Republic of the Philippines
DEPARTMENT OF SCIENCE AND TECHNOLOGY
Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA)

BAGONG PILIPINAS

03 January 2024

Report on:
Pagsanjan River Flow Assessment (results through river cross-sectioning activities) by PRBFFWC, NCR-PRSD, PAGASA

Activity Backgrounder:

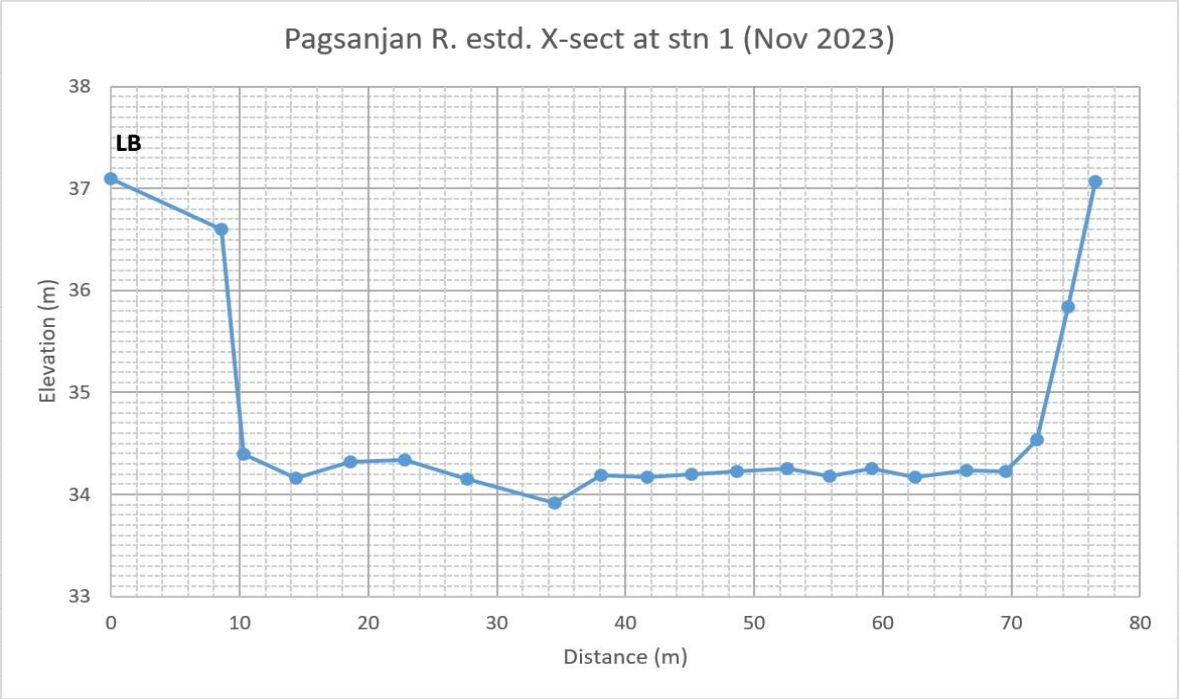
The Pampanga River Basin Flood Forecasting & Warning Center (PRBFFWC) & the National Power Corporation (NPC) personnel conducted a joint river cross-sectioning at some specific points along the Pagsanjan River (Laguna) from November 21 to 23, 2023 as per request by the latter. There were 3 river cross-sections surveyed along the said river channel and details of these are provided in the succeeding sections of this report.

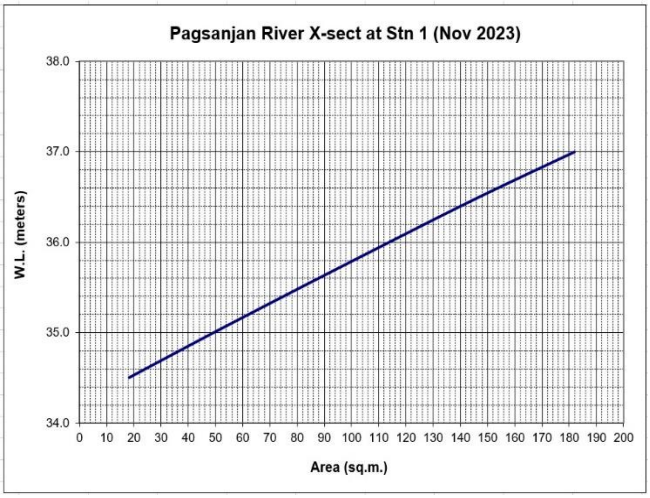
The main purpose of the undertaking was to come up with a river flood assessment levels for the Pagsanjan River based on the river cross-sections and possibly to determine the likely maximum water level and / or flow capacity that the Pagsanjan River channel can hold along its channel based on the measurement undertaking. The activity conducted was limited only to taking the river cross-sections and with a one-time stream gaging activity at 2 of the river sections during the time of the measurement proceedings.

It should be noted that the results provided herein are only initial as per available info / data gathered and may not totally represent the actual or present situation in the Pagsanjan River system. Results were limited to the measurements carried-out in the 3 stations only during the fieldwork activities, with additional other information taken (or estimated) from various sources such as the Google earth map and from those provided by the NPC personnel who supported the activity. The information herein may be revised / updated as new analyses emerges.

The River Cross-sections:
Station 1

Top pic (1): A google earth map representation of point for station 1 river section; Far left pic (2): river cross-section measurements were done through wading across the river channel; Left pic (3): the location / position of the temporary benchmark (TBM) was the ground elevation of a makeshift basketball half court located on the RB, d/s side of the measured x-sect; Below pic (4): a general view of the Pagsanjan River section as seen from the RB side of the river.



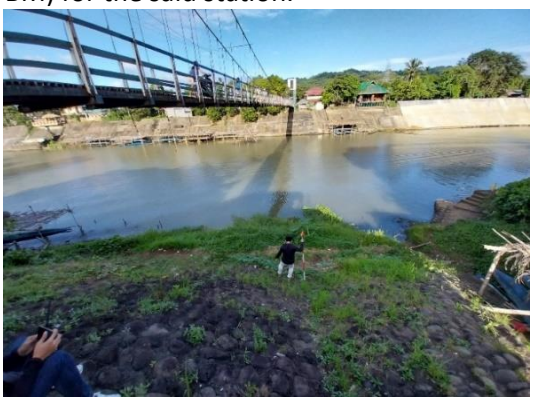


Top Figure (1): Above shows the estimated river x-section of Pagsanjan River at station 1 with the elevation of TBM reckoned from Google earth map.

Left Figure (2): The Elevation vs. Area (H-A or WL-A curve) at the said section showing a general straight line relationship.

Station 2 (Hanging Bridge)

Above pic (5) Google earth map view of Station 2 along Pagsanjan River showing the river flow (narrow arrow) direction and the estimated location (bold arrow) of the temporary bench mark (TBM) for the said station.

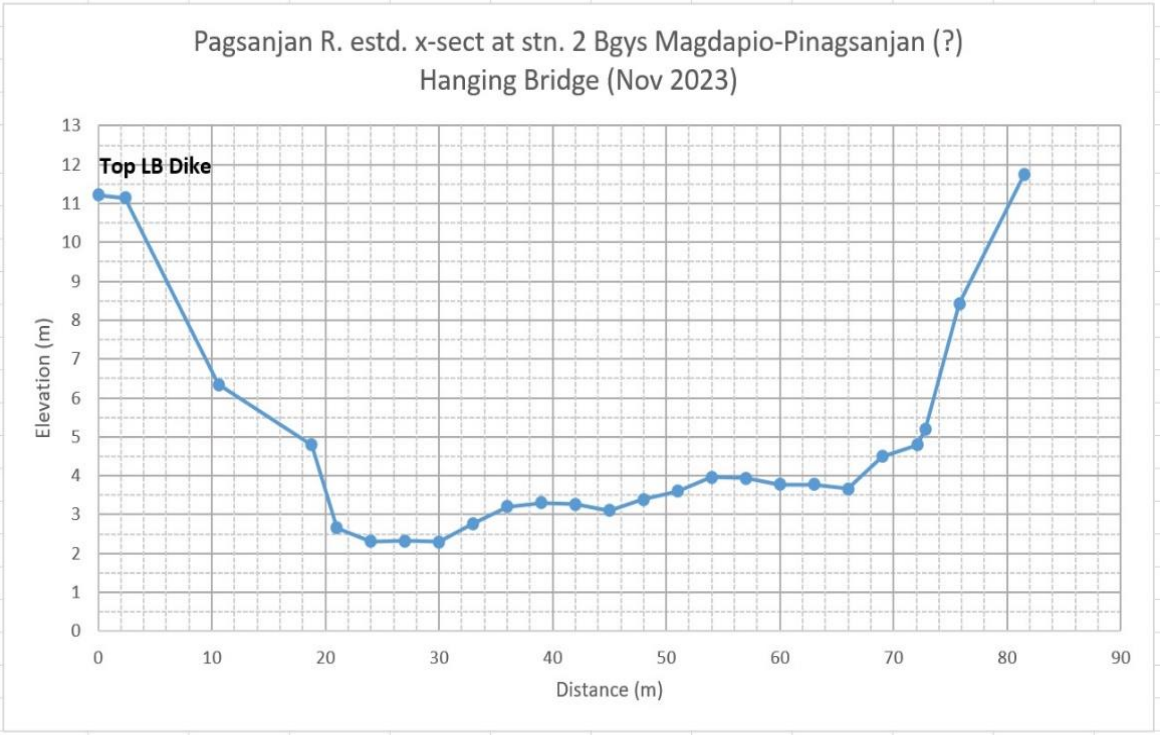


Above left pic (6) A view of the hanging bridge along the Pagsanjan River where depth sounding reference for station 2 x-sect was taken.

Above right pic (7) Shows the location of the TBM were the x-sect measurement was referred to, at the LB, u/s side of the hanging bridge.

Above right pic (8) Upstream view of the Pagsanjan River as seen from the hanging bridge (station 2)

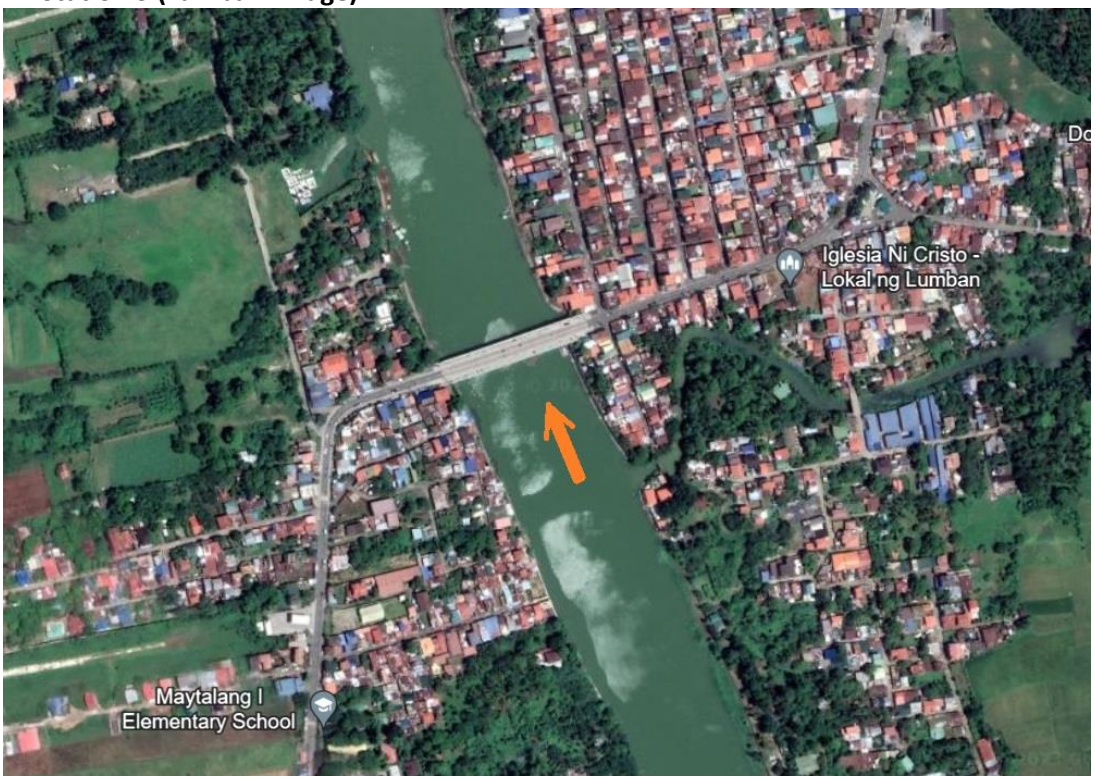
Above left pic (9) Downstream view of the Pagsanjan River as seen from the hanging bridge; note some bamboo shaded banca dock stations on both banks of the river.



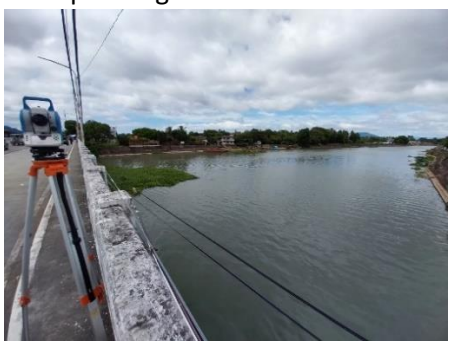
Top Figure (3): The surveyed cross-section of Pagsanjan River at station 2. The cross-section was taken at the u/s side of a hanging bridge at that river section.

Left Figure (4): The graph representing the H-A curve for the said station.

Station 3 (Lumban Bridge)



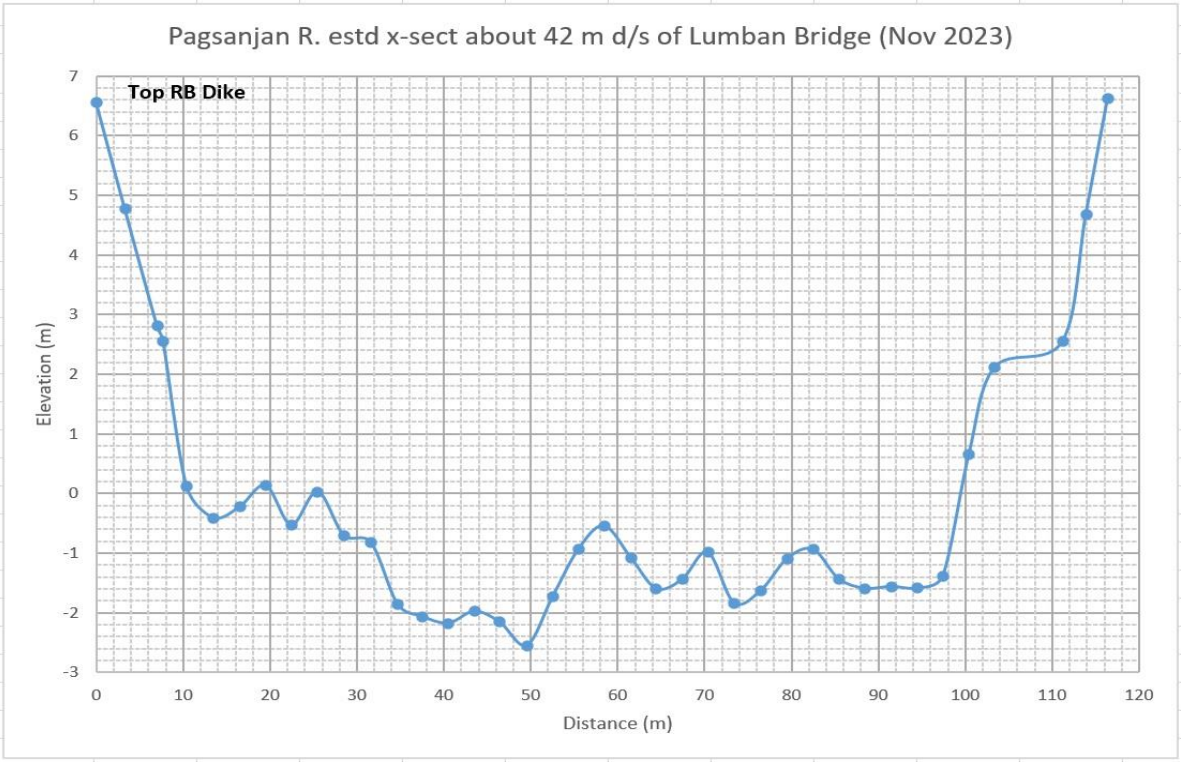
Top pic (10) Google earth view of the Pagsanjan River channel at station 3 (Lumban Bridge) with arrow pointing to the direction of river flow.

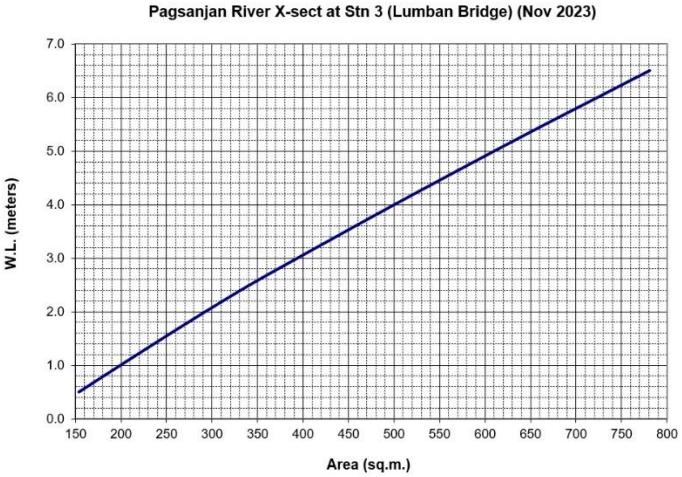


Above left pic (11) Shows the view of the LB side of the Pagsanjan river as seen at the downstream side of the Lumban Bridge.

Above middle pic (12) A general view of the RB portion of the station 3 channel as seen from the downstream side of the Lumban Bridge.

Above right pic (13) The staff gage at the Lumban Bridge situated at d/s side of one of the bridge's pier and was mentioned to be referred to MSL; the staff gage was the basis for elevation for the measured x-sect of the said station.



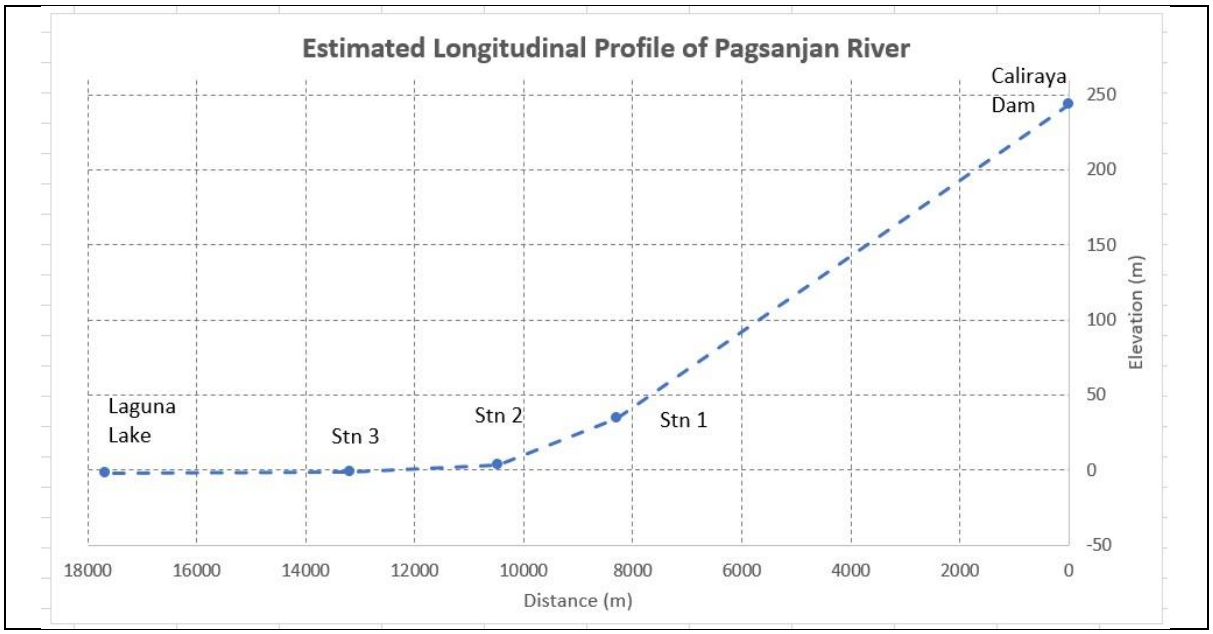


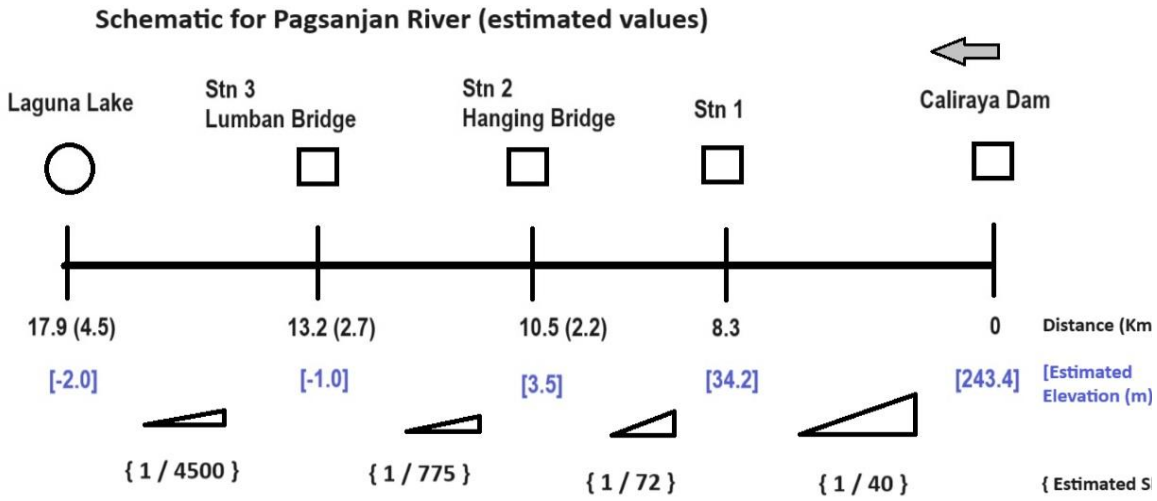
Top Figure (5): The estimated river cross-section of Pagsanjan River at station 3 (Lumban Bridge).

Left Figure (6): Shows the graph representing the estimated WL vs. Area (H-A curve) for the above surveyed cross-section.

Assessment Levels:

Figure below (7): The estimated longitudinal profile of Pagsanjan River starting from the base of Caliraya Dam down to its mouth at Laguna Lake. Most of the values provided were estimated from various sources.





Above Figure (8): The schematic diagram of the Pagsanjan River with various information showing distances (in kilometers) from Caliraya Dam down to Laguna Lake; incremental distances between stations (parenthesis); estimated river bed elevation [in blue text] and slope { } between station points. It should be noted that all the data / info mentioned in this schematic diagram are mostly estimated from various sources and are subject for further verification.

Table 1: Results based on River Cross-section per station & estimated resulting discharges:

Bridge station	Elevation (est.) at bank / dike level limit based on x-sect (m)	Remarks (lowest dike level location)	Estimated x-sect area at elevation (bank / dike level limit) (m^2)	Estimated maximum river velocity by Kraven's method (m/s)	Estimated discharge (m^3/s)
Station 1	37.0	Top of RB (no dike)	181	3.5	638
Station 2 (Hanging bridge)	11.0	Top of LB dike	490	3.5	1728
Station 3 (Lumban Bridge)	6.5	Top of RB dike	780	2.1	1663

Table 2:

Initial Assessment Levels (based on river x-sects)			
Station Bridge	Alert	Alarm	Critical
Station 1 elevation	**35.9 ***	**36.4 ****	**37 *****
estd Q (cumecs)			**638 +**
Station 2 elevation Hanging Bridge	**8.3 ***	**9.7 ****	**11.0 *****
estd Q (cumecs)			**1728 +**
Station 3 elevation Lumban Bridge	**3.85 ***	**5.1 ****	**6.5 *****
estd Q as per max Q, 60 & 80% (cumecs)	**990**	**1320**	**1650 +**
WL as per assesment of max Q (60 & 80% of max Q)	**5.0**	**5.7**	**6.5**
Basis:			
* Alert level assumes 60% of the X-sectional Area at dike level limit			
** Alarm level assumes 80% of the X-sectional Area at dike level limit			
*** Critical level assumes the estd X-sectional area at dike level limit			
+ Estimated Q values at critical level assumes the maximum velocity as rated in Kraven's method;			
lower & mid-discharges were based on 1 stream gaging measurement & from a 'combinational' eye-fit curve, respectively.			

Summary: Limitations & Analyses

There are a number of caveats which should be considered in consideration of the results presented in this report:

- First, there were only 3 river cross-sections measured along the stretch of the Pagsanjan River during the survey activities;
- 2 stream gaging, surface river velocity measurements, were performed at 2 of the stations measured, at station 2 and station 3, and such measurements were definitely considered to be at low flow conditions;
- Assumptions were made in several instances due to lack of directly measured or available data, except for the profile of the cross-sections; other information / data were gathered from various sources such as from Google earth map, from a few documents not cited in this report,

and from information provided by the NPC personnel; these data / info are as follows, e.g., elevation references, distances between stations, etc.;

- Peak velocities were mainly theoretically based. The maximum discharges presented in the assessment levels were computed using the maximum velocity as provided by Kraven's method; It should be noted that river velocity is subsequently reduced, and is related proportionately, as river stage recedes; further, based on Kraven's, the propagation time from Caliraya to station 3 (Lumban Bridge) at peak velocity is estimated to be around 1 hour and 11 minutes.
- The maximum allowable flow was based on the existing dikes measured at each x-sects, particularly for stations 2 and 3, the lowest elevation of the dike (or bank) at the measured x-section was taken for the maximum area for flow consideration;
- The suggested critical discharges (Table 2) did not consider informal settlers who are, from most of the time, situating themselves along the riverside areas of Pagsanjan River, along the river channel outside the dike protected zones. These inhabitants may already be affected by floodwaters even before the suggested critical or even at alarm level discharges had been attained at the respective x-sect points.
- Based on the foregoing bullets, the maximum pre-flood discharge along the Pagsanjan River is estimated at 1,650 cumecs at Lumban Bridge with a staff gage elevation of 6.5m as per survey proceedings. This, however, is as per x-sect measurements and can be treated as an initial starting point subject for adjustments and further modification through actual observations before, during, and after flood events; Lumban bridge was taken as the reference point since this station is the only one with a staff gage available along the Pagsanjan River.

Recommendations:

- Carry-out regular stream gauging activities (river x-sects and velocity measurements) at specific sections along the river and at various river stages with more focus on medium to higher flow regimes; to facilitate continuous measurements, it would be more convenient and as a suggestion that a fixed radar WL - discharge measuring instrument be installed in one of the sections along the river;
- Install staff gages at sectional points for a more permanent stage referencing and to be placed at locations that can be seen easily; or that water level / river gages be ubiquitously installed at riverside areas for critical level referencing and / or for purposes of possible early warning means to these areas;
- Maybe some additional or tighter x-sect measurements along the Pagsanjan River channel if possible; conduct river assessment surveys along the stretched of the river channel before, during, and after flood events for a more visual validation of flood levels at the riverside areas;
- Lastly, conduct information, education, and communication activities (IECs) at riverside barangays along the Pagsanjan River for flood hazard mitigation, prevention and risk reduction planning activities in coordination with local DRRMOs in the area.

Some pictures taken during the measurement activities (Nov 21-23, 2023)

Above pic (14) Taking river surface velocity measurements by wading along the shallow portions of Pagsanjan River in station 1.
Left pic (15) River surface velocity measurements being carried-out atop the hanging bridge in station 2.
Below left pic (16) Taking bank elevations at the LB in station 2.
Middle pic (17) Setting-up the total station for determination of x-sect elevations at station 3.
Below right pic (18) River surface velocity measurements being carried-out atop the Lumban Bridge (station 3).