	8.33	0.195	1.62	1.62	0.41	0.41	0.040	0.0056	0.0750	0.336	0.6	1.6	1.0
			17.58			0.00												0

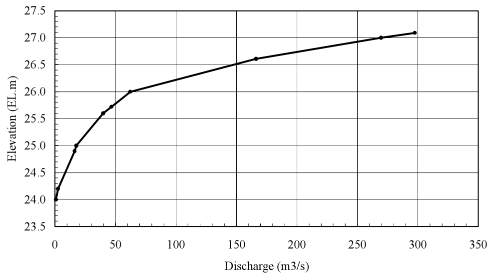
Discharge Rating Curve at NS-R1



HYDRAULIC PROPERTIES AT NS-R2

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	81.70	26.63	27.09	2.03	0.49	79.62	1.302	7.19	103.68	0.09	3.29	0.040	0.0093	0.0962	1.192	2.9	103.7	297.4
2	51.08	26.96	27.00	8.80	2.13	77.09	1.251	28.56	96.48	0.39	3.20	0.040	0.0093	0.0962	1.161	2.8	96.5	269.6
3	31.78	27.39	26.61	16.60	3.33	66.16	1.027	35.29	67.92	0.61	2.81	0.040	0.0093	0.0962	1.018	2.4	67.9	166.3
4	15.89	27.63	26.00	22.44	1.53	46.23	0.706	12.13	32.63	0.28	2.20	0.040	0.0093	0.0962	0.793	1.9	32.6	62.2
5	4.99	25.60	25.72	1.90	0.66	22.26	0.921	2.73	20.49	0.12	1.92	0.040	0.0093	0.0962	0.947	2.3	20.5	46.7
6	2.38	23.80	25.60	9.51	1.06	19.70	0.902	9.76	17.77	0.60	1.80	0.040	0.0093	0.0962	0.934	2.2	17.8	39.9
7	0.00	23.79	25.00	1.58	0.18	9.14	0.877	1.02	8.01	0.10	1.20	0.040	0.0093	0.0962	0.916	2.2	8.0	17.7
8	-2.90	24.20	24.90	2.57	1.23	7.38	0.948	5.33	6.99	0.70	1.10	0.040	0.0093	0.0962	0.965	2.3	7.0	16.2
9	-5.38	24.90	24.20	1.43	0.35	3.57	0.466	1.00	1.66	0.20	0.40	0.040	0.0093	0.0962	0.601	1.4	1.7	2.4
10	-18.35	25.72	24.00	1.43	0.35	1.78	0.370	0.66	0.66	0.20	0.20	0.040	0.0093	0.0962	0.516	1.2	0.7	0.8
11	-33.20	25.72	23.80	-	0.00	0.00	0.00	0.00										
12	-57.3744	26.61																
13	-68.1989	27.09																

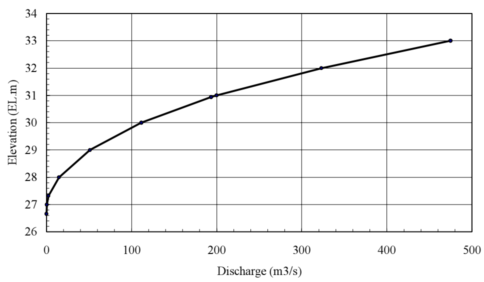
Discharge Rating Curve at NS-2



HYDRAULIC PROPERTIES AT NS-R3

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	69.47	37.03	36.17	0.94	0.11	79.49	3.222	0.75	256.14	0.01	9.51	0.040	0.0052	0.0724	2.182	3.9	256.1	1,011.3
2	35.92	36.17	36.16	1.47	1.80	78.44	3.256	11.60	255.40	0.16	9.50	0.040	0.0052	0.0724	2.197	4.0	255.4	1,015.4
3	12.79	34.10	36.00	9.17	11.22	75.17	3.243	60.71	243.80	1.00	9.34	0.040	0.0052	0.0724	2.191	4.0	243.8	966.7
4	9.98	30.94	35.00	8.26	10.10	54.78	3.342	37.29	183.09	0.90	8.34	0.040	0.0052	0.0724	2.235	4.0	183.1	740.6
5	0.00	26.66	34.10	0.92	0.13	36.43	4.002	3.18	145.79	0.10	7.44	0.040	0.0052	0.0724	2.521	4.6	145.8	665.1
6	-6.85	27.32	34.00	0.28	0.04	35.38	4.031	0.93	142.61	0.03	7.34	0.040	0.0052	0.0724	2.533	4.6	142.6	653.7
7	-18.33	33.97	33.97	1.93	1.30	35.06	4.041	28.84	141.68	0.97	7.31	0.040	0.0052	0.0724	2.537	4.6	141.7	650.5
8	-38.30	36.16	33.00	1.99	1.34	31.83	3.545	27.16	112.84	1.00	6.34	0.040	0.0052	0.0724	2.325	4.2	112.8	474.8
9	-72.12	36.52	32.00	1.99	1.34	28.50	3.006	24.55	85.68	1.00	5.34	0.040	0.0052	0.0724	2.083	3.8	85.7	323.0
			31.00	0.12	0.08	25.17	2.429	1.39	61.13	0.06	4.34	0.040	0.0052	0.0724	1.807	3.3	61.1	199.9
			30.94	1.87	2.39	24.97	2.393	19.90	59.74	0.94	4.28	0.040	0.0052	0.0724	1.789	3.2	59.7	193.4
			30.00	1.99	2.54	20.71	1.924	17.24	39.84	1.00	3.34	0.040	0.0052	0.0724	1.547	2.8	39.8	111.5
			29.00	1.99	2.54	16.17	1.397	13.18	22.60	1.00	2.34	0.040	0.0052	0.0724	1.250	2.3	22.6	51.1
			28.00	1.36	1.73	11.64	0.809	6.65	9.42	0.68	1.34	0.040	0.0052	0.0724	0.868	1.6	9.4	14.8
			27.32	3.34	0.81	8.56	0.324	2.03	2.77	0.32	0.66	0.040	0.0052	0.0724	0.471	0.9	2.8	2.4
			27.00	3.55	0.86	4.41	0.167	0.74	0.74	0.34	0.34	0.040	0.0052	0.0724	0.303	0.5	0.7	0.4
			26.66	0.00	0.00	0.00		0.00	0.00	26.66	-	0.040	0.0052	0.0724	0.000	0.0	0.0	0.0

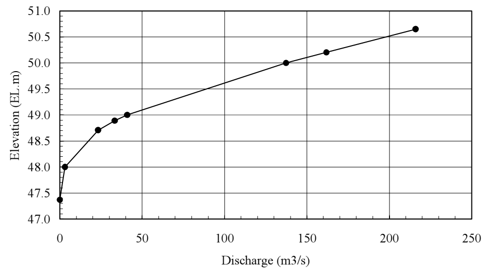
Discharge Rating Curve at NS-R3



HYDRAULIC PROPERTIES AT NS-R4

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	25.50	50.91	50.91	1.51	11.85	43.80	1.649	9.24	72.22	0.26	3.54	0.040	0.0071	0.0845	1.396	2.9	72.2	213
2	13.66	50.65	50.65	2.62	0.59	30.44	2.069	12.33	62.98	0.45	3.28	0.040	0.0071	0.0845	1.624	3.4	63.0	216
3	12.16	48.89	50.20	0.31	0.26	27.23	1.860	5.14	50.65	0.20	2.83	0.040	0.0071	0.0845	1.512	3.2	50.7	162
4	0.00	47.37	50.00	1.57	1.31	26.66	1.707	24.47	45.51	1.00	2.63	0.040	0.0071	0.0845	1.428	3.0	45.5	137
5	-10.84	48.71	49.00	0.17	0.14	23.77	0.885	2.57	21.04	0.11	1.63	0.040	0.0071	0.0845	0.922	1.9	21.0	41
6	-12.64	50.20	48.89	0.28	1.45	23.46	0.788	4.03	18.47	0.18	1.52	0.040	0.0071	0.0845	0.853	1.8	18.5	33
7	-17.57	51.06	48.71	5.79	5.72	21.72	0.665	11.25	14.44	0.71	1.34	0.040	0.0071	0.0845	0.762	1.6	14.4	23
			48.00	5.13	5.08	10.21	0.313	3.19	3.19	0.63	0.63	0.040	0.0071	0.0845	0.461	1.0	3.2	3
			47.37	0.00	0.00	0.00				47.37	-	0.040	0.0071	0.0845	0.000	0.0	0.0	0

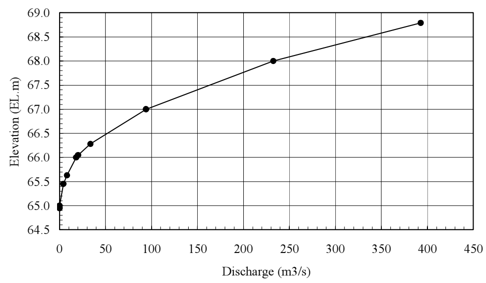
Discharge Rating Curve at NS-R4



HYDRAULIC PROPERTIES AT NS-R5

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1			68.79	2.76	2.50	33.90	2.206	23.73	74.77	0.79	3.84	0.040	0.0154	0.1240	1.695	5.3	74.8	393
2			68.00	3.49	3.16	28.64	1.782	24.36	51.04	1.00	3.05	0.040	0.0154	0.1240	1.470	4.6	51.0	232.6
3			67.00	2.51	2.28	21.99	1.213	13.61	26.68	0.72	2.05	0.040	0.0154	0.1240	1.137	3.5	26.7	94.1
4			66.28	0.80	0.32	17.20	0.760	3.71	13.07	0.23	1.33	0.040	0.0154	0.1240	0.832	2.6	13.1	33.7
5			66.05	0.79	0.07	16.08	0.582	0.76	9.36	0.05	1.10	0.040	0.0154	0.1240	0.697	2.2	9.4	20.2
6			66.00	5.87	0.51	15.22	0.565	4.32	8.60	0.37	1.05	0.040	0.0154	0.1240	0.683	2.1	8.6	18.2
7			65.63	0.45	0.25	8.83	0.484	1.49	4.27	0.18	0.68	0.040	0.0154	0.1240	0.616	1.9	4.3	8.2
8			65.45	1.11	3.34	8.14	0.342	2.62	2.78	0.45	0.50	0.040	0.0154	0.1240	0.489	1.5	2.8	4.2
9			65.00	0.10	0.30	3.68	0.042	0.14	0.16	0.04	0.05	0.040	0.0154	0.1240	0.121	0.4	0.2	0.1
10			64.96	0.02	3.26	3.28	0.005	0.02	0.02	0.01	0.01	0.040	0.0154	0.1240	0.029	0.1	0.0	0.0
11			64.95	0.00	0.00	0.00			0	64.95	-	0.040	0.0154	0.1240	0.000	0.0	0.0	0.0

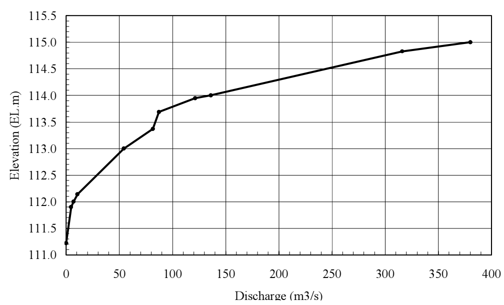
Discharge Rating Curve at NS-R5



HYDRAULIC PROPERTIES AT NS-R6

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Adjust (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	91.70	116.30	116.30	1.02	5.33		123.88	2.220	35.75	275.07	0.30	5.08	0.040	0.0083	0.0913	1.702	3.9	275.1	1,068
2	65.62	114.83	116.00	3.41	17.77		117.53	2.036	105.52	239.32	1.00	4.78	0.040	0.0083	0.0913	1.607	3.7	239.3	877
3	41.94	113.35	115.00	0.58	3.02		96.35	1.389	15.85	133.80	0.17	3.78	0.040	0.0083	0.0913	1.245	2.8	133.8	380
4	10.87	113.95	114.83	2.83	13.31	40.67	92.75	1.272	69.27	117.95	0.83	3.61	0.040	0.0083	0.0913	1.174	2.7	118.0	316
5	7.87	112.14	114.00	0.17	0.80		35.94	1.355	3.75	48.68	0.05	2.78	0.040	0.0083	0.0913	1.224	2.8	48.7	136
6	0.00	111.22	113.95	0.89	0.50		34.97	1.285	8.64	44.93	0.26	2.73	0.040	0.0083	0.0913	1.182	2.7	44.9	121
7	-6.62	111.90	113.69	13.33	0.62		33.58	1.081	8.18	36.29	0.32	2.47	0.040	0.0083	0.0913	1.053	2.4	36.3	87
8	-8.84	113.37	113.37	0.67	0.72		19.63	1.433	6.72	28.11	0.37	2.15	0.040	0.0083	0.0913	1.271	2.9	28.1	82
9	-22.17	113.69	113.00	1.56	1.66		18.24	1.173	13.94	21.40	0.86	1.78	0.040	0.0083	0.0913	1.112	2.5	21.4	54
10	-32.18	116.76	112.14	0.25	1.21		15.01	0.497	1.98	7.46	0.14	0.92	0.040	0.0083	0.0913	0.627	1.4	7.5	11
11	-52.25	127.95	112.00	0.18	0.86		13.55	0.404	1.29	5.48	0.10	0.78	0.040	0.0083	0.0913	0.547	1.2	5.5	7
12			111.90	6.65	5.86		12.51	0.335	4.19	4.19	0.68	0.68	0.040	0.0083	0.0913	0.482	1.1	4.2	5
			111.22	0.00	0.00				0.00	0							0	0	0

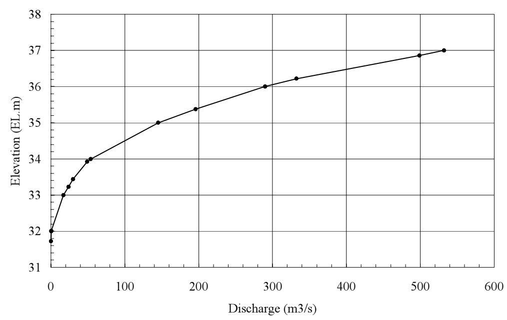
Discharge Rating Curve at NS-6



HYDRAULIC PROPERTIES AT DH-R1

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	56.99	39.82	39.52	2.59	3.16	114.75	3.740	57.48	429.22	0.52	7.80	0.040	0.00444	0.0666	2.410	4.0	429.2	1,723
2	35.39	36.22	39.00	4.98	6.08	109.00	3.410	102.27	371.74	1.00	7.28	0.040	0.00444	0.0666	2.266	3.8	371.7	1,403
3	23.65	35.38	38.00	2.04	2.49	97.94	2.751	38.79	269.47	0.41	6.28	0.040	0.00444	0.0666	1.964	3.3	269.5	881
4	15.39	33.92	37.59	12.67	3.59	93.41	2.470	49.72	230.69	0.59	5.87	0.040	0.00444	0.0666	1.827	3.0	230.7	702
5	7.55	33.23	37.00	3.01	0.85	77.15	2.346	10.40	180.97	0.14	5.28	0.040	0.00444	0.0666	1.765	2.9	181.0	532
6	3.33	32.00	36.86	4.84	3.89	73.29	2.327	43.53	170.57	0.64	5.14	0.040	0.00444	0.0666	1.756	2.9	170.6	499
7	0.00	31.72	36.22	1.66	3.08	64.56	1.968	13.49	127.04	0.22	4.50	0.040	0.00444	0.0666	1.570	2.6	127.0	332
8	-4.14	32.01	36.00	4.68	8.69	59.82	1.898	32.44	113.55	0.62	4.28	0.040	0.00444	0.0666	1.533	2.6	113.5	290
9	-7.49	33.44	35.38	2.87	2.18	46.44	1.746	16.40	81.11	0.38	3.66	0.040	0.00444	0.0666	1.450	2.4	81.1	196
10	-33.10	36.86	35.00	7.55	5.75	41.39	1.563	34.10	64.70	1.00	3.28	0.040	0.00444	0.0666	1.347	2.2	64.7	145
11	-48.76	37.59	34.00	0.60	0.46	28.09	1.090	2.16	30.61	0.08	2.28	0.040	0.00444	0.0666	1.059	1.8	30.6	54
12	-58.17	39.52	33.92	3.63	5.47	27.03	1.052	10.54	28.45	0.48	2.20	0.040	0.00444	0.0666	1.035	1.7	28.4	49
			33.44	0.53	2.40	17.93	0.999	3.36	17.91	0.21	1.72	0.040	0.00444	0.0666	0.999	1.7	17.9	30
			33.23	0.59	0.82	15.00	0.970	3.19	14.55	0.23	1.51	0.040	0.00444	0.0666	0.980	1.6	14.6	24
			33.00	2.52	3.54	13.59	0.836	10.26	11.36	0.99	1.28	0.040	0.00444	0.0666	0.887	1.5	11.4	17
			32.01	0.14	0.04	7.53	0.146	0.07	1.10	0.01	0.29	0.040	0.00444	0.0666	0.277	0.5	1.1	0.5
			32.00	4.01	3.34	7.35	0.140	1.03	1.03	0.28	0.28	0.040	0.00444	0.0666	0.269	0.4	1.0	0.5
			31.72			0.00			0		-	0.040	0.00444	0.0666	0.000	0.0	0.0	0.0

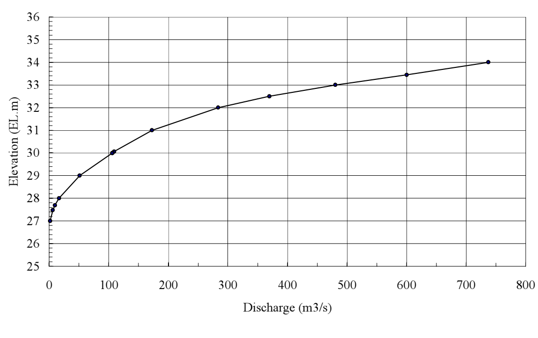
Discharge Rating Curve at DH-R1



HYDRAULIC PROPERTIES AT DH-R2

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	91.19	36.58	36.57	0.33	15.41	167.72	3.01	6.28	504.27	0.04	10.27	0.040	0.0059	0.0767	2.083	4.0	504.3	2,014
2	71.93	36.53	36.53	4.41	13.55	151.97	3.28	74.31	497.99	0.53	10.23	0.040	0.0059	0.0767	2.206	4.2	498.0	2,106.1
3	51.24	35.72	36.00	2.33	7.16	134.02	3.16	35.43	423.68	0.28	9.70	0.040	0.0059	0.0767	2.154	4.1	423.7	1,749.5
4	29.19	32.50	35.72	5.98	4.98	124.53	3.12	83.77	388.25	0.72	9.42	0.040	0.0059	0.0767	2.134	4.1	388.3	1,588.4
5	9.44	29.99	35.00	4.74	3.95	113.56	2.68	60.77	304.48	0.57	8.70	0.040	0.0059	0.0767	1.930	3.7	304.5	1,126.5
6	3.98	27.48	34.43	13.87	0.83	104.88	2.32	11.40	243.71	0.12	8.13	0.040	0.0059	0.0767	1.754	3.4	243.7	819.6
7	0.00	26.30	34.31	6.74	2.15	90.18	2.58	25.79	232.31	0.31	8.01	0.040	0.0059	0.0767	1.879	3.6	232.3	836.9
8	-4.51	27.69	34.00	11.95	3.81	81.30	2.54	39.01	206.52	0.55	7.70	0.040	0.0059	0.0767	1.862	3.6	206.5	737.0
9	-6.92	30.06	33.45	3.37	3.11	65.55	2.56	26.93	167.51	0.45	7.15	0.040	0.0059	0.0767	1.869	3.6	167.5	600.3
10	-9.18	31.00	33.00	3.75	3.46	59.06	2.38	26.54	140.58	0.50	6.70	0.040	0.0059	0.0767	1.783	3.4	140.6	480.4
11	-27.37	33.45	32.50	3.75	3.96	51.85	2.20	22.84	114.04	0.50	6.20	0.040	0.0059	0.0767	1.691	3.2	114.0	369.7
12	-46.0392	34.31	32.00	7.49	7.93	44.14	2.07	34.21	91.20	1.00	5.70	0.040	0.0059	0.0767	1.622	3.1	91.2	283.6
13	-59.9068	34.43	31.00	2.45	7.45	28.72	1.98	20.44	56.99	0.94	4.70	0.040	0.0059	0.0767	1.579	3.0	57.0	172.5
14	-77.565	36.57	30.06	0.09	0.48	18.82	1.94	1.00	36.55	0.06	3.76	0.040	0.0059	0.0767	1.557	3.0	36.6	109.1
			30.00	0.01	0.08	18.26	1.95	0.16	35.55	0.01	3.70	0.040	0.0059	0.0767	1.560	3.0	35.6	106.3
			29.99	1.41	2.37	18.16	1.95	14.56	35.39	0.99	3.69	0.040	0.0059	0.0767	1.560	3.0	35.4	105.8
			29.00	1.43	2.39	14.38	1.45	11.53	20.83	1.00	2.70	0.040	0.0059	0.0767	1.280	2.5	20.8	51.1
			28.00	0.44	0.74	10.56	0.88	2.93	9.29	0.31	1.70	0.040	0.0059	0.0767	0.918	1.8	9.3	16.4
			27.69	0.71	0.50	9.37	0.68	1.76	6.37	0.21	1.39	0.040	0.0059	0.0767	0.773	1.5	6.4	9.4
			27.48	1.63	1.69	8.16	0.56	2.99	4.61	0.48	1.18	0.040	0.0059	0.0767	0.683	1.3	4.6	6.0
			27.00	2.38	2.46	4.84	0.34	1.62	1.62	0.70	0.70	0.040	0.0059	0.0767	0.482	0.9	1.6	1.5
			26.30	0.00	0.00	0.00			0.00									

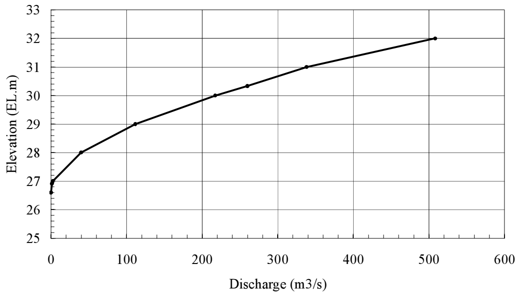
Discharge Rating Curve at DH-R2



HYDRAULIC PROPERTIES AT DH-R3

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	98.98	34.73	34.73	2.71	48.99	122.82	2.596	66.64	318.80	0.71	8.13	0.040	0.0053	0.0729	1.889	3.4	318.8	1,097.9
2	49.99	34.02	34.02	0.08	0.18	71.12	3.546	1.36	252.15	0.02	7.42	0.040	0.0053	0.0729	2.325	4.2	252.2	1,069.1
3	16.46	30.33	34.00	1.79	4.30	70.86	3.539	30.46	250.80	0.47	7.40	0.040	0.0053	0.0729	2.322	4.2	250.8	1,062.1
4	8.29	26.91	33.53	0.92	4.84	64.77	3.402	31.28	220.33	0.53	6.93	0.040	0.0053	0.0729	2.262	4.1	220.3	908.7
5	0.00	26.60	33.00	1.74	9.14	59.01	3.204	50.99	189.05	1.00	6.40	0.040	0.0053	0.0729	2.173	4.0	189.0	749.2
6	-6.87	26.93	32.00	1.74	9.14	48.13	2.869	40.48	138.06	1.00	5.40	0.040	0.0053	0.0729	2.019	3.7	138.1	508.3
7	-16.28	33.53	31.00	1.17	6.12	37.24	2.620	21.24	97.59	0.67	4.40	0.040	0.0053	0.0729	1.901	3.5	97.6	338.2
8	-22.49	35.22	30.33	0.57	0.85	29.95	2.549	9.09	76.35	0.33	3.73	0.040	0.0053	0.0729	1.866	3.4	76.3	259.8
9	-50.06	35.72	30.00	1.74	2.59	28.52	2.358	25.01	67.25	1.00	3.40	0.040	0.0053	0.0729	1.771	3.2	67.3	217.2
			29.00	1.74	2.59	24.19	1.746	21.20	42.24	1.00	2.40	0.040	0.0053	0.0729	1.450	2.6	42.2	111.7
			28.00	1.74	2.59	19.86	1.059	17.38	21.04	1.00	1.40	0.040	0.0053	0.0729	1.039	1.9	21.0	39.9
			27.00	0.12	0.18	15.53	0.236	1.07	3.66	0.07	0.40	0.040	0.0053	0.0729	0.381	0.7	3.7	2.5
			26.93	0.42	0.05	15.23	0.170	0.30	2.59	0.02	0.33	0.040	0.0053	0.0729	0.307	0.6	2.6	1.4
			26.91	6.46	8.30	14.76	0.155	2.29	2.29	0.31	0.31	0.040	0.0053	0.0729	0.288	0.5	2.3	1.2
			26.60	0.00	0.00	0.00		0.00	0.00	#REF!	-	0.040	0.0053	0.0729	0.000	0.0	0.0	0.0

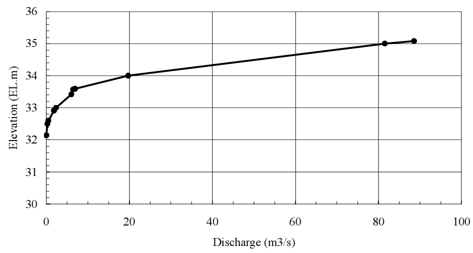
Discharge Rating Curve at DH-R3



HYDRAULIC PROPERTIES AT DH-R4

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	17.51	35.08	35.08	0.32	0.58	34.24	1.31	2.63	44.84	0.08	2.94	0.040	0.0044	0.0660	1.197	2.0	44.8	88.6
2	6.77	33.59	35.00	3.96	7.28	33.35	1.27	26.92	42.21	1.00	2.86	0.040	0.0044	0.0660	1.170	1.9	42.2	81.5
3	2.20	32.91	34.00	1.63	2.98	22.10	0.69	7.85	15.28	0.41	1.86	0.040	0.0044	0.0660	0.782	1.3	15.3	19.7
4	1.18	32.50	33.59	0.08	0.14	17.49	0.43	0.34	7.44	0.02	1.45	0.040	0.0044	0.0660	0.565	0.9	7.4	6.9
5	0.00	32.14	33.57	7.38	1.02	17.28	0.41	1.87	7.10	0.15	1.43	0.040	0.0044	0.0660	0.553	0.9	7.1	6.5
6	-1.95	32.60	33.42	0.55	2.85	8.87	0.59	2.81	5.23	0.42	1.28	0.040	0.0044	0.0660	0.703	1.2	5.2	6.1
7	-2.64	33.42	33.00	0.12	0.61	5.47	0.44	0.43	2.43	0.09	0.86	0.040	0.0044	0.0660	0.582	1.0	2.4	2.3
8	-10.03	33.57	32.91	0.41	0.83	4.74	0.42	1.21	2.00	0.31	0.77	0.040	0.0044	0.0660	0.562	0.9	2.0	1.9
9	-17.20	35.44	32.60	0.44	0.27	3.50	0.23	0.30	0.79	0.10	0.46	0.040	0.0044	0.0660	0.371	0.6	0.8	0.5
			32.50	1.57	1.23	2.80	0.17	0.49	0.49	0.36	0.36	0.040	0.0044	0.0660	0.312	0.5	0.5	0.3
			32.14	0.00	0.00	0.00			0									0.0

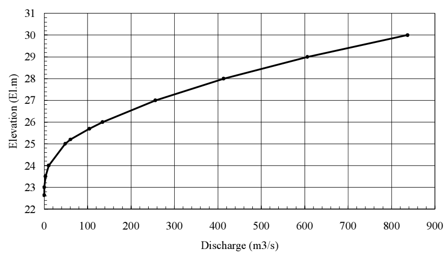
Discharge Rating Curve at DH-R4



HYDRAULIC PROPERTIES AT DH-R5

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	100.60	33.34	33.09	0.18	9.29	100.85	3.004	7.95	302.94	0.09	10.45	0.040	0.0074	0.0857	2.082	4.5	302.9	1,351.7
2	50.05	32.85	33.00	0.30	15.48	91.39	3.228	11.37	294.99	0.15	10.36	0.040	0.0074	0.0857	2.184	4.7	295.0	1,380.9
3	23.13	31.48	32.85	1.70	16.72	75.61	3.751	50.01	283.62	0.85	10.21	0.040	0.0074	0.0857	2.414	5.2	283.6	1,467.6
4	8.23	25.69	32.00	1.04	10.23	57.18	4.085	22.98	233.62	0.52	9.36	0.040	0.0074	0.0857	2.556	5.5	233.6	1,279.6
5	5.18	22.64	31.48	0.48	0.66	45.91	4.588	9.15	210.64	0.24	8.84	0.040	0.0074	0.0857	2.761	5.9	210.6	1,246.5
6	0.00	23.50	31.24	0.25	0.66	44.77	4.501	8.94	201.49	0.24	8.60	0.040	0.0074	0.0857	2.726	5.8	201.5	1,177.2
7	-13.54	25.20	31.00	1.03	2.76	43.86	4.390	35.50	192.55	1.00	8.36	0.040	0.0074	0.0857	2.681	5.7	192.6	1,106.5
8	-15.08	31.24	30.00	1.03	2.76	40.07	3.920	32.67	157.05	1.00	7.36	0.040	0.0074	0.0857	2.486	5.3	157.1	836.8
9	-18.29	33.09	29.00	1.03	2.76	36.27	3.429	29.84	124.38	1.00	6.36	0.040	0.0074	0.0857	2.274	4.9	124.4	606.2
10	-49.82	33.33	28.00	1.03	2.76	32.48	2.910	27.02	94.54	1.00	5.36	0.040	0.0074	0.0857	2.038	4.4	94.5	413.1
11	-100.30	32.51	27.00	1.03	2.76	28.69	2.354	24.19	67.52	1.00	4.36	0.040	0.0074	0.0857	1.769	3.8	67.5	256.1
12			26.00	0.32	0.86	24.90	1.740	6.92	43.33	0.31	3.36	0.040	0.0074	0.0857	1.447	3.1	43.3	134.4
			25.69	0.51	0.69	23.72	1.535	10.58	36.41	0.49	3.05	0.040	0.0074	0.0857	1.331	2.9	36.4	103.8
			25.20	1.61	0.28	22.52	1.147	4.08	25.83	0.20	2.56	0.040	0.0074	0.0857	1.096	2.3	25.8	60.6
			25.00	8.03	1.41	20.63	1.054	15.01	21.75	1.00	2.36	0.040	0.0074	0.0857	1.036	2.2	21.7	48.3
			24.00	4.01	0.71	11.19	0.602	4.14	6.74	0.50	1.36	0.040	0.0074	0.0857	0.713	1.5	6.7	10.3
			23.50	3.05	0.71	6.47	0.402	2.14	2.60	0.50	0.86	0.040	0.0074	0.0857	0.544	1.2	2.6	3.0
			23.00	2.20	0.51	2.71	0.168	0.46	0.46	0.36	0.36	0.040	0.0074	0.0857	0.305	0.7	0.5	0.3
			22.64	0.00	0.00	0.00		0.00	0.00			0.040	0.0074	0.0857	0.000	0.0	0.0	0.0

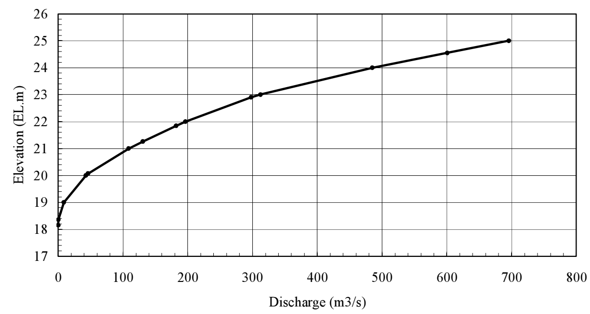
Discharge Rating Curve at DH-R5



HYDRAULIC PROPERTIES AT DH-R6

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	91.48	25.23	25.32	1.39	2.32	64.21	3.64	19.23	233.83	0.32	7.17	0.040	0.0031	0.0558	2.367	3.3	233.8	771.7
2	65.97	25.49	25.00	1.95	3.26	60.50	3.55	25.06	214.60	0.45	6.85	0.040	0.0031	0.0558	2.326	3.2	214.6	695.9
3	41.58	25.57	24.55	2.39	1.86	55.29	3.43	28.10	189.54	0.55	6.40	0.040	0.0031	0.0558	2.273	3.2	189.5	600.8
4	32.66	25.46	24.00	4.34	3.38	51.04	3.16	45.30	161.44	1.00	5.85	0.040	0.0031	0.0558	2.155	3.0	161.4	485.0
5	26.14	24.55	23.00	0.43	0.34	43.32	2.68	4.12	116.14	0.10	4.85	0.040	0.0031	0.0558	1.930	2.7	116.1	312.5
6	20.81	22.90	22.90	3.91	5.16	42.55	2.63	32.75	112.02	0.90	4.75	0.040	0.0031	0.0558	1.907	2.7	112.0	297.8
7	14.83	21.84	22.00	0.69	0.92	33.48	2.37	4.99	79.27	0.16	3.85	0.040	0.0031	0.0558	1.776	2.5	79.3	196.3
8	11.03	20.07	21.84	2.52	1.37	31.87	2.33	16.54	74.28	0.58	3.69	0.040	0.0031	0.0558	1.758	2.5	74.3	182.1
9	0.00	18.15	21.26	0.47	0.62	27.98	2.06	6.81	57.74	0.26	3.11	0.040	0.0031	0.0558	1.621	2.3	57.7	130.5
10	-8.70	18.36	21.00	1.69	2.20	26.89	1.89	22.34	50.93	0.93	2.85	0.040	0.0031	0.0558	1.531	2.1	50.9	108.7
11	-13.09	21.26	20.07	0.13	0.41	23.00	1.24	1.54	28.59	0.07	1.92	0.040	0.0031	0.0558	1.156	1.6	28.6	46.1
12	-30.2484	25.32	20.00	1.82	5.83	22.46	1.20	18.18	27.05	1.00	1.85	0.040	0.0031	0.0558	1.132	1.6	27.0	42.7
13	-37.9115	24.98	19.00	1.16	3.73	14.82	0.60	7.83	8.87	0.64	0.85	0.040	0.0031	0.0558	0.710	1.0	8.9	8.8
14	-56.4576	25.39	18.36	8.70	1.22	9.93	0.10	1.04	1.04	0.21	0.21	0.040	0.0031	0.0558	0.222	0.3	1.0	0.3
15	-72.6928	24.95	18.15	0.00	0.00	0.00	0.00	0.00	0.00	18.15	-	0.040	0.0031	0.0558	0.000	0.0	0.0	0.0

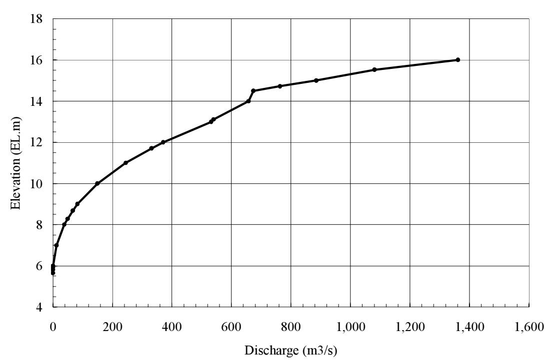
Discharge Rating Curve at DH-6



HYDRAULIC PROPERTIES AT DH-R7

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Adjust	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	178.83	23.68	23.92	12.45	4.49		311.74	8.249	275.44	2,571.51	0.92	18.27	0.040	0.00130	0.0361	4.083	3.7	2571.5	9,463.0
2	142.33	23.21	23.00	13.54	4.88		294.80	7.788	281.85	2,296.07	1.00	17.35	0.040	0.00130	0.0361	3.929	3.5	2296.1	8,132.0
3	112.09	23.62	22.00	13.54	4.88		276.39	7.288	263.58	2,014.22	1.00	16.35	0.040	0.00130	0.0361	3.759	3.4	2014.2	6,824.5
4	97.58	23.62	21.00	0.27	0.10		257.98	6.786	5.09	1,750.64	0.02	15.35	0.040	0.00130	0.0361	3.584	3.2	1750.6	5,656.1
5	96.28	15.10	20.98	11.58	4.78		257.61	6.776	241.05	1,745.55	0.98	15.33	0.040	0.00130	0.0361	3.581	3.2	1745.6	5,634.1
6	90.72	15.25	20.00	11.82	4.88		241.25	6.236	229.59	1,504.50	1.00	14.35	0.040	0.00130	0.0361	3.388	3.1	1504.5	4,594.7
7	87.33	23.81	19.00	11.82	4.88		224.55	5.678	213.04	1,274.91	1.00	13.35	0.040	0.00130	0.0361	3.183	2.9	1274.9	3,657.3
8	83.01	23.92	18.00	0.24	0.10		207.86	5.109	4.09	1,061.88	0.02	12.35	0.040	0.00130	0.0361	2.966	2.7	1061.9	2,839.2
9	53.43	17.72	17.98	0.68	1.27		207.52	5.097	52.91	1,057.79	0.26	12.33	0.040	0.00130	0.0361	2.962	2.7	1057.8	2,824.0
10	42.40	14.72	17.72	1.88	2.74		205.58	4.888	144.27	1,004.88	0.72	12.07	0.040	0.00130	0.0361	2.880	2.6	1004.9	2,608.8
11	27.12	11.71	17.00	2.60	3.81		200.96	4.282	195.15	860.61	1.00	11.35	0.040	0.00130	0.0361	2.637	2.4	860.6	2,045.7
12	14.21	8.68	16.00	1.22	1.79		194.55	3.421	89.62	665.46	0.47	10.35	0.040	0.00130	0.0361	2.270	2.0	665.5	1,361.7
13	4.73	5.93	15.53	6.20	2.02	14.66	191.54	3.006	90.38	575.84	0.53	9.88	0.040	0.00130	0.0361	2.083	1.9	575.8	1,081.2
14	0.00	5.65	15.00	3.28	1.07		168.65	2.878	46.01	485.45	0.28	9.35	0.040	0.00130	0.0361	2.023	1.8	485.5	885.4
15	-3.48	5.81	14.72	2.57	1.14		164.31	2.674	35.27	439.44	0.22	9.07	0.040	0.00130	0.0361	1.927	1.7	439.4	763.2
16	-11.42	8.29	14.50	3.44	2.59	40.87	160.60	2.517	57.33	404.17	0.50	8.85	0.040	0.00130	0.0361	1.850	1.7	404.2	674.0
17	-30.55	13.11	14.00	6.13	4.60		113.70	3.051	94.69	346.84	0.89	8.35	0.040	0.00130	0.0361	2.103	1.9	346.8	657.6
18	-65.78	12.95	13.11	0.45	0.57	36.32	102.96	2.449	7.07	252.15	0.11	7.46	0.040	0.00130	0.0361	1.817	1.6	252.2	540.0
19	-76.34	14.50	13.00	4.09	5.17		65.63	3.735	59.26	245.08	1.00	7.35	0.040	0.00130	0.0361	2.407	2.2	245.1	531.8
20	-97.74	12.83	12.00	1.19	1.50		56.36	3.297	15.49	185.82	0.29	6.35	0.040	0.00130	0.0361	2.215	2.0	185.8	371.0
21	-129.22	15.53	11.71	2.91	3.11		53.67	3.173	34.93	170.33	0.71	6.06	0.040	0.00130	0.0361	2.160	1.9	170.3	331.6
22	-139.62	13.76	11.00	4.09	4.38		47.66	2.841	42.15	135.40	1.00	5.35	0.040	0.00130	0.0361	2.006	1.8	135.4	244.8
23	-149.76	17.98	10.00	4.09	4.38		39.18	2.380	33.92	93.25	1.00	4.35	0.040	0.00130	0.0361	1.782	1.6	93.2	149.8
24	-185.10	20.98	9.00	1.31	1.40		30.71	1.932	9.12	59.32	0.32	3.35	0.040	0.00130	0.0361	1.551	1.4	59.3	82.9
25	-247.33	25.59	8.68	1.60	1.40		28.00	1.793	10.03	50.21	0.39	3.03	0.040	0.00130	0.0361	1.476	1.3	50.2	66.8
26	-269.67	24.68	8.29	0.97	1.04		25.01	1.607	6.76	40.17	0.29	2.64	0.040	0.00130	0.0361	1.372	1.2	40.2	49.7
27	-277.26	24.76	8.00	3.35	3.59		22.99	1.453	19.03	33.41	1.00	2.35	0.040	0.00130	0.0361	1.283	1.2	33.4	38.6
28	-294.14	23.72	7.00	3.35	3.59		16.05	0.896	12.38	14.38	1.00	1.35	0.040	0.00130	0.0361	0.929	0.8	14.4	12.1
29			6.00	0.23	0.25		9.11	0.219	0.62	2.00	0.07	0.35	0.040	0.00130	0.0361	0.364	0.3	2.0	0.7
30			5.93	0.40	2.03		8.63	0.160	0.89	1.38	0.12	0.28	0.040	0.00130	0.0361	0.295	0.3	1.4	0.4
			5.81	3.48	2.71		6.19	0.080	0.49	0.49	0.16	0.16	0.040	0.00130	0.0361	0.185	0.2	0.5	0.1
			5.65				0.00		0.00										0.0

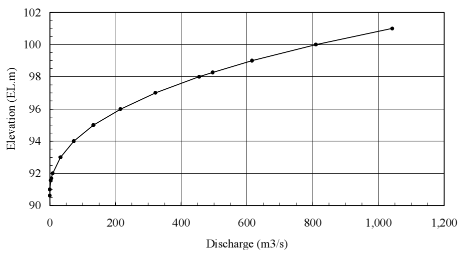
Discharge Rating Curve at DH-R7



HYDRAULIC PROPERTIES AT CE-R1

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	59.55	105.68	105.40	0.67	1.83	49.28	5.165	14.88	254.54	0.40	14.78	0.040	0.0172	0.1313	2.988	9.8	254.5	2,497
2	37.43	105.45	105.00	0.92	2.52	46.78	5.123	18.94	239.67	0.55	14.38	0.040	0.0172	0.1313	2.972	9.8	239.7	2,338
3	21.02	105.40	104.45	0.75	1.06	43.35	5.091	14.43	220.72	0.45	13.83	0.040	0.0172	0.1313	2.960	9.7	220.7	2,144
4	16.78	104.45	104.00	1.67	2.35	41.55	4.965	29.56	206.29	1.00	13.38	0.040	0.0172	0.1313	2.910	9.6	206.3	1,971
5	13.60	102.95	103.00	0.08	0.12	37.54	4.708	1.39	176.73	0.05	12.38	0.040	0.0172	0.1313	2.809	9.2	176.7	1,630
6	2.48	91.56	102.95	1.58	1.33	37.34	4.696	25.24	175.34	0.95	12.33	0.040	0.0172	0.1313	2.804	9.2	175.3	1,614
7	0.00	90.62	102.00	1.67	1.40	34.43	4.360	24.32	150.10	1.00	11.38	0.040	0.0172	0.1313	2.669	8.8	150.1	1,315
8	-1.47	91.69	101.00	1.67	1.40	31.36	4.011	22.01	125.79	1.00	10.38	0.040	0.0172	0.1313	2.524	8.3	125.8	1,042
9	-7.83	98.27	100.00	1.67	1.40	28.30	3.667	19.70	103.78	1.00	9.38	0.040	0.0172	0.1313	2.378	7.8	103.8	810
10	-17.53	105.55	99.00	1.22	1.02	25.23	3.332	12.92	84.08	0.73	8.38	0.040	0.0172	0.1313	2.231	7.3	84.1	616
11	-30.76	105.75	98.27	0.38	0.38	23.00	3.094	4.48	71.16	0.27	7.65	0.040	0.0172	0.1313	2.123	7.0	71.2	496
12	-49.49	106.25	98.00	1.39	1.40	22.25	2.997	15.36	66.68	1.00	7.38	0.040	0.0172	0.1313	2.079	6.8	66.7	455
13	-67.55	107.23	97.00	1.39	1.40	19.46	2.637	13.42	51.31	1.00	6.38	0.040	0.0172	0.1313	1.909	6.3	51.3	322
			96.00	1.39	1.40	16.67	2.273	11.48	37.89	1.00	5.38	0.040	0.0172	0.1313	1.729	5.7	37.9	215
			95.00	1.39	1.40	13.88	1.903	9.53	26.41	1.00	4.38	0.040	0.0172	0.1313	1.536	5.0	26.4	133
			94.00	1.39	1.40	11.09	1.522	7.59	16.88	1.00	3.38	0.040	0.0172	0.1313	1.323	4.3	16.9	73
			93.00	1.39	1.40	8.30	1.119	5.65	9.29	1.00	2.38	0.040	0.0172	0.1313	1.078	3.5	9.3	33
			92.00	0.43	0.43	5.52	0.660	1.36	3.64	0.31	1.38	0.040	0.0172	0.1313	0.758	2.5	3.6	9
			91.69	0.22	0.18	4.65	0.491	0.51	2.28	0.13	1.07	0.040	0.0172	0.1313	0.622	2.0	2.3	5
			91.56	0.95	1.58	4.25	0.417	1.48	1.77	0.56	0.94	0.040	0.0172	0.1313	0.558	1.8	1.8	3
			91.00	0.64	1.07	1.72	0.169	0.29	0.29	0.38	0.38	0.040	0.0172	0.1313	0.305	1.0	0.3	0.3
			90.62					0.00	0.00	0.00						0	0	0

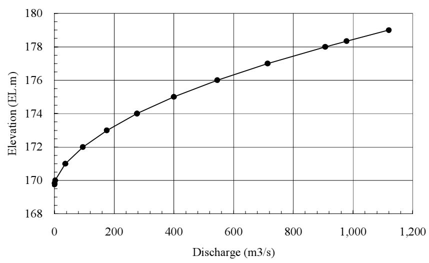
Discharge Rating Curve at CE-R1



HYDRAULIC PROPERTIES AT CE-R2

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	211.58	196.85	209.49	13.67	1.87	250.26	11.0766	107.43	2,772.0	0.49	39.83	0.040	0.02564	0.1601	4.969	19.9	2,772.0	55,140
2	150.59	205.28	209.00	23.16	3.17	234.71	11.3526	164.67	2664.58	0.83	39.34	0.040	0.02564	0.1601	5.051	20.2	2,664.6	53,880
3	89.60	213.71	208.17	3.37	0.65	208.38	11.9972	31.16	2499.92	0.17	38.51	0.040	0.02564	0.1601	5.241	21.0	2,499.9	52,446
4	55.12	204.37	208.00	5.55	1.07	204.35	12.0808	49.84	2468.76	0.28	38.34	0.040	0.02564	0.1601	5.265	21.1	2,468.8	52,032
5	31.03	195.70	207.72	3.76	2.75	197.73	12.2334	123.51	2418.91	0.72	38.06	0.040	0.02564	0.1601	5.309	21.3	2,418.9	51,411
6	8.72	178.34	207.00	5.23	3.82	191.21	12.0045	163.95	2295.40	1.00	37.34	0.040	0.02564	0.1601	5.243	21.0	2,295.4	48,175
7	3.42	169.66	206.00	5.23	3.82	182.16	11.7009	155.13	2131.45	1.00	36.34	0.040	0.02564	0.1601	5.154	20.6	2,131.5	43,977
8	0.00	169.76	205.00	3.29	2.41	173.11	11.4166	93.20	1976.32	0.63	35.34	0.040	0.02564	0.1601	5.070	20.3	1,976.3	40,113
9	-3.27	169.83	204.37	7.16	4.05	167.41	11.2488	191.45	1883.12	1.37	34.71	0.040	0.02564	0.1601	5.020	20.1	1,883.1	37,845
10	-8.89	179.91	203.00	5.23	2.95	156.20	10.8302	130.37	1691.67	1.00	33.34	0.040	0.02564	0.1601	4.895	19.6	1,691.7	33,149
11	-15.83	183.27	202.00	5.23	2.95	148.02	10.5481	122.46	1561.30	1.00	32.34	0.040	0.02564	0.1601	4.810	19.3	1,561.3	30,061
12	-21.75	186.63	201.00	3.35	1.89	139.84	10.2895	74.22	1438.83	0.64	31.34	0.040	0.02564	0.1601	4.731	18.9	1,438.8	27,248
13	-69.46	200.36	200.36	1.30	1.06	134.60	10.1383	40.43	1364.61	0.36	30.70	0.040	0.02564	0.1601	4.684	18.8	1,364.6	25,589
14	-107.23	207.72	200.00	3.62	2.95	132.23	10.0138	108.06	1324.18	1.00	30.34	0.040	0.02564	0.1601	4.646	18.6	1,324.2	24,627
15	-116.14	208.17	199.00	3.62	2.95	125.66	9.6774	101.81	1216.11	1.00	29.34	0.040	0.02564	0.1601	4.541	18.2	1,216.1	22,108
16	-152.95	209.49	198.00	3.62	2.95	119.10	9.3564	95.56	1114.30	1.00	28.34	0.040	0.02564	0.1601	4.440	17.8	1,114.3	19,807
			197.00	3.62	2.95	112.53	9.0535	89.30	1018.75	1.00	27.34	0.040	0.02564	0.1601	4.344	17.4	1,018.7	17,715
			196.00	1.08	0.89	105.96	8.7720	25.57	929.45	0.30	26.34	0.040	0.02564	0.1601	4.253	17.0	929.4	15,826
			195.70	2.53	1.14	103.98	8.6924	57.84	903.88	0.70	26.04	0.040	0.02564	0.1601	4.228	16.9	903.9	15,297
			195.00	3.62	1.63	100.31	8.4339	78.59	846.03	1.00	25.34	0.040	0.02564	0.1601	4.143	16.6	846.0	14,033
			194.00	3.62	1.63	95.07	8.0725	73.83	767.45	1.00	24.34	0.040	0.02564	0.1601	4.024	16.1	767.4	12,363
			193.00	3.62	1.63	89.82	7.7220	69.07	693.62	1.00	23.34	0.040	0.02564	0.1601	3.907	15.6	693.6	10,848
			192.00	3.62	1.63	84.58	7.3842	64.30	624.56	1.00	22.34	0.040	0.02564	0.1601	3.792	15.2	624.6	9,481
			191.00	3.62	1.63	79.34	7.0618	59.54	560.25	1.00	21.34	0.040	0.02564	0.1601	3.681	14.7	560.3	8,255
			190.00	3.62	1.63	74.09	6.7580	54.78	500.71	1.00	20.34	0.040	0.02564	0.1601	3.574	14.3	500.7	7,165
			189.00	3.62	1.63	68.85	6.4770	50.02	445.92	1.00	19.34	0.040	0.02564	0.1601	3.475	13.9	445.9	6,203
			188.00	3.62	1.63	63.60	6.2246	45.26	395.90	1.00	18.34	0.040	0.02564	0.1601	3.384	13.5	395.9	5,363
			187.00	1.34	0.60	58.36	6.0084	15.54	350.64	0.37	17.34	0.040	0.02564	0.1601	3.305	13.2	350.6	4,639
			186.63	3.30	2.65	56.42	5.9395	62.98	335.09	1.63	16.97	0.040	0.02564	0.1601	3.280	13.1	335.1	4,399
			185.00	2.03	1.63	50.46	5.3924	34.63	272.11	1.00	15.34	0.040	0.02564	0.1601	3.075	12.3	272.1	3,350
			184.00	1.48	1.19	46.81	5.0734	23.36	237.48	0.73	14.34	0.040	0.02564	0.1601	2.953	11.8	237.5	2,807
			183.27	0.62	0.44	44.14	4.8508	8.22	214.12	0.27	13.61	0.040	0.02564	0.1601	2.866	11.5	214.1	2,456
			183.00	2.29	1.63	43.08	4.7792	28.31	205.90	1.00	13.34	0.040	0.02564	0.1601	2.837	11.4	205.9	2,339
			182.00	2.29	1.63	39.16	4.5350	24.96	177.59	1.00	12.34	0.040	0.02564	0.1601	2.740	11.0	177.6	1,948
			181.00	2.29	1.63	35.24	4.3314	21.61	152.63	1.00	11.34	0.040	0.02564	0.1601	2.657	10.6	152.6	1,624
			180.00	0.21	0.15	31.32	4.1837	1.78	131.02	0.09	10.34	0.040	0.02564	0.1601	2.596	10.4	131.0	1,362
			179.91	1.04	1.48	30.96	4.1739	17.10	129.24	0.91	10.25	0.040	0.02564	0.1601	2.592	10.4	129.2	1,341
			179.00	0.76	1.07	28.44	3.9428	11.45	112.14	0.66	9.34	0.040	0.02564	0.1601	2.496	10.0	112.1	1,120
			178.34	0.39	0.40	26.61	3.7837	5.62	100.69	0.34	8.68	0.040	0.02564	0.1601	2.428	9.7	100.7	979
			178.00	1.15	1.17	25.82	3.6813	15.76	95.06	1.00	8.34	0.040	0.02564	0.1601	2.384	9.5	95.1	907
			177.00	1.15	1.17	23.51	3.3737	14.59	79.30	1.00	7.34	0.040	0.02564	0.1601	2.249	9.0	79.3	714
			176.00	1.15	1.17	21.19	3.0540	13.42	64.71	1.00	6.34	0.040	0.02564	0.1601	2.105	8.4	64.7	545
			175.00	1.15	1.17	18.87	2.7177	12.25	51.29	1.00	5.34	0.040	0.02564	0.1601	1.947	7.8	51.3	400
			174.00	1.15	1.17	16.55	2.3579	11.08	39.03	1.00	4.34	0.040	0.02564	0.1601	1.772	7.1	39.0	277
			173.00	1.15	1.17	14.24	1.9630	9.92	27.95	1.00	3.34	0.040	0.02564	0.1601	1.568	6.3	27.9	175
			172.00	1.15	1.17	11.92	1.5127	8.75	18.03	1.00	2.34	0.040	0.02564	0.1601	1.318	5.3	18.0	95
			171.00	1.15	1.17	9.60	0.9668	7.58	9.29	1.00	1.34	0.040	0.02564	0.1601	0.978	3.9	9.3	36
			170.00	0.19	0.20	7.29	0.2341	1.17	1.71	0.17	0.34	0.040	0.02564	0.1601	0.380	1.5	1.7	3
			169.83	3.27	0.08	6.89	0.0775	0.36	0.53	0.07	0.17	0.040	0.02564	0.1601	0.182	0.7	0.5	0
			169.76	3.43	0.12	3.54	0.0492	0.17	0.17	0.10	0.10	0.040	0.02564	0.1601	0.134	0.5	0.2	0
			169.66			0			0	169.66								

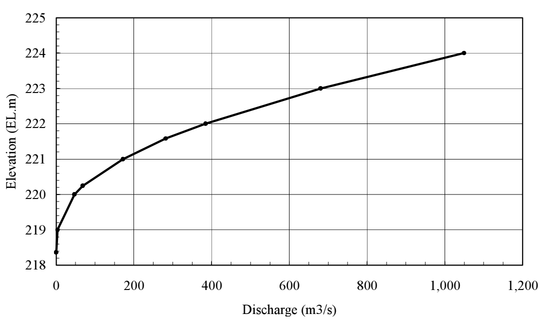
Discharge Rating Curve at CE-R2



HYDRAULIC PROPERTIES AT CE-R3

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	ΣS (m)	R (m)	Area (m^2)	ΣA (m^2)	Adusted ΣA (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	208.87	257.42	257.99	2.30	1.71	311.62	14.03	20.3	4,373.0	3,787.1	0.07	39.63	0.040	0.02857	0.1690	5.818	24.6	3,787.1	93,106
2	126.77	259.42	257.92	30.25	7.53	307.61	14.15	247.5	4,352.7	3,769.6	0.92	39.56	0.040	0.02857	0.1690	5.850	24.7	3,769.6	93,188
3	90.16	257.92	257.00	7.23	1.80	269.82	15.21	54.0	4,105.2	3,555.2	0.22	38.64	0.040	0.02857	0.1690	6.140	25.9	3,555.2	92,242
4	77.81	256.40	256.78	15.32	3.11	260.79	15.53	88.1	4,051.1	3,508.4	0.38	38.42	0.040	0.02857	0.1690	6.226	26.3	3,508.4	92,299
5	55.30	251.25	256.40	6.05	0.67	242.36	16.35	32.9	3,963.0	3,432.1	0.15	38.04	0.040	0.02857	0.1690	6.442	27.2	3,432.1	93,431
6	21.30	240.52	256.25	0.57	1.12	235.64	16.68	53.8	3,930.1	3,403.6	0.25	37.89	0.040	0.02857	0.1690	6.528	27.6	3,403.6	93,885
7	9.49	227.76	256.00	2.28	4.48	233.95	16.57	211.2	3,876.3	3,357.0	1.00	37.64	0.040	0.02857	0.1690	6.499	27.5	3,357.0	92,194
8	4.09	224.10	255.00	2.28	4.48	227.18	16.13	204.8	3,665.0	3,174.0	1.00	36.64	0.040	0.02857	0.1690	6.385	27.0	3,174.0	85,633
9	0.00	221.58	254.00	2.28	4.48	220.41	15.70	198.4	3,460.2	2,996.6	1.00	35.64	0.040	0.02857	0.1690	6.270	26.5	2,996.6	79,391
10	-13.03	218.36	253.00	2.28	4.48	213.65	15.27	192.0	3,261.8	2,824.8	1.00	34.64	0.040	0.02857	0.1690	6.154	26.0	2,824.8	73,462
11	-26.22	220.25	252.00	1.71	3.36	206.88	14.84	139.8	3,069.9	2,658.6	0.75	33.64	0.040	0.02857	0.1690	6.039	25.5	2,658.6	67,839
12	-37.6891	232.69	251.25	0.57	0.83	201.80	14.52	45.8	2,930.1	2,537.5	0.25	32.89	0.040	0.02857	0.1690	5.952	25.1	2,537.5	63,818
13	-61.3205	232.92	251.00	1.60	2.33	200.40	14.39	126.6	2,884.3	2,497.9	0.70	32.64	0.040	0.02857	0.1690	5.917	25.0	2,497.9	62,453
14	-96.0408	238.71	250.30	0.85	1.00	196.48	14.04	53.4	2,757.7	2,388.2	0.30	31.94	0.040	0.02857	0.1690	5.819	24.6	2,388.2	58,722
15	-126.689	250.3	250.00	2.83	3.32	194.63	13.89	174.3	2,704.3	2,342.0	1.00	31.64	0.040	0.02857	0.1690	5.780	24.4	2,342.0	57,196
16	-138.903	256.25	249.00	2.83	3.32	188.48	13.42	168.5	2,529.9	2,191.0	1.00	30.64	0.040	0.02857	0.1690	5.648	23.9	2,191.0	52,292
17	-160.261	256.78	248.00	2.83	3.32	182.33	12.95	162.7	2,361.4	2,045.1	1.00	29.64	0.040	0.02857	0.1690	5.515	23.3	2,045.1	47,659
18	-200.031	257.99	247.00	2.83	3.32	176.18	12.48	156.9	2,198.7	1,904.2	1.00	28.64	0.040	0.02857	0.1690	5.380	22.7	1,904.2	43,291
19	-234.9	257.21	246.00	2.83	3.32	170.03	12.01	151.1	2,041.8	1,768.3	1.00	27.64	0.040	0.02857	0.1690	5.244	22.2	1,768.3	39,184
			245.00	2.83	3.32	163.88	11.54	145.3	1,890.8	1,637.4	1.00	26.64	0.040	0.02857	0.1690	5.106	21.6	1,637.4	35,329
			244.00	2.83	3.32	157.73	11.07	139.5	1,745.5	1,511.6	1.00	25.64	0.040	0.02857	0.1690	4.966	21.0	1,511.6	31,720
			243.00	2.83	3.32	151.59	10.59	133.6	1,606.0	1,390.9	1.00	24.64	0.040	0.02857	0.1690	4.824	20.4	1,390.9	28,352
			242.00	2.83	3.32	145.44	10.12	127.8	1,472.4	1,275.1	1.00	23.64	0.040	0.02857	0.1690	4.680	19.8	1,275.1	25,217
			241.00	1.36	1.59	139.29	9.65	59.3	1,344.6	1,164.4	0.48	22.64	0.040	0.02857	0.1690	4.534	19.2	1,164.4	22,308
			240.52	1.47	0.71	136.34	9.43	63.0	1,285.3	1,113.1	0.52	22.16	0.040	0.02857	0.1690	4.463	18.9	1,113.1	20,990
			240.00	2.83	1.36	134.16	9.11	118.5	1,222.3	1,058.5	1.00	21.64	0.040	0.02857	0.1690	4.362	18.4	1,058.5	19,511
			239.00	0.82	0.40	129.97	8.49	33.7	1,103.8	955.9	0.29	20.64	0.040	0.02857	0.1690	4.163	17.6	955.9	16,814
			238.71	4.32	0.97	128.75	8.31	80.4	1,070.1	926.7	0.71	20.35	0.040	0.02857	0.1690	4.103	17.3	926.7	16,067
			238.00	6.08	1.36	123.47	8.02	107.3	989.7	857.1	1.00	19.64	0.040	0.02857	0.1690	4.005	16.9	857.1	14,506
			237.00	6.08	1.36	116.03	7.61	100.4	882.4	764.2	1.00	18.64	0.040	0.02857	0.1690	3.867	16.3	764.2	12,488
			236.00	6.08	1.36	108.58	7.20	93.4	782.0	677.3	1.00	17.64	0.040	0.02857	0.1690	3.729	15.8	677.3	10,673
			235.00	6.08	1.36	101.14	6.81	86.5	688.6	596.3	1.00	16.64	0.040	0.02857	0.1690	3.592	15.2	596.3	9,052
			234.00	6.08	1.36	93.70	6.43	79.6	602.1	521.4	1.00	15.64	0.040	0.02857	0.1690	3.456	14.6	521.4	7,615
			233.00	0.49	0.11	86.26	6.06	6.1	522.4	452.5	0.08	14.64	0.040	0.02857	0.1690	3.323	14.0	452.5	6,353
			232.92	23.63	0.31	85.66	6.03	14.6	516.4	447.2	0.23	14.56	0.040	0.02857	0.1690	3.312	14.0	447.2	6,259
			232.69	0.94	0.94	61.72	8.13	35.3	501.7	434.5	0.69	14.33	0.040	0.02857	0.1690	4.043	17.1	434.5	7,424
			232.00	1.36	1.36	59.84	7.80	49.5	466.5	404.0	1.00	13.64	0.040	0.02857	0.1690	3.932	16.6	404.0	6,711
			231.00	1.36	1.36	57.12	7.30	47.7	416.9	361.1	1.00	12.64	0.040	0.02857	0.1690	3.763	15.9	361.1	5,741
			230.00	1.36	1.36	54.39	6.79	45.9	369.2	319.8	1.00	11.64	0.040	0.02857	0.1690	3.585	15.1	319.8	4,844
			229.00	1.36	1.36	51.67	6.26	44.0	323.4	280.0	1.00	10.64	0.040	0.02857	0.1690	3.396	14.4	280.0	4,019
			228.00	0.33	0.33	48.95	5.71	10.3	279.4	241.9	0.24	9.64	0.040	0.02857	0.1690	3.194	13.5	241.9	3,265
			227.76	1.03	1.35	48.29	5.57	31.7	269.1	233.0	0.76	9.40	0.040	0.02857	0.1690	3.143	13.3	233.0	3,095
			227.00	1.36	1.78	45.91	5.17	39.6	237.4	205.6	1.00	8.64	0.040	0.02857	0.1690	2.990	12.6	205.6	2,597
			226.00	1.36	1.78	42.76	4.62	37.2	197.7	171.3	1.00	7.64	0.040	0.02857	0.1690	2.776	11.7	171.3	2,009
			225.00	1.22	1.60	39.62	4.05	31.5	160.5	139.0	0.90	6.64	0.040	0.02857	0.1690	2.541	10.7	139.0	1,493
			224.10	0.14	0.19	36.79	3.51	3.4	129.1	111.8	0.10	5.74	0.040	0.02857	0.1690	2.309	9.8	111.8	1,090
			224.00	1.36	1.91	36.47	3.45	32.3	125.7	108.9	1.00	5.64	0.040	0.02857	0.1690	2.282	9.6	108.9	1,050
			223.00	1.36	1.91	33.20	2.81	29.8	93.4	80.8	1.00	4.64	0.040	0.02857	0.1690	1.992	8.4	80.8	681
			222.00	0.57	0.80	29.93	2.12	11.8	63.6	55.0	0.42	3.64	0.040	0.02857	0.1690	1.652	7.0	55.0	384
			221.58	0.79	2.42	28.56	1.81	15.1	51.8	44.9	0.58	3.22	0.040	0.02857	0.1690	1.487	6.3	44.9	282
			221.00	1.02	3.13	25.35	1.45	17.0	36.7	31.8	0.75	2.64	0.040	0.02857	0.1690	1.280	5.4	31.8	172
			220.25	1.76	1.04	21.21	0.93	4.9	19.7	17.1	0.25	1.89	0.040	0.02857	0.1690	0.952	4.0	17.1	69
			220.00	7.05	4.17	18.40	0.81	12.6	14.8	12.8	1.00	1.64	0.040	0.02857	0.1690	0.866	3.7	12.8	47
			219.00	4.51	2.67	7.18	0.31	2.3	2.3	2.0	0.64	0.64	0.040	0.02857	0.1690	0.462	2.0	2.0	4
			218.36			0.00													0

Discharge Rating Curve at CE-R3



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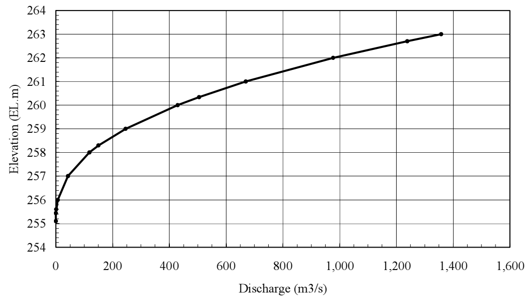
HYDRAULIC PROPERTIES AT CE-R4

	X	Y	Elevation (EL.m)	Peri-Left (m)	Adjust (m)	Peri-Right (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	87.37	273.36	273.36	0.73		9.04	171.77	5.296	56.91	909.63	0.36	18.26	0.040	0.0385	0.1961	3.038	14.9	909.6	13,549
2	57.50	272.17	273.00	1.69		20.85	162.00	5.264	117.95	852.72	0.83	17.90	0.040	0.0385	0.1961	3.026	14.8	852.7	12,651
3	30.18	271.32	272.17	0.35		5.47	139.45	5.269	21.77	734.77	0.17	17.07	0.040	0.0385	0.1961	3.028	14.8	734.8	10,908
4	17.70	264.57	272.00	1.39		21.87	133.64	5.335	77.28	713.00	0.68	16.90	0.040	0.0385	0.1961	3.053	15.0	713.0	10,673
5	9.02	260.34	271.32	0.65		0.67	110.39	5.759	32.49	635.72	0.32	16.22	0.040	0.0385	0.1961	3.213	15.8	635.7	10,014
6	1.30	255.60	271.00	2.04		2.10	109.06	5.531	99.15	603.22	1.00	15.90	0.040	0.0385	0.1961	3.127	15.3	603.2	9,250
7	0.00	255.10	270.00	2.04		2.10	104.92	4.804	95.52	504.07	1.00	14.90	0.040	0.0385	0.1961	2.847	14.0	504.1	7,036
8	-1.58	255.44	269.00	2.04		2.10	100.78	4.054	91.90	408.55	1.00	13.90	0.040	0.0385	0.1961	2.542	12.5	408.6	5,092
9	-7.32	258.30	268.00	0.31	38.25	0.32	96.64	3.277	13.47	316.65	0.15	12.90	0.040	0.0385	0.1961	2.206	10.8	316.7	3,425
10	-12.74	262.70	267.85	3.47		1.79	57.77	5.248	41.49	303.18	0.85	12.75	0.040	0.0385	0.1961	3.020	14.8	303.2	4,489
11	-17.71	265.37	267.00	4.08		2.10	52.52	4.983	43.45	261.69	1.00	11.90	0.040	0.0385	0.1961	2.917	14.3	261.7	3,743
12	-27.5167	267.85	266.00	2.57		1.32	46.34	4.710	24.39	218.24	0.63	10.90	0.040	0.0385	0.1961	2.810	13.8	218.2	3,006
13	-52.8783	267.08	265.37	0.78		0.78	42.44	4.567	13.40	193.84	0.37	10.27	0.040	0.0385	0.1961	2.753	13.5	193.8	2,616
14	-63.0418	266.31	265.00	0.91		0.90	40.88	4.414	14.93	180.45	0.43	9.90	0.040	0.0385	0.1961	2.691	13.2	180.4	2,380
15	-76.5526	273.92	264.57	1.21		1.30	39.07	4.236	18.70	165.52	0.57	9.47	0.040	0.0385	0.1961	2.618	12.8	165.5	2,125
16	-91.6942	275.73	264.00	2.11		2.28	36.56	4.015	29.73	146.82	1.00	8.90	0.040	0.0385	0.1961	2.526	12.4	146.8	1,818
17	-103.706	276.18	263.00	0.63		0.68	32.17	3.640	8.16	117.09	0.30	7.90	0.040	0.0385	0.1961	2.366	11.6	117.1	1,358
18	-112.685	274	262.70	1.11		1.60	30.85	3.531	17.82	108.93	0.70	7.60	0.040	0.0385	0.1961	2.319	11.4	108.9	1,238
19	-140.627	266.48	262.00	1.59		2.28	28.14	3.238	22.66	91.12	1.00	6.90	0.040	0.0385	0.1961	2.189	10.7	91.1	978
			261.00	1.05		1.51	24.27	2.820	13.16	68.45	0.66	5.90	0.040	0.0385	0.1961	1.996	9.8	68.5	670
			260.34	0.54		0.65	21.72	2.546	6.25	55.30	0.34	5.24	0.040	0.0385	0.1961	1.864	9.1	55.3	505
			260.00	1.59		1.91	20.53	2.389	16.45	49.05	1.00	4.90	0.040	0.0385	0.1961	1.787	8.8	49.1	430
			259.00	1.11		1.34	17.03	1.914	9.82	32.60	0.70	3.90	0.040	0.0385	0.1961	1.541	7.6	32.6	246
			258.30	0.67		0.57	14.59	1.562	3.74	22.78	0.30	3.20	0.040	0.0385	0.1961	1.346	6.6	22.8	150
			258.00	2.24		1.91	13.34	1.427	10.11	19.04	1.00	2.90	0.040	0.0385	0.1961	1.268	6.2	19.0	118
			257.00	2.24		1.91	9.19	0.971	6.48	8.92	1.00	1.90	0.040	0.0385	0.1961	0.981	4.8	8.9	43
			256.00	0.90		0.76	5.03	0.486	1.57	2.45	0.40	0.90	0.040	0.0385	0.1961	0.618	3.0	2.4	7
			255.60	0.36		0.45	3.37	0.259	0.45	0.87	0.16	0.50	0.040	0.0385	0.1961	0.406	2.0	0.9	2
			255.44	1.62		0.95	2.57	0.163	0.42	0.42	0.34	0.34	0.040	0.0385	0.1961	0.299	1.5	0.4	1
			255.10	0.00		0.00													0

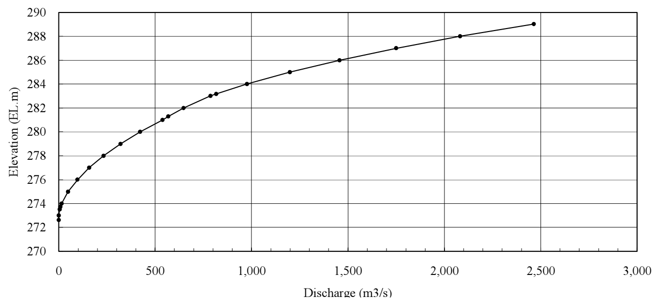
Discharge Rating Curve at CE-R4



HYDRAULIC PROPERTIES AT CE-R5

Elevation (m)	Depth (m)	Hydrailic Radius (m)				R	Area	Σ A	d	n	I	I^1/2	R^2/3	V	A	Q
		Left	Right	Total	Σ S	(m)	(m2)	(m2)						(m/s)	(m2)	(m3/s)
289.03	16.41	1.09	2.40	3.49	53.87	5.69	36.85	306.36	16.41	0.04	0.0102	0.101	3.186	8.0	306.4	2,465
288.00	15.38	1.06	2.33	3.39	50.38	5.35	33.30	269.51	15.38	0.04	0.0102	0.101	3.059	7.7	269.5	2,081
287.00	14.38	1.06	2.33	3.39	46.99	5.03	30.87	236.21	14.38	0.04	0.0102	0.101	2.934	7.4	236.2	1,750
286.00	13.38	1.06	2.33	3.39	43.60	4.71	28.43	205.34	13.38	0.04	0.0102	0.101	2.810	7.1	205.3	1,457
285.00	12.38	1.06	2.33	3.39	40.21	4.40	25.99	176.91	12.38	0.04	0.0102	0.101	2.685	6.8	176.9	1,199
284.00	11.38	0.87	1.91	2.78	36.82	4.10	19.50	150.92	11.38	0.04	0.0102	0.101	2.561	6.5	150.9	976
283.18	10.56	0.19	0.60	0.79	34.04	3.86	4.04	131.42	10.56	0.04	0.0102	0.101	2.461	6.2	131.4	817
283.00	10.38	1.06	3.32	4.38	33.25	3.83	20.39	127.38	10.38	0.04	0.0102	0.101	2.448	6.2	127.4	787
282.00	9.38	0.75	2.36	3.11	28.87	3.71	12.35	106.99	9.38	0.04	0.0102	0.101	2.395	6.0	107.0	647
281.29	8.67	0.31	0.37	0.68	25.76	3.67	4.04	94.64	8.67	0.04	0.0102	0.101	2.381	6.0	94.6	569
281.00	8.38	1.06	1.26	2.32	25.08	3.61	15.28	90.60	8.38	0.04	0.0102	0.101	2.354	5.9	90.6	539
280.00	7.38	1.06	1.26	2.32	22.76	3.31	14.17	75.32	7.38	0.04	0.0102	0.101	2.221	5.6	75.3	422
279.00	6.38	1.06	1.26	2.32	20.44	2.99	13.07	61.15	6.38	0.04	0.0102	0.101	2.076	5.2	61.2	321
278.00	5.38	1.06	1.26	2.32	18.12	2.65	11.96	48.08	5.38	0.04	0.0102	0.101	1.917	4.8	48.1	233
277.00	4.38	1.06	1.26	2.32	15.80	2.29	10.86	36.12	4.38	0.04	0.0102	0.101	1.735	4.4	36.1	158
276.00	3.38	1.06	1.26	2.32	13.48	1.87	9.75	25.26	3.38	0.04	0.0102	0.101	1.520	3.8	25.3	97
275.00	2.38	1.06	1.26	2.32	11.16	1.39	8.65	15.51	2.38	0.04	0.0102	0.101	1.245	3.1	15.5	49
274.00	1.38	0.30	0.35	0.65	8.84	0.78	2.22	6.86	1.38	0.04	0.0102	0.101	0.844	2.1	6.9	15
273.72	1.10	0.22	0.79	1.01	8.19	0.57	1.55	4.64	1.10	0.04	0.0102	0.101	0.685	1.7	4.6	8
273.51	0.89	2.21	1.91	4.12	7.18	0.43	2.53	3.09	0.89	0.04	0.0102	0.101	0.570	1.4	3.1	4
273.00	0.38	1.64	1.42	3.06	3.06	0.18	0.56	0.56	0.38	0.04	0.0102	0.101	0.322	0.8	0.6	0
272.62	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.00	0.04	0.0102	0.101	0.000	0.0	0.0	0
									0.00	0.04	0.0102	0.101	0.000	0.0	0.0	0

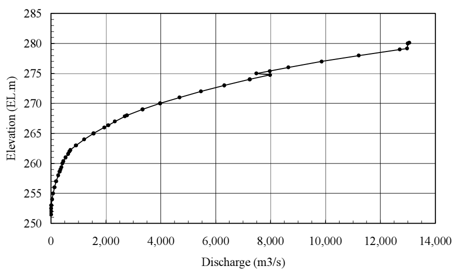
Discharge Rating Curve at CE-R5



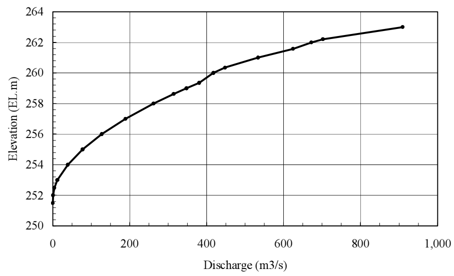
HYDRAULIC PROPERTIES AT CE-R6

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Adjust (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	97.93	279.91	280.12	4.43	0.79		192.00	7.92	20.5	1,520.9	0.12	28.63	0.040	0.00746	0.0864	3.974	8.6	1,520.9	13,051
2	78.80	280.12	280.00	30.63	5.44		186.79	8.03	124.6	1,500.5	0.83	28.51	0.040	0.00746	0.0864	4.011	8.7	1,500.5	12,995
3	48.15	275.39	279.17	0.32	1.11		150.71	9.13	22.3	1,375.9	0.17	27.68	0.040	0.00746	0.0864	4.368	9.4	1,375.9	12,977
4	23.90	262.21	279.00	1.87	6.56		149.28	9.07	126.7	1,353.5	1.00	27.51	0.040	0.00746	0.0864	4.348	9.4	1,353.5	12,708
5	16.99	261.58	278.00	1.87	6.56		140.85	8.71	118.6	1,226.8	1.00	26.51	0.040	0.00746	0.0864	4.233	9.1	1,226.8	11,214
6	12.07	260.35	277.00	1.87	6.56		132.42	8.37	110.6	1,108.2	1.00	25.51	0.040	0.00746	0.0864	4.122	8.9	1,108.2	9,863
7	5.60	259.35	276.00	1.14	4.00		123.99	8.05	63.5	997.6	0.61	24.51	0.040	0.00746	0.0864	4.015	8.7	997.6	8,649
8	3.34	253.00	275.39	0.73	0.82		118.85	7.86	39.4	934.1	0.39	23.90	0.040	0.00746	0.0864	3.953	8.5	934.1	7,973
9	0.00	251.49	275.00	0.49	0.54	17.28	117.30	7.63	26.0	894.7	0.26	23.51	0.040	0.00746	0.0864	3.875	8.4	894.7	7,486
10	-3.79	252.50	274.74	1.58	1.55		98.99	8.78	59.6	868.7	0.74	23.25	0.040	0.00746	0.0864	4.255	9.2	868.7	7,981
11	-8.90	258.63	274.00	2.14	2.09		95.86	8.44	77.3	809.1	1.00	22.51	0.040	0.00746	0.0864	4.146	9.0	809.1	7,243
12	-14.463	266.35	273.00	2.14	2.09		91.62	7.99	73.6	731.8	1.00	21.51	0.040	0.00746	0.0864	3.996	8.6	731.8	6,314
13	-21.9433	267.86	272.00	2.14	2.09		87.39	7.53	69.8	658.3	1.00	20.51	0.040	0.00746	0.0864	3.843	8.3	658.3	5,462
14	-34.9744	274.74	271.00	2.14	2.09		83.15	7.08	66.1	588.4	1.00	19.51	0.040	0.00746	0.0864	3.686	8.0	588.4	4,683
15	-43.3994	273.24	270.00	2.14	2.09		78.92	6.62	62.4	522.3	1.00	18.51	0.040	0.00746	0.0864	3.525	7.6	522.3	3,976
16	-52.2528	274.61	269.00	2.14	2.09		74.68	6.16	58.6	460.0	1.00	17.51	0.040	0.00746	0.0864	3.360	7.3	460.0	3,337
17	-59.47	279.17	268.00	0.30	0.29		70.44	5.70	7.9	401.3	0.14	16.51	0.040	0.00746	0.0864	3.190	6.9	401.3	2,764
18	-101.896	280.32	267.86	4.35	1.80		69.85	5.63	45.9	393.4	0.86	16.37	0.040	0.00746	0.0864	3.166	6.8	393.4	2,689
19	-151.971	279.98	267.00	3.28	1.36		63.70	5.46	31.3	347.6	0.65	15.51	0.040	0.00746	0.0864	3.099	6.7	347.6	2,326
			266.35	0.43	0.73		59.06	5.35	15.9	316.3	0.35	14.86	0.040	0.00746	0.0864	3.061	6.6	316.3	2,090
			266.00	1.23	2.09		57.89	5.19	43.8	300.3	1.00	14.51	0.040	0.00746	0.0864	2.997	6.5	300.3	1,943
			265.00	1.23	2.09		54.57	4.70	41.2	256.5	1.00	13.51	0.040	0.00746	0.0864	2.806	6.1	256.5	1,554
			264.00	1.23	2.09		51.24	4.20	38.7	215.3	1.00	12.51	0.040	0.00746	0.0864	2.604	5.6	215.3	1,210
			263.00	0.97	1.65		47.92	3.69	28.8	176.6	0.79	11.51	0.040	0.00746	0.0864	2.386	5.2	176.6	910
			262.21	0.26	2.31		45.29	3.26	7.2	147.8	0.21	10.72	0.040	0.00746	0.0864	2.200	4.8	147.8	702
			262.00	0.52	4.63		42.72	3.29	12.8	140.7	0.42	10.51	0.040	0.00746	0.0864	2.213	4.8	140.7	672
			261.58	0.71	2.39		37.57	3.40	15.5	127.9	0.58	10.09	0.040	0.00746	0.0864	2.262	4.9	127.9	625
			261.00	0.80	2.68		34.47	3.26	15.4	112.4	0.65	9.51	0.040	0.00746	0.0864	2.199	4.7	112.4	534
			260.35	0.43	2.29		30.99	3.13	7.3	97.0	0.35	8.86	0.040	0.00746	0.0864	2.139	4.6	97.0	448
			260.00	0.80	4.26		28.26	3.17	11.3	89.6	0.65	8.51	0.040	0.00746	0.0864	2.159	4.7	89.6	418
			259.35	0.43	0.37		23.20	3.38	5.2	78.3	0.35	7.86	0.040	0.00746	0.0864	2.251	4.9	78.3	381
			259.00	0.46	0.39		22.40	3.27	5.3	73.1	0.37	7.51	0.040	0.00746	0.0864	2.201	4.8	73.1	348
			258.63	0.82	0.67		21.55	3.15	8.7	67.8	0.63	7.14	0.040	0.00746	0.0864	2.147	4.6	67.8	314
			258.00	1.30	1.06		20.06	2.94	12.9	59.1	1.00	6.51	0.040	0.00746	0.0864	2.054	4.4	59.1	262
			257.00	1.30	1.06		17.70	2.61	11.7	46.2	1.00	5.51	0.040	0.00746	0.0864	1.895	4.1	46.2	189
			256.00	1.30	1.06		15.33	2.25	10.5	34.5	1.00	4.51	0.040	0.00746	0.0864	1.715	3.7	34.5	128
			255.00	1.30	1.06		12.97	1.84	9.3	23.9	1.00	3.51	0.040	0.00746	0.0864	1.504	3.2	23.9	78
			254.00	1.30	1.06		10.61	1.38	8.1	14.6	1.00	2.51	0.040	0.00746	0.0864	1.237	2.7	14.6	39
			253.00	0.65	1.21		8.25	0.78	3.4	6.4	0.50	1.51	0.040	0.00746	0.0864	0.848	1.8	6.4	12
			252.50	1.94	1.21		6.38	0.48	2.3	3.0	0.50	1.01	0.040	0.00746	0.0864	0.611	1.3	3.0	4
			252.00	1.98	1.24		3.22	0.24	0.8	0.8	0.51	0.51	0.040	0.00746	0.0864	0.387	0.8	0.8	1
			251.49	0.00	0.00						0	0							0

Discharge Rating Curve at CE-R6



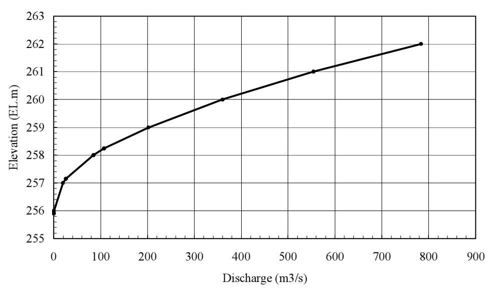
Discharge Rating Curve at CE-R6



HYDRAULIC PROPERTIES AT CE-R7

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	99.52	275.49	275.39	0.94	0.87	66.51	8.22	19.01	546.67	0.39	19.49	0.040	0.01714	0.1309	4.073	13.3	546.7	7,287
2	58.66	274.00	275.00	2.40	2.23	64.71	8.15	45.84	527.66	1.00	19.10	0.040	0.01714	0.1309	4.051	13.3	527.7	6,997
3	49.32	274.80	274.00	1.44	1.34	60.08	8.02	25.50	481.83	0.60	18.10	0.040	0.01714	0.1309	4.007	13.1	481.8	6,319
4	28.19	275.39	273.40	0.47	0.89	57.30	7.96	16.29	456.33	0.40	17.50	0.040	0.01714	0.1309	3.988	13.1	456.3	5,957
5	21.15	271.86	273.00	1.18	2.23	55.93	7.87	38.88	440.04	1.00	17.10	0.040	0.01714	0.1309	3.956	12.9	440.0	5,697
6	8.69	257.15	272.00	0.17	0.31	52.52	7.64	5.23	401.16	0.14	16.10	0.040	0.01714	0.1309	3.878	12.7	401.2	5,092
7	2.84	255.90	271.86	1.01	1.13	52.04	7.61	31.45	395.93	0.86	15.96	0.040	0.01714	0.1309	3.868	12.7	395.9	5,013
8	0.00	255.92	271.00	1.18	1.31	49.90	7.30	35.20	364.47	1.00	15.10	0.040	0.01714	0.1309	3.764	12.3	364.5	4,491
9	-7.52	258.24	270.00	1.18	1.31	47.41	6.95	33.73	329.27	1.00	14.10	0.040	0.01714	0.1309	3.640	11.9	329.3	3,923
10	-17.03	273.40	269.00	1.18	1.31	44.92	6.58	32.25	295.54	1.00	13.10	0.040	0.01714	0.1309	3.511	11.5	295.5	3,396
11	-24.46	276.81	268.00	1.18	1.31	42.43	6.21	30.78	263.29	1.00	12.10	0.040	0.01714	0.1309	3.377	11.1	263.3	2,910
12	-26.6815	276.77	267.00	1.18	1.31	39.94	5.82	29.31	232.51	1.00	11.10	0.040	0.01714	0.1309	3.236	10.6	232.5	2,463
13	-33.5554	276.84	266.00	1.18	1.31	37.45	5.43	27.83	203.20	1.00	10.10	0.040	0.01714	0.1309	3.088	10.1	203.2	2,054
14	-50.8326	276.56	265.00	1.18	1.31	34.96	5.02	26.36	175.37	1.00	9.10	0.040	0.01714	0.1309	2.931	9.6	175.4	1,682
15	-82.9918	275.55	264.00	1.18	1.31	32.47	4.59	24.89	149.01	1.00	8.10	0.040	0.01714	0.1309	2.762	9.0	149.0	1,347
16	-100.772	276.76	263.00	1.18	1.31	29.98	4.14	23.41	124.13	1.00	7.10	0.040	0.01714	0.1309	2.579	8.4	124.1	1,048
			262.00	1.18	1.31	27.49	3.66	21.94	100.71	1.00	6.10	0.040	0.01714	0.1309	2.377	7.8	100.7	783
			261.00	1.18	1.31	24.99	3.15	20.46	78.78	1.00	5.10	0.040	0.01714	0.1309	2.150	7.0	78.8	554
			260.00	1.18	1.31	22.50	2.59	18.99	58.31	1.00	4.10	0.040	0.01714	0.1309	1.887	6.2	58.3	360
			259.00	0.90	1.00	20.01	1.96	13.45	39.32	0.76	3.10	0.040	0.01714	0.1309	1.569	5.1	39.3	202
			258.24	0.81	0.31	18.12	1.43	3.99	25.87	0.24	2.34	0.040	0.01714	0.1309	1.268	4.2	25.9	107
			258.00	2.88	1.11	16.99	1.29	12.25	21.88	0.85	2.10	0.040	0.01714	0.1309	1.184	3.9	21.9	85
			257.15	0.51	0.72	12.99	0.74	1.81	9.63	0.15	1.25	0.040	0.01714	0.1309	0.819	2.7	9.6	26
			257.00	3.39	4.78	11.77	0.66	7.53	7.82	1.00	1.10	0.040	0.01714	0.1309	0.761	2.5	7.8	19
			256.00	0.27	0.38	3.59	0.08	0.26	0.29	0.08	0.10	0.040	0.01714	0.1309	0.187	0.6	0.3	0.2
			255.92	2.84	0.10	2.93	0.010	0.03	0.03	0.02	0.02	0.040	0.01714	0.1309	0.046	0.2	0.0	0.004
			255.90															0

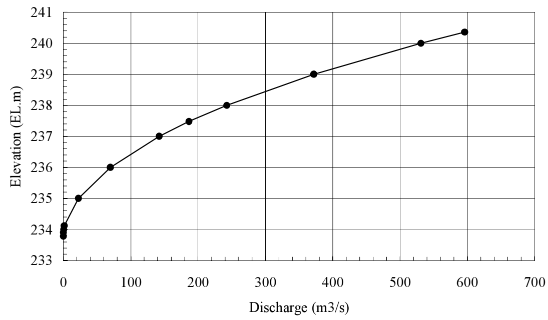
Discharge Rating Curve at CE-R7



HYDRAULIC PROPERTIES AT CE-R8

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	57.52	238.70	240.72	0.44	26.72	51.55	1.805	11.68	93.03	0.36	6.94	0.040	0.0172	0.1313	1.482	4.9	93.0	453
2	36.87	240.72	240.36	0.44	0.56	24.39	3.335	6.71	81.34	0.36	6.58	0.040	0.0172	0.1313	2.232	7.3	81.3	596
3	10.15	240.36	240.00	1.23	1.55	23.39	3.191	17.34	74.64	1.00	6.22	0.040	0.0172	0.1313	2.167	7.1	74.6	531
4	6.75	237.48	239.00	1.23	1.55	20.62	2.779	15.45	57.30	1.00	5.22	0.040	0.0172	0.1313	1.977	6.5	57.3	372
5	1.62	233.90	238.00	0.64	0.81	17.84	2.346	7.29	41.85	0.52	4.22	0.040	0.0172	0.1313	1.765	5.8	41.8	243
6	0.00	233.78	237.48	0.59	0.84	16.40	2.108	6.24	34.56	0.48	3.70	0.040	0.0172	0.1313	1.644	5.4	34.6	187
7	-4.39	234.12	237.00	1.23	1.75	14.97	1.892	11.42	28.32	1.00	3.22	0.040	0.0172	0.1313	1.530	5.0	28.3	142
8	-9.51	241.34	236.00	1.23	1.75	12.00	1.409	9.28	16.90	1.00	2.22	0.040	0.0172	0.1313	1.257	4.1	16.9	70
9	-35.95	242.75	235.00	1.08	1.54	9.02	0.845	6.39	7.62	0.88	1.22	0.040	0.0172	0.1313	0.894	2.9	7.6	22.4
10	-42.57	242.80	234.12	1.55	0.21	6.41	0.193	0.66	1.23	0.12	0.34	0.040	0.0172	0.1313	0.333	1.1	1.2	1.3
11	-63.72	243.73	234.00	1.29	0.17	4.64	0.125	0.39	0.58	0.10	0.22	0.040	0.0172	0.1313	0.249	0.8	0.6	0.5
12	-78.545	247.16	233.90	1.55	1.62	3.18	0.060	0.19	0.19	0.12	0.12	0.040	0.0172	0.1313	0.153	0.5	0.2	0.1
13	-92.0397	252.17	233.78	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.040	0.0172	0.1313	0.000	0.0	0.0	0.0

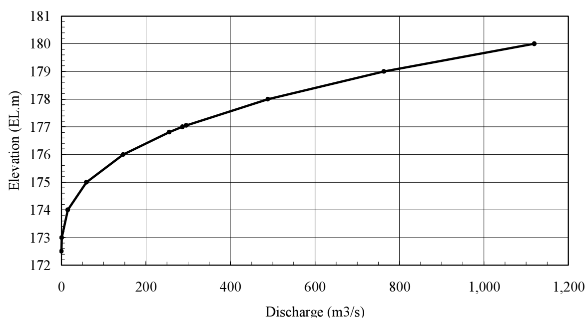
Discharge Rating Curve at CE-R8



HYDRAULIC PROPERTIES AT CE-R9

	X	Y	Elevation (EL.m)	Peri-Left (m)	Peri-Right (m)	Σ S (m)	R (m)	Area (m^2)	Σ A (m^2)	Δd (m)	d (m)	n	I	I^1/2	R^2/3	V (m/s)	A (m^2)	Q (m^3/s)
1	145.36	203.36	198.69	9.55	6.55	157.34	10.48	86.06	1,648.7	0.63	26.18	0.040	0.01429	0.1195	4.789	14.3	1,648.7	23,594
2	97.20	198.91	198.06	0.91	0.09	141.23	11.06	7.69	1,562.6	0.06	25.55	0.040	0.01429	0.1195	4.965	14.8	1,562.6	23,188
3	68.66	199.88	198.00	15.16	1.52	140.23	11.09	119.47	1,554.9	1.00	25.49	0.040	0.01429	0.1195	4.973	14.9	1,554.9	23,107
4	49.82	198.06	197.00	0.30	0.03	123.55	11.62	2.22	1,435.5	0.02	24.49	0.040	0.01429	0.1195	5.130	15.3	1,435.5	22,006
5	34.73	184.80	196.98	6.56	1.48	123.22	11.63	105.06	1,433.2	0.98	24.47	0.040	0.01429	0.1195	5.134	15.3	1,433.2	21,989
6	13.13	176.81	196.00	6.70	1.52	115.17	11.53	99.52	1,328.2	1.00	23.49	0.040	0.01429	0.1195	5.104	15.3	1,328.2	20,261
7	0.00	172.51	195.00	1.74	0.39	106.96	11.49	24.61	1,228.7	0.26	22.49	0.040	0.01429	0.1195	5.091	15.2	1,228.7	18,694
8	-12.28	177.05	194.74	1.85	1.12	104.82	11.49	68.34	1,204.1	0.74	22.23	0.040	0.01429	0.1195	5.091	15.2	1,204.1	18,318
9	-24.48	180.89	194.00	2.51	1.52	101.85	11.15	89.37	1,135.7	1.00	21.49	0.040	0.01429	0.1195	4.991	14.9	1,135.7	16,941
10	-40.05	191.46	193.00	2.51	1.52	97.83	10.70	85.93	1,046.3	1.00	20.49	0.040	0.01429	0.1195	4.854	14.5	1,046.3	15,180
11	-47.59	194.74	192.00	1.35	0.82	93.81	10.24	44.97	960.4	0.54	19.49	0.040	0.01429	0.1195	4.715	14.1	960.4	13,533
12	-62.4184	196.98	191.46	0.82	0.70	91.64	9.99	37.61	915.4	0.46	18.95	0.040	0.01429	0.1195	4.638	13.9	915.4	12,690
13	-88.2913	198.69	191.00	1.78	1.52	90.12	9.74	79.85	877.8	1.00	18.49	0.040	0.01429	0.1195	4.561	13.6	877.8	11,965
			190.00	1.78	1.52	86.83	9.19	77.24	798.0	1.00	17.49	0.040	0.01429	0.1195	4.388	13.1	798.0	10,463
			189.00	1.78	1.52	83.53	8.63	74.63	720.7	1.00	16.49	0.040	0.01429	0.1195	4.207	12.6	720.7	9,061
			188.00	1.78	1.52	80.24	8.05	72.02	646.1	1.00	15.49	0.040	0.01429	0.1195	4.017	12.0	646.1	7,757
			187.00	1.78	1.52	76.94	7.46	69.41	574.1	1.00	14.49	0.040	0.01429	0.1195	3.818	11.4	574.1	6,551
			186.00	1.78	1.52	73.64	6.85	66.80	504.7	1.00	13.49	0.040	0.01429	0.1195	3.608	10.8	504.7	5,441
			185.00	0.36	0.30	70.35	6.22	13.05	437.9	0.20	12.49	0.040	0.01429	0.1195	3.384	10.1	437.9	4,428
			184.80	1.42	2.31	69.69	6.10	50.64	424.8	0.80	12.29	0.040	0.01429	0.1195	3.337	10.0	424.8	4,237
			184.00	1.78	2.88	65.96	5.67	59.54	374.2	1.00	11.49	0.040	0.01429	0.1195	3.181	9.5	374.2	3,557
			183.00	1.78	2.88	61.30	5.13	55.36	314.7	1.00	10.49	0.040	0.01429	0.1195	2.976	8.9	314.7	2,798
			182.00	1.78	2.88	56.63	4.58	51.19	259.3	1.00	9.49	0.040	0.01429	0.1195	2.757	8.2	259.3	2,136
			181.00	0.20	0.32	51.97	4.00	5.38	208.1	0.11	8.49	0.040	0.01429	0.1195	2.522	7.5	208.1	1,568
			180.89	2.97	2.57	51.46	3.94	40.96	202.7	0.89	8.38	0.040	0.01429	0.1195	2.494	7.5	202.7	1,511
			180.00	3.33	2.88	45.93	3.52	40.46	161.8	1.00	7.49	0.040	0.01429	0.1195	2.315	6.9	161.8	1,119
			179.00	3.33	2.88	39.71	3.05	34.58	121.3	1.00	6.49	0.040	0.01429	0.1195	2.105	6.3	121.3	763
			178.00	3.17	2.74	33.50	2.59	27.40	86.7	0.95	5.49	0.040	0.01429	0.1195	1.885	5.6	86.7	489
			177.05	0.14	0.14	27.59	2.15	1.30	59.3	0.05	4.54	0.040	0.01429	0.1195	1.666	5.0	59.3	295
			177.00	0.55	0.55	27.30	2.12	4.80	58.0	0.19	4.49	0.040	0.01429	0.1195	1.653	4.9	58.0	287
			176.81	2.34	2.60	26.21	2.03	18.16	53.2	0.81	4.30	0.040	0.01429	0.1195	1.604	4.8	53.2	255
			176.00	2.88	3.21	21.27	1.65	17.21	35.1	1.00	3.49	0.040	0.01429	0.1195	1.395	4.2	35.1	146
			175.00	2.88	3.21	15.18	1.18	11.46	17.8	1.00	2.49	0.040	0.01429	0.1195	1.114	3.3	17.8	59
			174.00	2.88	3.21	9.08	0.70	5.70	6.4	1.00	1.49	0.040	0.01429	0.1195	0.791	2.4	6.4	15
			173.00	1.41	1.57	2.99	0.23	0.69	0.7	0.49	0.49	0.040	0.01429	0.1195	0.377	1.1	0.7	1
			172.51															0

Discharge Rating Curve at CE-R9



APPENDICES FOR

CHAPTER 9

SCOPING DOCUMENT NO : S-____-____

EIA FORM RRA 1-A : FIRST LEVEL SCOPING CHECKLIST FOR ENVIRONMENTAL IMPACT STATEMENTS (EIS)

Project Title : CALA-EAST WEST ROAD PROJECT
Project Location : LAGUNA-CAVITE PROVINCE
Project Proponent : DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
Address : ____
Tel.No. ____ *Fax No.* ____ *Contact Person :* ____
EIS Consultant : IN-HOUSE
Address: ____
Tel. No. ____ *Fax No.* ____ *Contact Person :* ____
Date of Scoping : SEPT. 14, 2005 Venue : ____
EMB/DENR Representative/s : ALLEN B. VILLANUEVA

GENERAL ("MUST") REQUIREMENTS

REQUIREMENT	SPECIFIC REQUIREMENTS /SPECIAL INSTRUCTIONS
Table of Contents	
Executive Summary	
➢ Brief Description of the project including project cost	✓
➢ Brief Description of the Data Gathering, scope of study, duration / period, team, methodology, documentation.	✓
➢ Brief Description of the project environment (focus on main conclusions and their basis)	✓
➢ Tabulated summary and discussion of major impacts, main mitigating measures, main components of the Environmental Management Plan, etc.	✓
➢ Tabulated Summary of the Environmental Monitoring Plan.	✓
Project Description	
➢ Basic project information – project name, proponent, address, cost, etc.	✓
➢ Project location – barangay, municipality, province, etc.; indicate geographic coordinates	✓
➢ Project Rationale (in terms of environmental, economic and social parameters in relation to nat'l economic dev't)	✓
➢ Technology and siting alternatives considered selection criteria applied	alternative routes, criteria
➢ Project Components (include Physical Plan/Site Development Map)	✓
➢ Description of Project Phases / Specific Activities - Pre-construction/Commissioning/Mobilization - Construction - Operation Process Description *(include material and energy balance-if appropriate)* - ~~Abandonment/Decommissioning~~/Demobilization	✓
Environmental Management / Monitoring Plan	
➢ Impact/s Mitigation Program	✓
➢ Detailed Monitoring Plan with Costing (amt. of EMF)	✓
➢ IEC and Social Development Program	✓
➢ Environmental Risk Management and Emergency Response Program to include designation of buffer zones	✓
➢ ~~Abandonment~~ / Rehabilitation Plan	✓ routine & periodic
➢ Institutional Plan	✓
➢ Proposed Amount of EGF/CLRF showing computation and its basis.	X
Accountability Statement from the EIS Consultants and Project Proponent	✓ Profile consultants / company
Certificate of Zoning Viability	✓ ROWA
DA Certificate of Viability for Conversion *(if in agricultural land and conversion is necessary)*	
Land Title/ Proof of Land Jurisdiction/Ownership	
PAWB Endorsement (if w/in protected area)	X
SEC Registration	X
NWRB Water Use Permit/Certificate of Water Availability	X
Review Fund	✓
Electronic File of the EIS including maps	✓

ENVIRONMENTAL IMPACT IDENTIFICATION, ASSESSMENT AND MITIGATION / MANAGEMENT										
	SCOPE OF STUDY									
	TEMPORAL SCOPE									GEOGRAPHICAL SCOPE (delineation of 1° and 2° impact areas)
ENVIRONMENTAL PARAMETER	PRE-CONST. / CONSTRUCTION PHASE			OPERATION PHASE			ABANDONMENT PHASE AND BEYOND			
	Yes	No	Remarks	Yes	No	Remarks	Yes	No	Remarks	
1. Land Features and Uses	✓			✓						
1.1. Land use	✓			✓						
1.2. Topography/ Physiography	✓			✓						
1.3. Geology/Soils	✓			✓						
1.4 Aesthetics	✓									
2. Species and Ecosystems										
2.1 Terrestrial Fauna	✓				✓					
2.2 Terrestrial Flora	✓				✓					
2.3 Aquatic Fauna	✓				✓					
2.4 Aquatic Flora	✓				✓					
3. Air and Water										
3.1 Air Quality	✓			✓						
3.2 Surface Water Quality	✓			✓						
3.3 Groundwater Quality	✗			✗						
4. Socio-Economic Considerations										
4.1 Population/Settlement/Migration	✓			✓						
4.2 Employment/Livelihood	✓			✓						
4.3 Health	✓			✓						
4.4 Cultural and Historical Value	✓		If applicable	✓		NHI				
4.5 Resource use competition	✓		agricultural aspect	✓						

SCOPING FOR (PROJECT): ____________________

PgP 09.12.05 Draft

ENVIRONMENTAL RISK ASSESSMENT (if applicable)					
RECEPTOR	Required?		SOURCE OF RISK (Hazards)	SCENARIOs TO BE CONSIDERED	METHODOLOGY*/MODEL TO BE USED
	Y	N			
People					
Socio-Economic					
Water Quality					
Air Quality					

*Essential Components of the ERA Study : System Description, hazard identification, consequence analysis, frequency analysis, risk estimation, risk management and emergency preparedness and response plan)

BASELINE ENVIRONMENTAL CONDITION				
Technical Requirements	Req'd ?		SCOPE / SPECIAL INSTRUCTIONS / MAP SCALE	ACCEPTABLE SOURCE / SAMPLING METHODOLOGY
	Y	N		
1.0 Physical Environment				
1.1 Geology			seismic design parameters for bridges	
1.1.1. Regional/General Geological Map			& flyovers	
1.1.2. Geological Cross-Sections			foundation conditions for flyovers	
1.1.3. Sequence Stratigraphic Column of Rock Units			drainage	
1.1.4. Geomorphological Map			bank protection / scouring	
1.1.5. g factor Contour Map for Rocks				
1.1.6. g factor Contour Map for Medium Soils				
1.1.7. Seismicity Map				
1.1.8. Differential Settling Hazard Map				
1.1.9. Bathymetric and Morphostructural Map				
1.1.10. Results of Petrographic and Mineragraphic Analyses				
1.1.11. Results of Geochemical Analyses of Rock Samples				

SCOPING FOR (PROJECT) : ____________________

PgP 09/12/05 Draft

BASELINE ENVIRONMENTAL CONDITION				
Technical Requirements	Req'd ? Y	Req'd ? N	SCOPE / SPECIAL INSTRUCTIONS / MAP SCALE	ACCEPTABLE SOURCE / SAMPLING METHODOLOGY
1.2 Pedology				
1.2.1. Topographic Map showing Drainage System	✓			
1.2.2. Slope and Elevation Map	✓			
1.2.3. Soil Investigation Report including maps on the following :				
• Soil Erosion	✓			
• Soils Types	✓			
• Soil Fertility	✓			
• Vegetation	✓		discussion	
1.2.4. Laboratory Results of Soil Sample Analysis		X		
1.3 Hydrology				
1.3.1. Regional Hydrogeologic Map	✓			
1.3.2. Streamflow Measurements/ Mean Monthly Flow Data	✓			
1.3.3. Flood Peaks, Volumes, frequency rating curves and Stormwater flow estimates	✓			
1.3.4. Spring and Well Inventory		X		
1.4 Oceanography				
1.4.1. Predicted Tides	N	A		
1.4.2. 24-Hour Tidal Cycles	N	A		
1.4.3. Surface Current System	N	A		
1.5 Water Quality				
1.5.1. Physico-Chemical Characteristics of Wells and Springs		X		
1.5.2. Physico-Chemical Characteristics of Inland Surface Waters	✓		MAJOR CROSSING TW	
1.5.3. Physico-Chemical Characteristics of Coastal Waters		X		
1.5.4. Bacteriological Characteristics of Wells and Springs		X		
1.5.5. Bacteriological Characteristics of Inland Surface Waters	✓		MAJOR CROSSING TW	
1.5.6. Bacteriological Characteristics of Coastal Waters		X		

SCOPING FOR (PROJECT) : ______________________

PgP 09.12.05 Draft

Appendix 9.1

BASELINE ENVIRONMENTAL CONDITION				
Technical Requirements	Req'd ?		SCOPE / SPECIAL INSTRUCTIONS / MAP SCALE	ACCEPTABLE SOURCE / SAMPLING METHODOLOGY
	Y	N		
1.5.7. Sampling Site Map	✓			
1.6 Meteorology/Climatology				
1.6.1. Monthly Average Rainfall of the Area	✓			
1.6.2. Climatological Normals/Extremes	✓			
1.6.3. Wind Rose Diagrams		X		
1.6.4. Frequency of Tropical Cyclones	✓			
1.7 Air Quality /Noise				
1.7.1. Ambient Air Quality (TSP, SO_x, NO_x, ~~PM10~~, etc.) 24-Hour Sampling	✓		existing road, new road, all alignments	
1.7.2. Noise Levels	✓			
1.7.3. Sampling Station Map (air and noise)	✓			
1.7.4. Air Dispersion Diagrams/Isophlet		X		
2.0 Biological Environment				
2.1. Vegetation, Wildlife and Insect Profile				
2.1.1. Flora and Fauna Species Inventory or Survey	✓			
2.1.2. Summary of Endemicity /Conservation Status	✓		Secondary data	
2.1.3. Summary of Abundance, Frequency and Distribution	✓			
2.1.4. Site Observation/ Transect Walk Map	✓			
2.2 Aquatic Fresh/Marine Environment				
2.2.1. Abundance/Densities/Biomass of Seagrasses/Seaweeds		X		
2.2.2. Density/Abundance of Planktonic and Benthic Algae		X		
2.2.3. Benthic Fauna Population and Density of Benthic Organisms		X		
2.2.4. List of Fish Species/Estimated Biomass	✓			
2.2.5. Ranks and Proportion of Commercially and Non-commercially Important Indicator Species	✓			
2.2.6. Seabottom Cover Map showing Coral & Seagrass Beds etc.		X		
2.2.7. Sampling Site Map	✓			

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BASELINE ENVIRONMENTAL CONDITION				
Technical Requirements	Req'd ? Y	Req'd ? N	SCOPE / SPECIAL INSTRUCTIONS / MAP SCALE	ACCEPTABLE SOURCE / SAMPLING METHODOLOGY
3.0 Socio-Economic and Cultural Environment				
3.1 Demography				
3.1.1. Settlement Map and Population Distribution Map	✓			
3.1.2. Land Use Map *(include locations of ecological, military reserves, scenic spots and areas of religious, historic and cultural significance)*	✓			
3.1.3. Population Growth Rate	✓			
3.1.4. Number of Households and Household Size by Barangay	✓			
3.1.5. Summary of Demographic data per Barangay to be directly affected: Land Area, Population, Population Density, Main Sources of Income, Sex and age Composition, Literacy, Highest Educational Attainment, Employment Status	✓		Matrix form (Summary by towns)	
3.1.6. Household Profile based on results of the Survey	✓			
3.1.7. IPs/Vulnerable Groups		✗		
3.2 Health				
3.2.1. Morbidity and Mortality Rates (Infants and Adults) from Direct Impact Areas	✓			
3.2.2. 5-Year Trend in Morbidity and Mortality	✓			
3.2.3. Notifiable Diseases in the Area including Endemic Diseases	✓			
3.2.4. Local Health Resources (Government and Private)	✓			
3.2.5. Environmental Health and Sanitation Profile: water supply, human excreta management, waste management and disposal systems and food hygiene	✓			
3.3. Other Social Services/Utilities				
3.3.1. Water Supply and Demand	✓			
3.3.2. Transportation	✓			
3.3.3. Power Supply and Demand	✓			
3.4. Public Participation and Social Acceptability				

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BASELINE ENVIRONMENTAL CONDITION				
Technical Requirements	Req'd ? Y	Req'd ? N	SCOPE / SPECIAL INSTRUCTIONS / MAP SCALE	ACCEPTABLE SOURCE / SAMPLING METHODOLOGY
3.4.1. Public Perception Survey Questionnaire and Results Summary	✓			note: methodology used
3.4.2. Endorsement / Proof of consultation with LGUs /RDC	✓		FGD included in the EIS	
3.4.3. Endorsement / Proof of consultation with NGOs / POs	✓		(minutes / summary)	
4.0 Others				
			Relocation Action Plan / Traffic Management Plan / Compensation Package / Solid Waste, Construction Spoil Program	

SCOPED BY : EIARC MEMBERS

NAME	EXPERTISE	SIGNATURE	NAME	EXPERTISE	SIGNATURE
Engr. Antonio Kaimo	Civil- Sanitary Engineering	[signature]			
Mr. Ramon Quebral	Geologist	[signature]			
Mr. Joseph Lalo	Socio-Economics	[signature]			

EIA PERSONNEL

Allen B. Villanueva
Signature over Printed name

Signature over Printed name

REPRESENTATIVE/S OF THE PROJECT PROPONENT

ALVIN R. MADRID
Signature over Printed name

Signature over Printed name

NOTED BY:

EIA Division Chief/ Chief. R&A Section

EIA CONSULTANTS:

Signature over Printed name

Signature over Printed name

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