Government of West Bengal
Irrigation & Waterways Department
Jalasampad Bhavan, Western Block, 3rd Floor
Bidhannagar, Kolkata- 91

Memo No. 393 -IB
IW/O/IB-Misc-14/2011 (Pt)

Date 14th February 2017

From: B. Mukhopadhyay
Deputy Secretary to the
Government of West Bengal

To : 1. The Principal Secretary
Public Works Department
Nabanna, Howrah

2. The Principal Secretary
Public Health Engineering Department
New Secretariat Building, 7th floor
1 Kiran Shankar Roy Road, Kolkata- 700 001

3. The Principal Secretary
Panchayat & Rural Development Department
Joint Administrative Building
Block- HC, Plot No. 7, Sector III
Salt Lake City, Kolkata- 700 106

4. The Principal Secretary
Water Resources Investigation & Development Department
11 Mirza Ghalib Street, Kolkata- 700 016

5. The Secretary
Urban Development & Municipal Affairs Department
Nagarayan, Block- DF-8, Sector- I
Bidhannagar, Kolkata- 700 064

6. The Chief Executive Officer
Kolkata Metropolitan Development Authority
Unnayan Bhavan, 3rd Floor, Administrative Block
DJ - 11, Scc - II, Salt Lake, Kolkata – 700 091

7. The Commissioner
Kolkata Municipal Corporation
5, S. N Banerjee Road, Kolkata – 700 013

Sir,

I am to inform that this department has prepared a guideline to be followed by other departments /organizations while submitting proposals of waterway vetting by Irrigation & Waterways Department for any structure, like bridge, culvert etc. proposed to be constructed across rivers, irrigation canals, drainage channels by that department. A copy of the aforesaid guideline is enclosed for ready reference.

Encl: As stated

(B. Mukhopadhyay)
Deputy Secretary to the
Government of West Bengal

Memo No. 393/1(9) -IB
IW/O/IB-Misc-14/2011 (Pt)

Date 14th February 2017

Copy forwarded for information and necessary action to :-

1. Chief Engineer (North)
   Irrigation & Waterways Directorate
2. Chief Engineer (South)
   Irrigation & Waterways Directorate
3. Chief Engineer (South-West)
   Irrigation & Waterways Directorate
4. Chief Engineer (North East)
   Irrigation & Waterways Directorate
5. Chief Engineer (Design & Research)
   Irrigation & Waterways Directorate
6. Chief Engineer (West)
   Irrigation & Waterways Directorate
7. Chief Engineer (Teesta Barrage Project)
   Irrigation & Waterways Directorate
8. Director of Personnel & Ex-Officio Chief Engineer
   Irrigation & Waterways Directorate
9. Sujay Saha,
   Executive Engineer
   Irrigation & Waterways Department, for uploading in departmental web link

(B. Mukhopadhyay)
Deputy Secretary to the
Government of West Bengal

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1-1A (B)

pl put up
03.02.17

Government of West Bengal
Irrigation and Waterways Directorate
Office of the Director of Designs
CENTRAL DESIGN OFFICE
JalasampadBhavan (1st floor), Bidhannagar
Kolkata - 700 091

Memo. No.1M-10/145 Dated, Kolkata, the 2nd February, 2017

From: -
Mahendra Pratap Ghosh
Director of Designs.

To: -
The Secretary to the Govt. of West Bengal,
Irrigation & Waterways Department,
JalasampadBhavan (1st Floor),
Salt Lake, Kolkata.

Sub: GUIDELINES & DATA REQUIREMENT IN CONNECTION WITH EXAMINATION OF WATERWAY OF BRIDGES, CULVERTS, ETC.

Reference: Memo No 350(8)/1(5)-IB / IW/O/IB-MISC-14/2011(Pt) Date: 11.01.2017 of I&WD, WB

Sir,

Inviting reference to above enclosed please find herewith the guidelines & data requirement in connection with examination of waterway of bridges for getting formal vetting from Irrigation & Waterways Department (Annexure I). A sample calculation for assessing the discharge is also enclosed (Annexure II). Moreover, the followings are observed when a proposal is received for formal waterway vetting which kills considerable time: -

- Most of the time the proposing departments send the proposal without authenticated hydraulic data from the concerned division of Irrigation & Waterways Department. The Long Section, Cross Section and the reference GTS/PWD B.M. are also to be certified by the field wing of I & W Dte. Authentication of hydraulic data by the concerned field division of Irrigation & Waterways Dte. is must for getting formal waterway vetting.
- In many cases the hydraulic data as received from the field division of I & W Dte do not match with the hydraulic data as spelt in the General Arrangement Drawing sent by the proposing department. For speedy disposal of work the proposing department may obtain the hydraulic data from the field division of I & W Dte. and provide waterway according to this data. A copy of this data may be sent along with the proposal to this end. Various methods for assessing the discharge is annexed in Annexure-II.
- Waterway should not be constricted. For constriction of waterway please refer para 6 (iv) page 2 of 3 of Annexure-I.

For disposal of formal vetting the above procedure may be followed.

This is for your kind information and necessary circulation among other departments / organizations for speedy disposal of the cases of waterway vetting.

Enclosure: As above.

Yours faithfully

02/02/17
Director of Designs

Memo. No.1M-10/145/1 Dated, Kolkata, the 2nd February, 2017

Copy submitted for information to The Chief Engineer (D & R), Jalasampad Bhavan (1st Floor), Salt Lake, Kolkata-700091.

02/02/17
Director of Designs

CHECKLIST

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DATA REQUIREMENT IN CONNECTION WITH EXAMINATION OF WATERWAY OF BRIDGES

A. GENERAL INFORMATION

1. Name of the stream/channel/River :
2. Name of Road/Highway/Railway :
3. Crossing chainage (in mile/km./m.) :
4. Location Details
   a. Name of connecting villages/towns:
   b. Name of Block, Mouza, P.S. :
   c. Name of Sub-division and District :
5. Geographical co-ordinates (Lat., Long.):

B. HYDROLOGICAL DATA OF THE CATCHMENT

1. Nature of land-use & land cover (in %):
2. Max. Recorded High Flood
   :

C. RIVER/CHANNEL DATA

1. Name of River/Channel:
2. Nature of River/Stream (perennial/rain-fed/flashy) :
3. Stage (rocky/boulder/braided/meander/delta/tidal):
4. Type of Main channel (clean/straight/weedy/sluggish etc.) :
5. Type of over banks/flood plain (vegetation cover, cultivation etc.) :
6. Type of bed material/ Silt Factor :
7. In case of drainage 'khal'/Irrigation canal
   a. Name of reach & exact chainage at crossing :
   b. Original Gradient Statement of the concern reach:

D. RIVER/STREAM CROSS-SECTION DATA

1. No. of given Cross-Sections [as per Para-D, Pg.-1, **Annexure-I]** :
2. Distance between Cross Sections (in m.) :
3. Hydraulic data at proposed location
   a. H.F.L. (in m. GTS) with year of occurrence :
   b. O.F.L. (in m. GTS) :
   c. L.W.L. (in m. GTS) :
   d. W.L. (in m. GTS) during survey period :
   e. Design Discharge (in cumec) :
   f. Estimated velocity (in m/s) :
   g. Scour Depth (in. m.)
   h. Afflux (in. m.) :
4. HHTL, HTL & LTL (in m. GTS) (if tidal channel) :

E. RIVER/CHANNEL LONG-SECTION[as per Para-E, Pg.-2 **Annexure-I]**

1. Length of the surveyed reach (in m.) :

2. Whether bed levels, HFLs & WLs incorporated :
3. Longitudinal slope (or statistical mean slope) :

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F. MISCELLANEOUS

1. Whether the river/channel is navigable?
2. If yes, then whether last 20 years HFL data attached?
3. Whether Lacey's regime waterway constricted?
4. If yes, then %-age of constriction provided:
5. Whether an existing bridge is being replaced?
6. If yes, then its technical details attached?
7. Are all relevant drawings and documents prepared in line with the "*Guidelines & Data requirement in connection with examination of waterway of Bridges*" of CDO**(Annexure-I)**?
8. Do all drawings and documents bear the dated seal and signature of the Consultant and responsible officers (not below the rank of Executive Engineer) of the Government Department/Organization proposing the construction?
9. Whether these drawings and documents are verified and authenticated for hydraulic data by the concerned Executive Engineer of I. & W. Dte., Govt. of West Bengal?

G. NUMBER OF ENGINEERING DRAWINGS SUBMITTED FOR APPRAISAL

[as per Para-I, Pg.-3, **Annexure-I**]

1. General Arrangement Drawing (GAD) :
2. River/Channel Cross-Section Drawing :
3. River/Channel Long.-Section Drawing :
4. Index/Key map, if not shown in the GAD :
5. Topographical Survey Plan of the Site :
6. Hydrological calculation sheets :
7. Geotechnical Investigation Report; if any :
8. Google-Earth image/field photographs; if any :

H. IS/IRC CODAL REFERENCES USED :

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ANNEXURE-I

Office of the Director of Designs
CENTRAL DESIGN OFFICE
Irrigation & Waterways Directorate
Government of West Bengal
Jalasampad Bhawan (1st Floor), Salt Lake City
Kolkata-700091

GUIDELINES & DATA REQUIREMENT IN CONNECTION WITH EXAMINATION OF WATERWAY OF BRIDGES

(A) INTRODUCTION

The proposal should have the following basic information: -

i) Name of the river/stream/channel/canal on which the structure is being proposed. The crossing chainage in case of artificial channel should have to mention.

ii) Name of road/highway/railway, location of the proposed bridge along-with its mileage/ kilometrage.

iii) Name of nearest village/town, block, mouza, police station and district.

iv) Geographical co-ordinates (latitude and longitude) of the site obtained from GPS.

(B) MAPS AND PLANS

i) An **index map** drawn in a suitable scale showing the following

   i. Existing bridges and other hydraulic structures within vicinity on upstream side and downstream side of the site.

   ii. In case of **existing/defunct bridge** on the main stream, number & length of span, clear waterway, number & size of vent, depth of submergence should be mentioned with special reference to the silted-up spans or the signs of undue scour or attacks on pier/abutments.

ii) A **site plan** to a suitable scale showing details of the surveyed reach/site selected and extent not less than 100m. upstream and 100m. downstream from the centre-line of the crossing and covering the bridges to a sufficient distance, (which in the case of peak discharge, Q_{peak}>300 cumec) shall not be less than 500m. on either side of the centre-line of the crossing. The plan should show:

   i. outlines of the banks,

   ii. alignment of existing bridges at the proposed crossing, its approach angle, direction of skew (if the crossing is aligned on skew lines),

   iii. number of the cross-sections and long-sections of the river/channel taken within the scope of the site plan and the exact location of other extreme points.

iii) A ***"Google-Earth"*** image of the site from *internet* showing proposed bridge location is preferred.

(C) HYDROLOGICAL DATA OF THE CATCHMENT

i) Daily rainfall data of all the stations within the catchment for as many years as available.

ii) The nature of land-use and land cover of the catchment.

iii) Maximum high flood-discharge along with corresponding level for as many years as available at the proposed site or near the site.

(D) RIVER/CHANNEL CROSS-SECTION DATA

Cross section of the river/channel across the centre-line of the proposed bridge and at least five (5) cross-sections on the upstream side and five (5) cross-sections on the downstream side of the C/L of crossing, at intervals not exceeding 150 m. The cross-section should show the following:

i) **The bed line up to top of the bank and the ground line to a sufficient distance beyond the edges of the stream so that ground level up to 1.500 meters above the H.F.L can be shown,** right and left banks facing downstream should be indicated on the cross-section.

ii) Highest flood level (HFL), Ordinary flood level (OFL), Low water level (LWL) recorded. The

cross-sections shall invariably show the existing water level during field survey. In case of irrigation canals, the designed full supply level (FSL), bed level (BL), bed width, side slope (both canal side and country side), free-board, type (whether lined or unlined), top and width of embankment on either side shall be furnished.

iii) Maximum velocity, corresponding to highest flood discharge recorded (if available).

iv) Maximum scour corresponding to highest flood discharge recorded.

v) Type & mean diameter/Silt factor of the bed material.

vi) If the stream is in tidal region highest high tide level (HHTL) and lowest low tide level (LLTL).

(E) RIVER/CHANNEL LONG-SECTION DATA

i) Long-section of the river or channel at 30m. interval up to a minimum of 500m. (1000m. in case of peak discharge Q_{peak}>300 cumec) on the upstream side and a minimum of 300m. (500m. in case of peak discharge Q_{peak}>300 cumec) on the downstream side along the approximate centre-line of the river/channel.

ii) The section should show the HFLs, LWLs, bed levels, and water levels during survey.

iii) Longitudinal slope [(equivalent stream slope or statistical mean stream slope as per CWC guidelines of the river/channel.

(F) MISCELLANEOUS DATA

i) The estimated design discharge at the proposed site, detailed calculation with assumptions should be furnished. Estimated velocity, estimated high flood level and estimated depth of scour shall be stated.

ii) In case of wide variations of computed peak design discharge by different methods [empirical formulae, rational formula, area-velocity (conveyance factor & slope) method, adoption of nearby bridge/culvert data, flood-frequency analysis], the recommended rule (Cl.6.2.1 of IRC:SP:13-2004) for fixing Design Discharge may be resorted to, giving due regard to sound economy (Cl.6.2.2 of IRC:SP:13-2004).

iii) If the river is a **navigable** one, the horizontal and vertical clearances necessary from navigational point of view and in accordance with Ministry of Road Transport & Highways Pocket Book for Bridge Engineers (Latest Edition). Navigational High Flood Level (NHFL) should be assessed based on HFL data. **The vertical clearance should be authenticated by competent authority.**

iv) Lacey's regime linear waterway computed for 50 years peak flood discharge shall preferably be not constricted more than 20%, and the amount of afflux for such constriction as per IS/IRC Codal provisions shall be calculated, reported and taken care of in fixing the vertical clearance. This afflux may be permitted, provided it does not interfere with the functions of structure or embankments located on the upstream side, and does not submerge the localities present on upstream side. ***However, the Rivers in the Sundarban Region must not be constricted.***

v) Whether the river is a **flashy** one or the water channel builds up slowly should be stated.

vi) If the river or channel is a **tidal** one, whether it is sluiced; and if sluiced, the location of the sluice in reference to location of the bridge.

(G) REFERENCE TO INDIAN STANDARD (is) & INDIAN ROADS CONGRESS (irc) CODES & SPECIAL PUBLICATIONS

i) IS:2912-1999 (ISO 1070:1992) (Reaffirmed 2004) Indian Standard on Liquid Flow Measurement In Open Channels—Slope-Area Method (First Rev.),

ii) IRC:5-1998 (Standard Specifications & Code of Practice for Road Bridges, SECTION: I, General Features of Design (Seventh Revision),

iii) IRC:6-2000 (Standard Specifications & Code of Practice for Road Bridges, SECTION: II, Loads & Stresses (Fourth Revision),

iv) IRC:21-2000 (Standard Specifications & Code of Practice for Road Bridges, SECTION: III, Cement Concrete (Plain & Reinf.) (Third Revision),

v) IRC:78-2000 (Standard Specifications & Code of Practice for Road Bridges, SECTION: VII, Foundations & Substructure (Second Revision),

vi) IRC: 89-1997 (Guidelines for Design and Construction of River Training and Control Works

for Road Bridges; First Revision)

vii) IRC: SP:13-2004 (Guidelines for the Design of Small Bridges & Culverts).

viii) IRC: SP: 20-2002 (Rural Roads Manual)

ix) IRC: SP: 82-2008 (Guidelines for Design of Causeways and Submersible Bridges)

x) Pocket Book for Bridge Engineers (2000) by Ministry of Road Transport & Highways (MORTH, formerly MOST).

(H) HYDRAULIC DATA AUTHENTICATION BY FIELD DIVISION

i) Preliminary scrutiny of supplied data would be done by the local Division and Circle office of I.&W. Dte., Govt. of West Bengal under whose jurisdiction the river/ channel/canal is located. Data such as recorded HFL and its corresponding discharge, observed flood slope between two successive gauging sites (observation points) on the same river at sufficient distance apart for a particular flood-year (in case of rivers), canal/channel data as per design/ original gradient statement in case of artificial channel should be provided.

ii) All hydraulic data shall have to be authenticated by the Field Division of Irrigation & Waterway Directorate, Government of West Bengal before submitting for formal vetting to this office.

iii) The levels spelt in the drawing shall be with reference to G.T.S. or P.W.D. Bench Mark. The location and value of the reference GTS B.M. datum near the proposed structure shall be stated in the GAD. Drawings prepared on the basis of any arbitrary B.M. shall not be entertained.

(I) REQUISITE NUMBER OF DRAWINGS TO BE SUBMITTED TO THIS OFFICE FOR EXAMINATION OF WATERWAY & ACCORDING FORMAL VETTING OF WATERWAY ONLY.

All the drawings required and mentioned hereinafter shall necessarily bear the seal, name and dated signature of responsible officers sending the proposal. The drawings shall bear a number and date and is to be prepared based on G.T.S./P.W.D. Bench Mark and on the guidelines and data as per above stipulations. Unsigned photocopies of drawings/GAD are not entertained.

(1) General Arrangement Drawing (GAD) of the bridge structure in a single sheet *(not below A2 size):* 5(five) numbers *of the GAD to be submitted.*

The GAD should clearly show the following:

i) The plan and elevation of the bridge with proper dimensions along with its approach way (covering a fair distance in case of skew bridge).

ii) The vertical clearance of the bridge deck from HFL/HHTL/NHFL after considering afflux and horizontal clearance between the piers/abutment as per IRC provisions. It should also show the soffit level of the bridge deck and the finished road top level.

iii) The outer details of the foundation, its termination level and total waterway provided.

iv) Road/locality direction on either side of the bridge, it corresponding chainage/kilometrage, C/L position of the proposed bridge.

v) Location and value of the nearest G.T.S./P.W.D. B.M. from which survey is conducted.

(2) River/Channel Cross Section: 1(one) set, along-with soft copy to facilitate speedy data entry in examination of required waterway)

(3) River/Channel Long-Section: 1(one) set, along-with soft copy to facilitate speedy data entry in examination of required waterway

(4) Site Survey Plan: 1(one) set.

(5) Hydrological calculations: 1(one) set

(6) Google-Earth image of the site showing proposed bridge location: 1(one) set.

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B] SLOPE-AREA METHOD:-

In this method, the highest flood level (HFL) reached in a peak flood is estimated on the evidence of local witnesses, which may include identification of flood marks on structures or trees close to the bridge site. The discharge is calculated by: Q=AV

Where, Q = peak discharge in m^3/s and A = wetted area in m^2

V = velocity of flow in m/s which can be calculated by the Manning's formula:

$$V = \frac{1}{n}\left(R^{2/3} S^{1/2}\right)$$

Where, n = rugosity coefficient depends on type of channel and bed material and shall be fixed judicially either from Table A1 or Table A2 of IS:2912.

R = hydraulic mean depth = A/P, P being wetted perimeter in m.

S = slope of the surface of the water in the stream noted by observations during floods or from flood marks which may be taken as equal to bed slope in absence of precise data. Bed slope shall be calculated from long-section as per CWC's guideline for equivalent stream slope using following equation:

$$S = \frac{\Sigma[Li.(D_{i-1} + D_i)]}{L^2}$$

Where, D_{i-1} & D_i = Difference of RL between deepest river bed and Refence Datum (that shall be assumed at or below deepest bed level) for (i-1) & i^{th} chainage,

L_i = segmental length between two consecutive cross-section taken,

And L = total surveyed reach from

Cross-sections and long-section of channel shall be surveyed as per (D) and (E) of the guideline. Say 'm' no. sections have been taken. Then mean flow area and mean wetted perimeter shall be computed as follows:

$$\bar{A} = \frac{A_1 + 2A_2 + \ldots + 2A_{m-1} + A_m}{2(m-1)} \quad \& \quad \bar{P} = \frac{P_1 + 2P_2 + \ldots + 2P_{m-1} + P_m}{2(m-1)}$$

Mathematical model/software programs like MIKE11, HEC-RAS 5.1 is available for discharge computation using by slope-area method where channel geometry, boundary conditions, choice of theorem/formulae can be given as inputs and simulation results can be viewed as graphs, tabular or pictorial forms.

C] EMPIRICAL FORMULA:-

Based on studies conducted, some empirical formulae for specific regions have been evolved. The empirical formulae for flood discharge suggested are in the form of $Q = CA^n$

Where, Q = Maximum flood discharge in m^3/s,

A = Catchment Area in sq. km.

C = An Empirical Constant; depending upon nature and location of catchment

n = A Constant

The most commonly adopted empirical formulae for West Bengal is Dicken's formula based on data of rivers in Central India. Here, n= ¾ and C = 11 to 14 where the annual rainfall is 60 to 120 cm. & C = 14 to 19 where annual rainfall is more than 120 cm.

Empirical formulae involve only one known variable viz. area of the catchment and therefore a large number of remaining factors that affect the run-off such as shape, slope, permeability of catchments etc. are to be accounted for in selecting an appropriate value of the coefficient C. The value of C at the best is valid only for the region for which it has been determined, as each basin has its own characteristics affecting run-off and thus it should be chosen with due caution.

The maximum value should be considered for design.

ANNEX-II

GUIDE LINES FOR COMPUTATION OF PEAK DESIGN DISCHARGE BY DIFFERENT METHODS

Flood-Frequency Analysis is the most correct and appropriate method of obtaining design discharge from a gauged catchment for particular return period. Maximum Probable Flood may be calculated from year-wise observed peak flood by using following statistical methods like Gumble's Distribution Method, Log Normal Method, Ven Te Chow's Method, Log-Pearson Type-III Distribution Method etc. but as most of the catchments are ungauged and assessment of correct catchment run-off is not easy. Here, design discharge shall be determined using following methods: -

A] RATIONAL METHOD: -

The rational method for flood discharge takes into account the intensity, distribution and duration of rainfall as well as the characteristics of the catchment area, such as shape, slope, permeability and initial wetness of the catchment. The method consists of several formulae may generally be adopted for small and medium catchments i.e. catchment areas up to 500 sq. km and up to 2000 sq. km in exceptional cases.

Discharge by Rational formula shall be calculated as per Clause 4.7 of IRC SP:13-2004 for Peak-Runoff from catchment for desired return period.

The maximum run-off (m^3/s) can be calculated by either of the two formulae, $Q = \lambda I_o A$

Or $Q = 0.028 P f A I_c$,

Where, λ = A function of the catchment characteristics shall be given by:

$$\lambda = \frac{0.056\, f\, P}{t_c + 1}$$

Where, P = Permeability coefficient of the catchment depending on the soil cover conditions and slope of catchment etc. This coefficient of run-off shall be taken judicially from table 4.1 of the code.

f = Factor for non-uniformity of rainfall over the catchment (areal reduction factor), shall be taken from Figure 4.2 of the code knowing the catchment area.

And t_c = time of concentration in hours which is calculated by:

$$t_c = \left(0.87 \times \frac{L^3}{H}\right)^{0.385}$$

Here, L = Distance from the critical point to the structure in km.

And H = The fall in level from the critical point to the structure in m. Both L & H are catchment characteristics and shall be assessed either from Survey of India topographical maps, or by using GIS software.

A = Area of catchment in hectares, shall be assessed either from topographical sheet, or by using GIS software.

I_o = Maximum intensity of R-year one hour rainfall in cm. over the catchment is assessed by formula $I_o = \frac{F}{2}\left(1 + \frac{1}{T}\right)$

Whereas, F = Rainfall in cm. dropped by the severest storm in T-hours

T = storm duration in hr. of the severest storm over the catchment

In absence of any readily available ORG (Ordinary Rain Gauge) or SRRG (Self Recording Rain Gauge) data of the area, CWC's isopluvial maps may be used to compute Io directly from T-hours R-years Rainfall value over the centroid of catchment.

In the other formula, I_c = Critical or design intensity of rainfall in cm./hr. shall be obtained by using the formula,

$$I_c = I_o\left(\frac{2}{t_c + 1}\right)$$

and P, f, A, I_o & t_c as defined before.