TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING

PASCHIAMANCHAL CAMPUS

DEPARTMENT OF GEOMATICS ENGINEERING

LAMACHAUR-16, POKHARA

A REPORT ON SURVEY CAMP 2080

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Acknowledgements:

We are appreciative to the Department of Geomatics Engineering at Paschimanchal Campus for providing us with the opportunity to put our theoretical surveying expertise into practice. This year, unlike prior years, we were able to conduct survey camp at a scheduled time and in a pleasant environment. In addition, survey camp was successfully completed thanks to the persistent work of our department.

The dedication and tireless efforts of our mentors, Er. Pradip Aryal, Er. Roshan Poudel, Er. Umesh Bhurtyal, Er. Saurav Gautam, Er. Netra Bahadur Katuwal and other teachers, are credited with the survey camp's successful completion. They guided us through every step of the survey camp, from start to finish, and assisted us in finding solutions to various problems we encountered during field work in the survey camp. We'd like to thank Mr. Suke Awal for his assistance in providing us with the instruments we needed and leading us through the proper handling and safety of each instrument. We would like to express our gratitude to other teachers and colleagues for their continued support and cooperation while running the survey camp on campus.

The topographical survey of the college premises, Road Alignment Survey, and Bridge Site Survey which were done in Kali Khola were based on the parameters specified in the field book. Despite our best efforts to follow the criteria, the report may contain various mistakes. As a result, any feedback and recommendations regarding this report would be greatly appreciated.

Abstract:

The main objective of the Survey Camp 2080 organized by Department of Geomatics Engineering, IOE Paschimanchal Campus for the students of 077-BGE Batch is to provide opportunity to consolidate and update the student's theoretical and practical knowledge in Engineering Surveying in Field conditions. The venues for the camp were, namely, Kali khola and its surroundings-Pokhara and Paschimanchal Campus-Pokhara.

This Report consists of tabulated data, graphs and maps of the survey of the road along Kali khola and the bridge of the same along with the traverse of the campus.

In this camp, the students carried out necessary field works in predetermined groups in order to attain an opportunity to make decisions and have active participation in the planning and execution of field works for the preparation of Topographical map and detailed road and bridge survey. This Survey Camp has helped tremendously in building up the confidence to conduct Engineering Survey with Accuracy and Professionalism.

The Report has been prepared with data and calculations recorded during the survey camp, and is a reflection of the experience and knowledge gained by the students in the camp, as such, we apologize for any mistakes and errors in the document, and hope that the readers would provide positive feedback upon reading through the Report.

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Abbreviations:

AP: Applied Department Building
BC: Building Corner
BEST: Bagmati Engineering Student Tribe
BP: BP Park
CAFÉ: Cafeteria
CTN: Chitwan Park
DB: D-Block
FP: Foot Path
GEO: B-Block
GESS: Gorkha Engineering Student Society
LT: Ladies Toilet
MEC: Mechanical Block
MEC-D: Mechanical Department Building
MSC: MSC. Hostel
OFS: Offset
POLE: Pole
RD: Road
ROCK: Rock
SH: Spot Height
SUPA: Sudurpaschim Samparka Samaj
TL: Tanahu Lamjung Park
TAP: Tap
TOILET: Toilet
TREE: Tree
TT: Table Tennis Board

Chapter-1

Introduction

Background

The process of establishing the relative position of natural and manmade features on or beneath the earth's surface, presenting this information graphically in the form of plans or statistically in the form of tables, and laying out measurements on the earth's surface is referred to as surveying. Normally, requires measurements, computations, plan creation, and execution particular location determination Geometric components are used by surveyors, physics, engineering, metrology, trigonometry, regression analysis. The law and programming languages They make use of tools like total station, retroreflectors, 3D scanners, robotic total stations, GPS receivers, Drones, GIS, radios, handheld tablets, digital levels, subsurface locators, etc. software for surveying. Surveying has had a role in the growth of the industry, human environment since the dawn of recorded history. The major goal of surveying courses for Geomatics engineering students is to teach them the fundamentals of various surveying techniques. In their professional lives, surveying techniques important to engineering tasks practice. All surveying courses must be completed, including a 10-day survey camp. Pashchimanchal's Department of Geomatics Engineering coordinated the event. Pokhara Campus will improve students' ability to use all surveying methods. Lecture classes discuss this technique. This is a detailed report on the work done by Group 4, which consists of six sections. During the camp time, members It briefly describes how things function. During that camp period, this group used many methods and techniques. Furthermore, it also contains observations, computations, error correction methods, and the primary problems encountered at work and solutions, as well as outcomes.

Objectives of Survey Camp:

The camp's major goal is to give a foundation in the practical implementation of various survey tasks that may be encountered in the future. It improves practical knowledge, allowing different jobs and projects to be implemented. On the other hand, it entails a perpetual sense of self-assurance. It directs you where to walk the path that leads to success

The main objectives of survey camp are as follows:

a. To become familiar with potential fieldwork issues.
b. To become familiar with proper instrument handling and operation.
c. To learn about the spirit and value of teamwork, as surveying is not a one-person job.
d. To accomplish a project on time and so understand the value of time.
e. To collect required data in a methodical manner in the field.
f. f. To compute and manipulate observed data with the needed accuracy, and to display it in diagrammatic and tabular form so that others can understand it.
g. To deal with errors and missing data from the field during office work.
h. To prepare for the final report.

Classification of Surveying:

Survey may be classified on the different heading depending upon the uses or purposes of resulting map.

- <u>Based on nature of field</u>
    - Land Survey
    - Hydrographic Survey
    - Astronomical Survey
- <u>Based on object of survey</u>
    - Engineering Survey
    - Military Survey
    - Mine Survey
    - Geological Survey
    - Archaeological Survey
- <u>Based on instruments used</u>
    - Chain survey
    - Theodolite survey
    - Traverse survey
    - Triangulation survey
    - Tachometric survey
    - Plane Table Survey
    - Photogrammetric survey
    - Aerial Survey

The type of survey we did in our survey camp was an engineering survey, which included the preparation of a topographic map and required both horizontal and vertical controls. We perform theodolite traverse survey for fixing control points, tachometric survey for detailing with total station alliance, and triangulation survey for establishing control points in bridge site survey, depending on the instrument employed.

Principles of surveying:

While surveying, we became careful about the different principles of surveying. Since we had our first 5 days of survey in our college, Paschimanchal Campus. We started with the first principle: Working from whole to part. As well as we performed the survey camp keeping in mind the principles: Location of point by measurement from two points of reference, Consistency in work, Independent Check, Accuracy required.

Accuracy and errors:

In any kind of survey, errors are inevitable. As precision is the degree to which the repeated observations under same condition shows the same result but accuracy is the level of perfection achieved via observation. It is the degree to which an observation is close to the true value. Precision instruments, precise processes, and good planning are all required for accuracy.

The difference between two measured values of the same quantity is called a discrepancy; it is not an error.

We have different sources and types of error, in maximum cases we tried to avoid errors but there were some as follows:

- ❖ Sources of errors:
    - o Instrumental error: Eg:- a tape too short
    - o Personal error: Eg:- error while taking staff reading
    - o Natural error: errors due to different natural phenomenon such as temperature, refraction, etc.
- ❖ Types of errors:
    - o Mistakes
    - o Systematic errors
    - o Accidental errors
    - o In our survey, all the computations were made within permissible error limit.

As mentioned earlier, the survey camp was divided into three major works:

Topographical survey
Road alignment survey
Bridge Site survey

Major works carried out:

- ❖ Topographical Survey in Pashchimanchal Campus:
    - Reconnaissance survey
    - Fixing major stations and forming the major traverse covering the project area.
    - Fixing minor stations in the detail area.
    - Measuring distance by using tape both ways between the major stations and later with total station for greater accuracy.
    - Two peg test (Test for Permanent adjustment of level)
    - Transfer of R.L from BM to CP1 and to other stations with level machine.
    - Detailing with T.S. along with preparation of rough sketches.
    - Plotting & topographical map preparation.
- ❖ Road Alignment in Kali Khola premises:
    - Fixing the stations IP0, IP1….
    - Computation of chainages for each beginning, middle and end of curves with the help of theodolite for total length of about 830 m.
    - Cross-sectioning and then fly levelling for determination of reduced levels.
    - Setting out of curve.
    - Drawing plan, L-section and cross-section in suitable scale.
- ❖ Bridge Site Survey:
    - Reciprocal levelling.
    - Triangulation to determine width of river.
    - L-section of river.
    - Preparing contour map of river.
    - Cross-sectioning of the river and also determining high flood level.

Topographic Map Presentation:

Details:

- Scale for Plot of Major Traverse: 1:1000
- Scale for Plot of Minor Traverse: 1:600
- Paper size: A1
- Contour interval: 0.5 m

Control Points Establishment:

- At least 10 – 15 stations (Main control stations)
- Distance measurement by TS with precision less than 1:2000
- Vertical control by levelling.
- Fly Levelling (± 25√K mm accuracy)
- Leg ratio: Major Traverse = 1:2 & Minor Traverse = 1:3

Road Alignment Survey:

- Chainage should be at least 1000 m & deflection angle not too low.
- Preparing plan of road in scale 1:1000.
- Preparing L-section of road with scale 1:100 for vertical and 1:1000 for horizontal.
- Preparing cross-section graphs of road in scale 1:100.

Bridge Site Survey:

- Triangulation was done to determine length of bridge axis.
- Reciprocal levelling was done to determine R.L. of one of stations.
- Preparing contour map of river with contour interval 1 m and scale 1:500.
- L-section of river.
- Cross-section graphs of river in scale with vertical 1:100 and horizontal 1:500.

Survey Camp Area:

Figure 1: Paschimancal Campus Area

Figure 2: Kali- Khola Area

Source: https://www.google.com/maps/@28.2545616,83.9773072,682m/data=!3m1!1e3!5m1!1e4

TOPOGRAPHIC SURVEY

Introduction:

Topography is a field of geo science and planetary science and is concerned with local detail in general, including not only relief but also natural and artificial features, and even local history and culture. Topography defines the shape or configuration of the earth's surface. Topographic surveying is the process of determining the positions, both on the plan and elevation, of the natural and artificial features of a locality for the purpose of delineating them by means of conventional signs upon a topographic map. The basic purpose of a topographic map is to indicate the three-dimensional relationships for the terrain of any given area of land. Thus, on a topographic map, the relative positions of the points are represented both horizontally as well as vertically.

Therefore, the fieldwork in a topographical surveying consists of three parts.

i. Establishing both horizontal and vertical control.

ii. Locating the contours. iii. Locating the details such as rivers, streams, lakes,

canals, houses, and trees etc.

Objectives:

The main objective is to prepare the topographic map of the given area with horizontal and vertical control with required accuracy. It helps us determine the positions of features both on plan and elevation and indicate them by means of conventional signs and symbols on the topographic map.

Brief description of the area:

Topographic survey was carried out at Pashchimanchal Campus, Lamachaur, Pokhara. The major traverse was run covering a major portion of campus area while minor link traverse was run through the area where our detailing work was assigned. Our objective was to prepare a topographic map of the detail area. Therefore, our major task was to prepare the topographic map of the area including RIC Building, Administration, Mechanical and Automobile Workshops, Electrical labs, Girls Hostel, Auditorium hall, MSc Hostel, Canteen, Mechanical Workshops, different parks, Roads Boundary wall and so on.

Norms (Technical specifications):

- Reconnaissance survey of the area to be surveyed: A closed traverse (major and minor) was formed around the premises of the area by fixing or marking appropriate no. of stations. During the selection of traverse stations, the leg ratio i.e. the ratio of length of the longest traverse leg to the length of the smallest leg should be less than or equal to 1:2 for major traverse and 1:3 for the minor traverse. References were taken for the major and minor traverses.

- Two-way measurement of the traverse legs: Discrepancy (Accuracy of two-way measurement in the case of major & minor traverse) is 1:1000. Two-way measurement means measurement of the traverse leg in the forward as well as in the backward direction.

- Determination of horizontal angles between stations: With the help of bearing of one of stations, horizontal angles between corresponding stations were determined. The difference between the mean angles as well as the difference in each angle observation should be within 10′.

• Determination of RL of traverse stations by fly levelling from the given B.M: A two peg test was carried out to determine if the level required permanent adjustment. Balancing of back sight and fore sight is necessary for the elimination of different types of errors including collimation error. The permissible error of fly levelling is $\pm 25\sqrt{K}$ mm, where K is the distance of the levelling passed in kilometer.

• Adjustment of traverse or balancing the traverse: The permissible angular error or the angular mis-closure for the sum of interior angles of the traverse should be within $C\sqrt{N}$, where N denotes the no. of traverse leg or traverse stations and, C=10” for major traverse and C=15” for minor traverse. For both major and minor traverse the relative error of closure should be less than 1:1000.

• Detailing or the detail survey of the plot by Total Station: The details were extracted from

T.S. Conventional symbols were used to denote the detailing along with the contours of 0.5m contour interval in the same scale.

• Plotting of the traverse stations by co-ordinate method: An appropriate scale was adopted, i.e.1:500 for the major traverse and 1:1000 for minor traverse and all the details like trees, buildings, parks, roads, etc. were represented with conventional symbols.

Instruments used:

The following are the instruments used for topographic survey:

1. Measuring tape
2. Pegs
3. Ranging rods
4. Tripod stand
5. Auto level
6. Levelling Staff
7. Total Station
8. Clampers
9. Reflectors (Target prisms with stands and levelling bubble provided)
10. Hammer
11. Marker pen
12. Field books

Figure 3: Measuring Tape

Figure 4: Ranging Rods

Figure 5: Tripod Stand

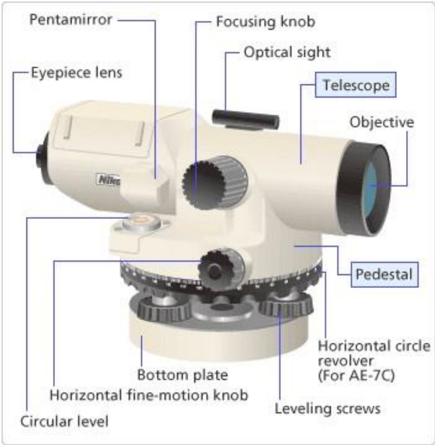
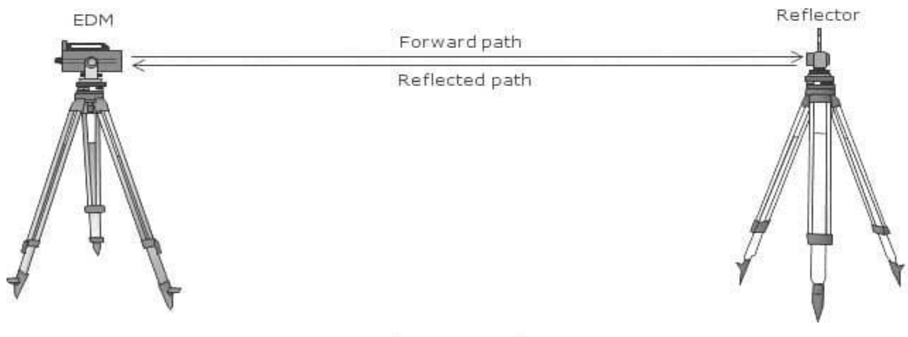


Figure 6: Level Machine *Figure 7: Levelling Staff* *Figure 8: Pegs*

Total Station:

A total station is an optical instrument used in modern surveying and is a combination of an electronic Theodolite (transit), an electronic distance meter (EDM) and software running on an external computer known as a data collector. With a total station one may determine angles and distances from the instrument to points to be surveyed. With the aid of trigonometry and triangulation, the angles and distances may be used to calculate the coordinates of actual positions (X, Y, and Z or northing, easting and elevation) of surveyed points, or the position of the instrument from known points, in absolute terms.

Measurement of distance is accomplished with a modulated microwave or infrared carrier signal, generated by a small solid-state emitter within the instrument's optical path, and bounced off of the object to be measured. The modulation pattern in the returning signal is read and interpreted by the onboard computer in the total station. The distance is determined by emitting and receiving multiple frequencies and determining the integer number of wavelengths to the target for each frequency. Most total stations use a purposebuilt glass Porro prism as the reflector for the EDM signal, and can measure distances up to a few kilometers, but some instruments are "reflector less", and can measure distances to any object that is reasonably light in color, out to a few hundred meters. The typical Total Station EDM can measure distances accurate to about 3 millimeters or 1/100th of a foot.



The basic principle of Total Station is that the distance between any two points can be known once the time light wave takes to travel the distance and back and the velocity of light is known. Then the following relation, which is already programmed in total station's computer is used to calculate distance:

Distance = (Velocity * Time)/ 2

In this formula, time is total time taken by light wave from EDM to reach reflector and return.

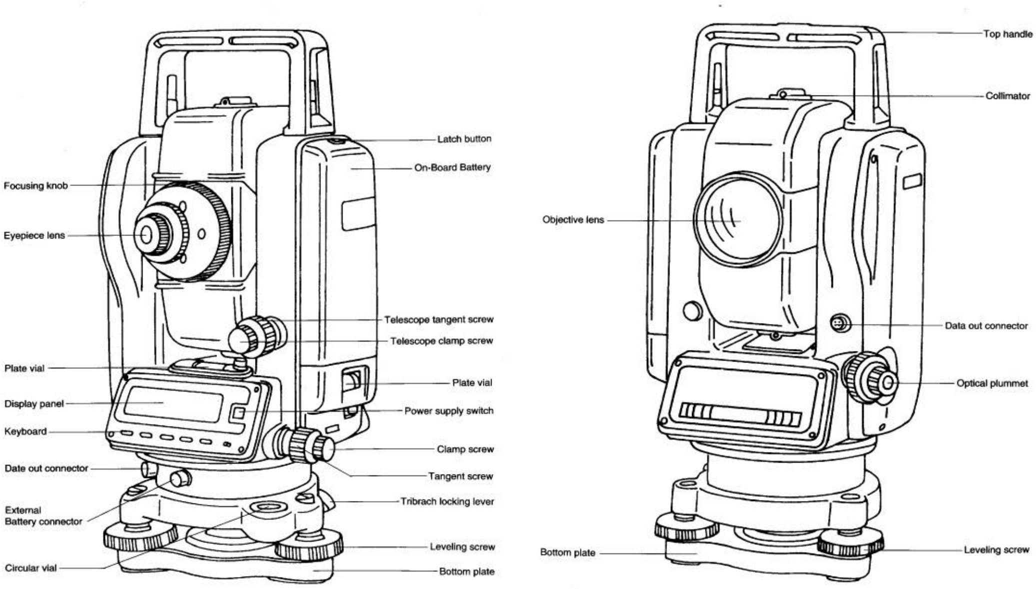


Figure 9: Description of parts of Total Station

Source: https://www.facebook.com/Civil.Engineering.projects/photos/total-station-partsname/402154319885903/

A total station is a modern-day surveying instrument that has several advantages like:

1. Quick setup of the instrument on the tripod by utilizing the laser plummet.
2. Programmed with on board area computation for computing the area of a field.
3. It supports local languages.
4. It shows the graphical view of land and plots.
5. No recording and writing errors.
6. It gives more accurate measurements than other conventional surveying instruments.
7. Data can be saved and transferred to a PC.
8. It has integrated database.
9. Computerization of old maps.

10. All in one and multitasking instrument, from surveying to GIS creation by using the appropriate software.
11. Faster work, saves time, quick finishing off the job

Disadvantages of Total Station:

1. The instrument is costlier than other conventional surveying instruments.
2. It might be troublesome for the surveyor to investigate and check the work when surveying.
3. Working with total station is not so easy, as more skilled surveyors are required to conduct a total station survey.

Methodology:

The methodology is based on the principles of surveying. They are as follows:

• Working from whole to a part

• Location of a point with respect to at least two control points

• Independent check

• Consistency in work

• Required accuracy

The different methodologies were used in surveying to solve the problems arise in the field. These methodologies are as follows:

Reconnaissance (Recci):

Reconnaissance means the exploration or scouting of an area. In survey, it involves walking around the survey area and roughly planning the number of stations and the position of the traverse stations. Recci is primarily done to get an overall idea of the site. This helps to make the necessary observations regarding the total area, type of land, topography, vegetation, climate, geology and inter-visibility conditions that help in detailed planning. The following points must be taken into consideration for fixing traverse stations:

• The adjacent stations should be clearly inter-visible.

• The whole area should include the least number of stations possible.

• The traverse station should maintain the ratio of minimum traverse leg to maximum traverse legless than 1:2 for major traverse and 1:3 for minor traverse.

• The stations should provide minimum level surface required for setting up the instrument.

• The steep slopes and badly broken ground should be avoided as far as possible to avoid difficulties as well as reduction in accuracy in the measurement of the traverse legs.

• The station should not be selected such that the line of sight lies very much near the ground level to avoid likely error due to atmospheric refraction.

Taking the above given points into consideration, the traverse stations were fixed. Then two-way taping was done for each traverse leg. Thus, permanent fixing of the control points completed reconnaissance.

Traversing:

Traversing is a type of surveying in which a number of connected survey lines form the framework of survey. It is also a method of control surveying. The survey consists of the measurement of angles between successive lines or bearings of each line and the length of each lines.

The directions and lengths of the lines are measured with the help of angle measuring instrument and length measuring instruments like Total Station (or Theodolite) and an Electronic Distance Measurement (EDM) system respectively. If the co-ordinates of the first station and the bearing of the first line are known, the co-ordinates of all successive points can be computed as follows:

$X_2 = X_1 + L\cos\theta$

$Y_2 = Y_1 + L\sin\theta$

Where, L=Length of traverse leg, Θ is the bearing of the line and (X_1, Y_1) is known coordinate.

Types of Traverse:

A: Closed Traverse:

A traverse is said to be closed when a complete circuit is made or when it begins and ends at points whose positions on plan are known. (Or) If the traverse formed by the lines closes at a station i.e. if they form a polygon or it starts and finishes at the points of known coordinates, then the traverse is called closed traverse. A traverse is said to be a closed loop traverse if it returns to the starting point, thereby forming a closed polygon. In addition, a traverse which begins and ends at the points whose position on the plan is known are referred as a closed linked traverse. In both the cases, the angle can be closed geometrically, and the position closure can be determined mathematically. The work may be checked and balanced.

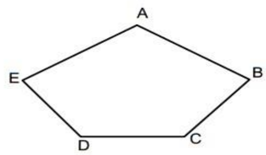
B: Open Traverse:

If the traverse ends elsewhere other than at the starting point or at some other point, then the traverse is termed as an open traverse. It consists of a series of lines expanding in the same direction. It is employed for surveying long narrow strips of country such as the path of highway, canal, pipeline, etc.

Major traverse:

The whole site which was to be surveyed was enclosed by a number of inter-connecting survey lines forming a closed circuit or a framework joining successive major control points. This was the required major traverse. The skeleton of lines joining those control points, which covers the whole entire area, is called major traverse. Work on major traverse must be precise. Therefore, two-set of readings should be taken for major traverse.

In the survey camp, two traverses - major and minor had to be established. The major traverse had12 control stations including two given common points. The control stations were named as M1, M2and so on along with CP1 & CP2 (the common points). The leg ratio of maximum traverse leg to minimum traverse leg was maintained 1:2. The discrepancy in length between the forward measurements and the backward measurements of all the traverse legs was within 1:1000.



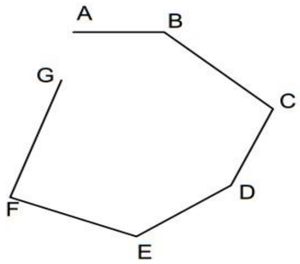


Figure 10: Closed Traverse and Open Traverse

Fixing of control points:

After the completion of reconnaissance of the area to be surveyed, the major traverse control points were fixed by driving pegs into the ground or by marking the points with marker including the group name and the station number. Some of the points needed to be kept in the mind while fixing major traverse stations are as follows:

- Inter-visibility of the adjacent major traverse stations.
- Maintaining of the permissible leg ratio of 1:2.
- Measurement of traverse legs without any obstruction.
- Fixing of stations with reference points as well as a neat sketch.
- Fixing of stations driving wooden pegs and marking with marker.

Measurement of traverse legs:

Work on the major traverse should be precise. Thus, after appropriate selection and fixing of major traverse stations, two-way measurements of the traverse legs were carried out making use of EDM in the total station. The distances between the adjacent control points were accurately measured as far as possible for the accuracy of the whole traverse. The precision of the measurement should be within1:1000.

Discrepancy and linear misclosure:

In order to measure the lengths of the sides of the traverse, two ways taping (forward and backward) is done. In difficult areas where taping is not possible, other methods like the subtense bar is used. The difference in values obtained by forward and backward taping is called discrepancy. The reciprocal of mean of the two measurements divided by the discrepancy is called precision. Both the discrepancy and the precision for each traverse leg should be within the given limits.

Mathematically,

Discrepancy = | Forward length - Backward length |

And

Linear precision = 1 / (Mean length / Discrepancy)

Measurement of trverse angles:

The horizontal angles between the traverse stations were measured by the help of a known bearing of a station. The difference in two angles and as well in each of the angular observation cannot exceed 1' as stated earlier.

Sum and the correction of the interior angles:

Permissible Angular Error for the closed traverse $=C\sqrt{N}$

Where, N = no. of traverse legs

$C=10'$

For a closed traverse,

Sum of interior angles = $(2n – 4) \times 90°$

Closing error = $(2n – 4) \times 90° - \sum$ Observed sum of internal angles

If the angular error is within the permissible value of $10'\sqrt{N}$, then the error in the sum of internal angles is equally distributed. Bearing computation of the traverse legs:

The bearing of the common line CP1-CP2 was observed with the help of a compass. The bearing of the remaining traverse legs was computed. They were calculated using following relation:

Bearing of successive line = Fore bearing of the previous line + clockwise traverse angle ± 180°.

Computation of the co-ordinates:

After the computation of bearings and having the average lengths of all traverse legs, the positions or the co-ordinates of the major stations are calculated.

a) Consecutive co-ordinates:

The latitude of the survey line is defined as its coordinate length measured parallel to an assumed meridian. It is also termed as northing. The departure of the survey line is defined as its coordinate length measured perpendicular to an assumed meridian. It is also termed as easting.

Each station point is defined by its latitude and departure with respect to the origin.

Latitude of B = Latitude of A + $L*\cos\Theta$

Departure of B = Departure of A + $L*\sin\Theta$

Where, Θ= Bearing of the line AB

L = Length of the line AB

b) Independent co-ordinates

The latitude and departure of any line with respect to common origin of co-ordinates are called independent co-ordinates or total co-ordinates. The independent co-ordinates are calculated after the traverse is completely balanced. They are obtained by adding algebraically the latitudes and departures of the traverse legs between that station and origin.

Closing Error:

In closed traverse when plotting according to the field measurements, if the end point of the traverse will not coincide exactly with the starting point due to the error in the field measurements of the length and angles, then it is called closing error. In a closed loop algebraic sum of Latitude (ΣL) and of departure (ΣD) must be zero. Mathematically,

Closing error (e) = $\sqrt{[(\Delta L)^2 + (\Delta D)^2]}$

And

Direction, $\tan \theta = (\Delta D)/(\Delta L)$

The sign of ΔL and ΔD will thus define the quadrant in which the closing error lies. The relative error of closure (Accuracy ratio) = Error of Closure / Perimeter of the traverse

= e / P

= 1 / (P /e)

Balancing the traverse:

The process of adjusting the consecutive co-ordinates by applying the correction to the latitudes & departures of each of the traverse legs such that their algebraic sum is equal to zero is called balancing the traverse or balancing the consecutive co-ordinates. A closed traverse can be balanced by any one of the following methods.

1. Bowditch's method
2. Transit rule
3. Graphical method
4. Axis method

1. Bowditch's Method:

The method is based on the assumption that errors in the linear measurement are proportional to $\sqrt{L}$ and the errors in the angular measurements are inversely proportional to $\sqrt{L}$ where L is the length of a line. The method is applicable when both the linear as well as angular measurements are of equal precision.

The Bowditch rule is:

Correction to latitude (or departure) of any side =Total error in latitude or departure ×Length of that side/perimeter of the traverse

$C_{lat} = \sum(Lat) \times L / \sum L_s$

$C_{dep} = \sum Dep \times L / \sum L_s$

Where, C_{lat} = Correction to latitude of any side

C_{dep} = Correction to departure of any side

$\Sigma(Lat)$ = Total error in latitude

L_s = Length of any side

Levelling:

Levelling is defined as the branch of surveying which deals in finding the elevations of the given points with respect to a given or an assumed datum. It also deals with establishing the points at a given elevation with respect to a given or an assumed datum. It deals with the measurement in a vertical plane. It helps to provide the vertical controls in a topographic map. The elevations of the relevant points must be known so that complete topography of the area can be explored. Accurate determination of the elevations of different points along the certain alignment is a necessary part. Hence, it is a subject of prime importance to engineers and the project as a whole.

Types of levelling:

Two types of levelling are used in general Engineering practices, namely direct levelling (spirit levelling) and indirect levelling (trigonometric levelling).

Direct Levelling:

It is the branch of levelling in which the vertical distances with respect to the horizontal line (perpendicular to the direction of gravity) may be used to determine the relative difference in elevation between two adjacent points. A level provides horizontal line of sight i.e. a line tangential to the level surface at a point where the instrument stands. The difference in the elevation of the two, points is the vertical distance between the two-level lines. With a level set up at any place, the difference in the elevation between any two points within proper lengths of sight is given by the difference between the rod readings taken on these points. By a succession of instrument stations and related readings, the difference in elevation between widely separated points is thus obtained.

Following are some special methods of direct levelling:

a. Simple Levelling

It is the method of levelling which is used to determine the difference of elevation between two points which are visible from a single point. This method is applied when the distance between two points is not too long. In this type of levelling, only the middle wire reading against the staff held is observed and recorded.

b. Differential Levelling

It is the method of direct levelling the object of which is solely to determine the difference in the elevation of two points regardless of the horizontal positions of the points with respect to each other. This type of levelling is also known as fly levelling. All three wire readings are observed and recorded. This method was employed at the survey camp to transfer the RL to major and minor traverse stations.

c. Profile levelling

It is the method of levelling the object of which is to determine the elevations of the points at measured intervals along the given line in order to obtain the profile of the surface along that line.

d. Cross- sectioning

It is the process of taking the levels on each side of the main line at right angles to that line, in order to determine a vertical cross- section of the surface of the ground, or of underlying strata, or of both.

e. Reciprocal levelling

It is the method of levelling in which the difference in the elevation between two points is accurately determined by two sets of reciprocal observations when it is not possible to set up the level between the two points.

f. Indirect levelling

Indirect method of trigonometric levelling is the process of levelling in which the elevations of the points are computed from the vertical angles and horizontal distances measured in the field, just as the length of any side in any triangle can be computed from proper trigonometric relations.

Adjustment of level

A: Temporary adjustment of level:

The adjustment of level that needs to be done before each observation is known as the temporary adjustment of level. The temporary adjustment of the level is done in following steps:

a) Setting up the level:

The operation of setting up includes the fixing the instrument on the stand and levelling the instrument approximately.

b) Levelling up:

Accurate levelling is done with the help of foot screws and with reference to the plate levels. The purpose of levelling is to make the vertical and horizontal line of sight truly horizontal.

c) Removal of parallax:

Parallax is a condition arising when the image formed by the objective not formed in the plane of cross hairs. Parallax is eliminated by focusing the eyepiece for distinct vision of the crosshairs and by focusing the objective to bring the image of the object in the plane of the cross hairs.

B: Permanent adjustment of level:

Permanent adjustment of the level is the adjustment of level that is done when the corresponding relationship between the parts of the instrument is disturbed. To check the need of the permanent adjustment of the auto level the two-peg test is carried out. Two staffs were placed at A and B of known length (about 50 m). First the instrument was setup on the line near B and both staff readings (Top, Middle, and Bottom) were taken. Then, the instrument was setup at the middle C on the line and again both staff readings on A and B was taken. Then computation was done in order to check whether the adjustment was within the required accuracy or not.

Booking and calculation of reduced levels:

There are two methods of booking and reducing the elevation of points from the observed staff readings. They are as follows:

a. Height of Instrument method (HI method)

b. Rise and fall method

a. HI Method:

In this method, firstly the height of instrument is calculated by back sighting to a known station i.e. adding back sight (BS) to RL of BM or previous known station for each setting of instrument. The RL of the next station is then calculated by subtracting the foresight (FS) to the HI. If any intermediate sights (IS) are taken, then their RL is also calculated by subtracting IS from HI. HI is calculated for every new set up of instrument.

Arithmetic Check:

$\sum BS - \sum FS$ =Last R.L -First R.L

b. Rise and Fall Method:

It is the method which was mostly used in the survey camp for fly levelling as well as in the case of transferring RL from TBM to the entire major and the minor traverse stations. In rise and fall method, the height of instrument is not at all calculated but the difference of level or elevation between consecutive points is found by comparing the staff readings on the two points for the same setting of the instrument. The difference between their staff readings indicates a rise or fall according as the staff reading at the point is smaller or greater than that at the preceding point. The figures for rise and fall worked out thus for all the points give the vertical distance of each point above or below the preceding one, and if the level of any one point is known the level of the next will be obtained by adding its rise or subtracting its fall, as the case may be.

$\sum BS - \sum FS$ = Last R.L. – First R.L. = $\sum Rise - \sum Fall$

Fly Levelling:

The fly levelling was carried out between TBM_1 and TBM_2 and check levelling was performed to check the results.

Level transfer to the major and minor traverse stations:

The R. L of the temporary benchmark was then transferred to the control stations of the major and minor traverse. The closing error was found to be within the permissible limits. The misclosure was adjusted in each leg of the levelling path by using the following formula:

Permissible error = $\pm 25\sqrt{k}$ mm.

Where k is the total perimeter in Km

Actual Error (e) = $\Sigma BS - \Sigma F.S.$ = Last R.L. – First R.L.

Correction i^{th} leg = $-(e * (L_1 + L_2 + \ldots + L_i)/P$

Where L_1, L_2, L_i = Length of 1^{st}, 2^{nd}, i^{th} leg.

Detailing:

Detailing can be done by using total station either in EDM mode or in Co-ordinate mode.

Tachometry:

Tachometry is a branch of angular surveying in which the horizontal and vertical distances of points are obtained by optical means. Though it has less accuracy, it is faster and convenient than the measurements by tape or chain. It is very suitable for steep or broken ground, deep ravines, and stretches of water or swam where taping is impossible.

The objective of the tachometric survey is to prepare contoured maps or plans with both horizontal and vertical controls. For the survey of high accuracy, it provides a check on the distances measured by tape. The formula for the horizontal distance is,

$D = K \times S \times Cos^2\Theta + C \times cos\Theta$

Where S = Staff intercept

K = Multiplying (Total station) constant =100

C=additive factor = 0 (For analytical lens).

The formula for the vertical distance is,

$V = (½) \times K \times S \times Sin^2\theta + C \times sin\theta$

Where, S = staff intercept = (top reading –bottom reading)

And Θ = Vertical Angle

Thus, knowing the V value, reduced level (R. L.) of instrument station, Height of instrument (H. I.) and central wire reading (h) the R. L. of any point under observation can be calculated as:

R. L. of point = R. L. of instrument station + H. I. ± V- h

The process of allocating the object position on the map with the help of vertical and horizontal measurements with sufficient accuracy as per job is called detailing. Here the detailing was carried out using a Total Station by measuring direct coordinate of target in coordinate mode with referencing from the pre-determined station. The coordinates of the major station were already calculated and corrected before the detailing work. Then the Total station was set up at one station and oriented by back sighting another control station. The total station is an instrument that provides the coordinates (Easting, Northing and RL) by itself in recorded form with codes to facilitate better understanding. Separate manual booking was also done with necessary sketches to facilitate independent checks and for help in plotting. Then the position of the object was plotted with the help of recorded data and a rough sketch made during detailing.

In order to prepare the topographic map of the given area detail survey or detailing is carried out. Detail survey can either be carried out by tachometry, coordinate method using total station or by using plane table survey. Some of the steps followed while carrying out the detail survey are summed up as follows:

• Instrument was set at each control point with accurate centering and levelling.

• The vertical distance from the center of the trunnion axis to the peg at the ground was measured as the height of the instrument.

- The instrument was orientated with reference to a fixed station which is already well defined.
- Target was held vertically as far as possible with proper levelling of the bubble for the case detail survey and in the case of RL transfer from BM to major and minor traverse stations the staff was held vertically as possible.
- Permanent details were not missed as far as possible and were indicated by numbering in the reference map for the future reference of plotting.
- After the extraction of the details from the total station, they were plotted in the A0 paper with scale 1:600.

Contouring:

A contour is an imaginary line of constant elevation on the ground surface. It is the line in which the surface of the ground is intersected by the level surface.

Contour interval and Horizontal Equivalent:

The vertical distance between any two consecutive contours is called the contour interval. The contour interval is kept constant for a contour plan or the topographic map otherwise the general appearance of the map will be misleading. The horizontal distance between two points on two consecutive contours is known as horizontal equivalent and it depends upon the steepness of the ground. The choice of the proper contour interval depends upon the following considerations:

- The nature of the ground
- The scale of the map
- The purpose and the extent of the survey
- Time and expense of field and the office work

Characteristics of Contours:

The characteristic features of the contour which are used while plotting and reading a contour map or the topographic map are summed up as follows:

1. Two contour lines of different elevations cannot cross each other. They can cross each other only in the case of overhanging cliff.
2. Two contour lines of different elevations cannot unite to form a single. If they do, it is only in the case of vertical cliff.
3. Closely spaced contour lines represent a steep slope. Broadly spaced contour lines represent a gentle slope. Equally spaced contour lines represent a uniform slope. A series of straight, parallel and equally space contours represent a plane surface.
4. A contour line cannot split into two or more contour lines.
5. A series of closed contour lines with higher value of contour i.e. with contour having higher value of elevation inside represent a hill whereas a series of closed contour lines with lower value of contour inside represent a pond or the depressed land.
6. A contour line must close upon itself, though not necessary within the limits of the map.

7. Contour lines cross a watershed or the ridge line at right angles. They form curves of Ushaped round it with the concave side of the curve towards the higher ground.
8. Contour lines cross a valley line at right angles. They form sharp curves of V- shaped across it with the convex side of the curve towards the higher ground.
9. The same contour appears on the either side of a ridge or valley, for the highest horizontal plane that intersects the ridge line must cut it on the both the sides. The same is true of the lower horizontal plane that cuts a valley.

Methods of Locating Contours:

The location of a point in topographic survey involves both horizontal as well as vertical control. The methods of locating contours, therefore, depend upon the instruments used which are:

a. Direct method

b. Indirect method

In the direct method, the contour to be plotted is actually traced on the ground. Only those points are surveyed which needs to be plotted. After having surveyed those points, they are plotted and the contours are drawn through them. The method is slow and tedious and is used for the small areas where great accuracy is required.

In the indirect method, some suitable guide points are selected and surveyed; the guide points need not necessarily be on the contours. These guide points, having been plotted, serve as basis for the interpolation of contours. This is the method most used in engineering surveys.

Interpolation of the Contour lines:

Interpolation of the contour is the process of spacing the contours proportionately between the plotted ground points established by indirect methods. The method of interpolation is based on the assumption that the slope of the ground between the two points, which are surveyed, is uniform. There are different methods of interpolation of contours. They are as follows:

i. Estimation ii.

Arithmetic

calculations iii.

Graphical method **i.**

Estimation:

This method is extremely rough and is used for small scale work only. The position of the contour points between the guides points are located by estimation.

ii. Arithmetic Calculations:

The method, though accurate, is time consuming. The position of contour points between the guide points are located by arithmetic calculation.

$X=H\times Y/V$

where,

X= Horizontal distance of the point to be located

H= Horizontal distance between two guide points

V= Vertical distance between two guide points

Y= Vertical distance between the point to be located and lower elevation point

iii. Graphical Method:

In the graphical method, the interpolation is done with the help of a tracing paper or a tracing cloth.

Result

The longest distance of the traverse was 140.464m and the least distance of the traverse was 74.261m.

Comments and Conclusion:

In this way, topographical map of the detail area was created, for which first the control stations were located and the lengths between the stations were taken. Levelling and then fly levelling were done to determine elevations of several points. The measurements related to details were taken with total station which were plotted later on A1 paper on scale 1:600.

ROAD ALIGNMENT SURVEY

Introduction:
Roads are paths prepared to provide ways between different places for the use of the vehicles, people and the animals. Roads are used in countries like Nepal, where there are less chances of airways and almost negligible chances of other transportation systems. Rural road alignment has mainly two important tasks – to run a road between two points, i.e. to fix or choose appropriate road alignment between two points which are far apart and to carry out the survey for the safe, economical and appropriate construction along the route. This specific job is essential for an engineer combating with the mountainous topography of Nepal. This part of the survey camp deals with the road alignment survey carried out at Bhalam-Bridge to Swine Farm beside Kali Stream.

Objectives of road alignment survey:
The following are objectives of carrying out road alignment survey:

- To set out curve with appropriate radius and deflection angle.
- To prepare plan, cross-section and L-section of the road.
- To work in co-ordination with team members to ease out setting of curve.
- To get technical knowledge on working procedure & methodology on setting out curve.

Brief description of the area:
The site for the road alignment survey is located at Bhalam-Bridge to Swine Farm beside Kali Stream, which is almost 20 minutes' walk from the campus area where the topographic survey was carried out. The place was accessible via various suspension bridges and a motorable bridge from Dip & Batulechaur areas. The area was surrounded by hills and Kali stream flowing beside made the environment cooler. The land was undulated with no large boulders or rocks of any kind along the proposed site. The soil is uniform throughout the whole length of the road. Soft clayey soil was found along the road course.

Technical specifications (Norms):

1. Simple horizontal circular curves had to be set out where the road changed its direction, determining and pegging three points on the curve- the beginning of the curve, the middle of curve and the end of the curve along the centerline of the road.
2. A convenient radius and deflection angle was chosen.
3. The plan was drawn in A1 paper on scale 1:500.
4. L-section was drawn in graph paper to determine total cut and fill.
5. Cross sections were drawn in graphs to determine cuts and fills. They were drawn on scale 1:100.

Instruments used:

The equipment used in the surveying during the road alignment survey are as follows:

1. Theodolite
2. Tripod stand
3. Ranging rods
4. Level machine
5. Levelling staff
6. Measuring Tape
7. Pegs
8. Hammer
9. Marker
10. Field book

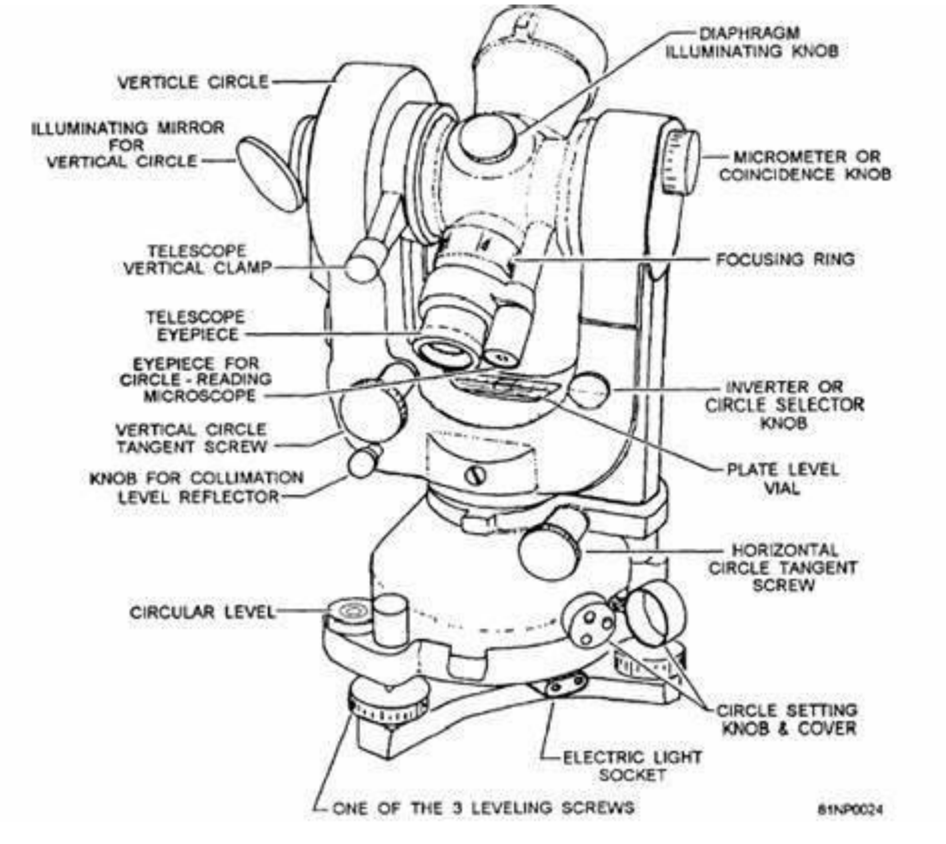


Figure 11: Theodolite and its parts

A theodolite is a highly accurate instrument used for measuring horizontal and vertical angles. Though this instrument may appear complicated, its manipulation is simple. The theodolite is used only for measuring angles, both vertical and horizontal, and for placing marks, or stations, in a straight line in any desired direction. However, it is not used for the purpose of making calculations directly. Tacheometry and trigonometric levelling can be done to determine the distances or vertical heights.

The instrument is mounted on three strong legs to give rigidity, and is set up directly over a mark, or station, by a "plumb bob" hanging from the instrument. The machine is levelled up true by thumb screws operating a spirit bubble, like that on a carpenter's level. For horizontal angles two flat circular plates, about six inches in diameter and half an inch thick, move one above the other. The edge of the lower plate is graduated with great precision shewing degrees and half degrees, and on the upper plate is a scale shewing further graduation in minutes. The moving of one plate on the other permits of any angle through which the plates have moved being read. For vertical angles two similar plates with the graduated markings are mounted vertically on the machine. The complete circle is divided into 360 degrees, each further divided by the upper scale into 60 minutes, and further divided into 60 seconds.

Mounted on the horizontal axis of the instrument is a small telescope, whose other end is eyepiece, of which fine cross lines intersect at right angles fixing the central point in the line of sight.

Methodology:

Fixing of stations:

By visual inspection and self-judgment, the appropriate location for the stations to be placed is decided which is basically done by inspecting where the road had turns. The stations were named IP0, IP1, and IP2 and so on.

Measurement of Lengths and Deflection Angles:

The distances between the IP's were measured with the help of measuring tape by ranging between IP's. One set of horizontal angles was measured for the deflection angle. The face left reading was observed, and the deflection angles were calculated. As the traverse formed as open traverse, no angular correction could be made. So as far as possible, both the linear measurements as well as the angular measurements were observed carefully and precisely.

Horizontal Alignment:

The center line of the road for fixing the direction of the proposed road in the horizontal plane is known as horizontal alignment. For fixing horizontal alignment, the bearing of the initial line connecting two initial IP's was measured using compass. The interior angle was measured with the help of theodolite at each IP and the deflection angles were computed.

Deflection angle (Δ) = (360° or 180°) – observed angle

Curve Setting:

Curves are generally used on rural road where it is necessary to change the direction of the motion of the vehicle. A curve may be circular, parabolic or spiral and is always tangential to the two straight directions commonly known as tangents. Curves which are generally used on highways are as follows:

1. Simple Circular Curve

2. Transition Curve

3. Vertical Curve

1. Simple Circular Curve:

A simple circular curve is the one which consists of a single arc of a circle. It is tangential to both straight lines namely tangents. During the road survey, it is always kept in mind that the radius of the simple circular curve should not be less than 12m. As far as possible, flat circular curves are preferred to that of the sharp one. Flat curves are comfortable to the passengers and there is less possibility of accident. Before setting out the curve, its elements are essential to be computed. Some essential elements of simple circular curve are as follows:

• Length of Tangent = $R\tan\Delta/2$

Where, R= radius of simple circular curve & Δ = deflection angle

• Length of long chord = $2R\sin\Delta/2$

• Apex distance = $R\ (\sec\Delta/2-1)$

• Mid ordinate = $R\ (1-\cos\Delta/2)$

• Length of curve = $\pi R\Delta/180$

• Chainage of T1= Chainage of IP - $R\tan\Delta/2$

• Chainage of T2= Chainage of T1 + $\pi R\Delta/180$

Setting out of Simple Circular Curves a simple circular curve can be set in the field by various linear and angular methods which are listed as follows:

a. Linear method: Linear method is defined as the method of setting curve in which only chain or tape is used, i.e. no angular instruments are used to set the curve. This method is preferable where high accuracy is not required and the length of the curve to be set is short. Some common linear methods of setting of the simple circular curve are as follows:

• By ordinates from the long chord

• By perpendicular offset from tangents

• By radial offset from tangents

• By offset from the chords produced

• By successive bisection of the curves

b. Angular method: Angular method is the one in which both angles and the distances are used to set the curve in the field. Generally, tangential deflection angle is observed with the help of theodolite and the distance is measured by making use of tape provided. Some of the most common angular methods of setting out of simple circular curve are as follows:

• Rankine's method of tangential angles

• Two Theodolite method

Levelling and fly levelling to determine reduced levels:
Levelling operation was carried out to determine the reduced levels of the road at various chainages. L-section and similarly, cross-sections were drawn with its help to determine total volume of cut/fill required.

After setting out curve, following works are done:

1. The plan of the road is drawn on scale 1:1000 in A1 paper.
2. The longitudinal section of the road is drawn to determine total height of cut/fill.
3. Cross sections at every 20 m intervals are drawn using the data obtained from the field like side slopes, chainage, etc. considering drainage and maintaining a stable slope. The cross-sections are drawn in scale 1:100 in graph papers.

Result:
The highest elevation of the road levelling was found to be 1030.699m and the lowest elevation was found to be 999.252. The latitude and departure of each station of traverse was tabulated in the table.

Comments and Conclusion:
Survey of the road alignment is done to make safe, easy, short and economical road. Geological stability and soil stability are also considered. Horizontal curves are set according to Road design standards for comfort and other factors.

While setting the road alignment, it should be kept in mind that the minimum IP points should be taken as far as possible and deflection angles should be minimal as far as possible. In this way, road survey work was carried out successfully.

BRIDGE SITE SURVEY

Introduction:
The bridge site survey is intended to determine the appropriate location for bridge site selection. This survey was carried out on Kali Stream. Bridges are important infrastructures in engineering and therefore, appropriate measures should be taken during their site selection and construction. Bridge site survey included determination of length of bridge axis by triangulation, determination of R.L. of a station by reciprocal levelling, and drawing cross-sections of river.

Location:
The venue for this survey was in Kali stream. It lies besides the Bhalam-Dadagaon Road. This site could be accessible from the Pashchimanchal Campus at an estimated 20 minutes' walk.

Geology of the area:
This site was surrounded by vertical cliffs on sides. There was huge elevation difference as we proceeded towards south. The river was basically wide with not that large volume of water as the survey was carried out in dry season, making us easy to perform the survey.

Objectives of bridge site survey:
The following are objectives of carrying out bridge site survey:

- To determine the length of bridge axis by triangulation.
- To perform reciprocal levelling to determine the elevation of one of the stations.
- To determine the L-section, contour map and cross-sections to get general idea on the layout of river.
- To determine if bridge placed on that axis will be feasible or not in long-term.
- To work in co-ordination with team members to gain concept on this topic.
- To get technical knowledge on working procedure & methodology on this field.
- To uplift our knowledge of software like EXCEL, AUTOCAD, SWDTM, etc. that may come into use.

Technical specifications (Norms):
1. First of all, triangulation was done to determine the length of bridge axis.
2. Then, reciprocal levelling was carried out to determine the elevation of one of the stations.
3. Marks were made at intervals of every 25m upstream and downstream about the main station up to total length of 150m upstream and 75m downstream.
4. Tacheometric surveying was carried out to determine horizontal angles of all staff positions placed at various points and their staff readings too.

5. From these data, reduced levels of all staff positions were calculated.
6. These data were utilized to draw the L-section, cross-section and contour map of river in appropriate scales.

Instruments used:

- Pegs
- Theodolite
- Tripod stand
- Ranging rods
- Levelling staffs
- Markers
- Field book

Methodology:

Following steps were adopted during the bridge site survey:

Triangulation:

Triangulation surveying is the tracing and measurement of a series or network of triangles to determine distances and relative positions of points spread over an area, by measuring the length of one side of each triangle and deducing its angles and length of other two sides by observation from this baseline.

Triangulation is preferred for hills and undulating areas, since it is easy to establish stations at reasonable distances apart, with inter-visibility. In plane and crowded areas, it is not suitable as the inter-visibility of stations is affected. The difficulty is overcome by building towers which is quite expensive.

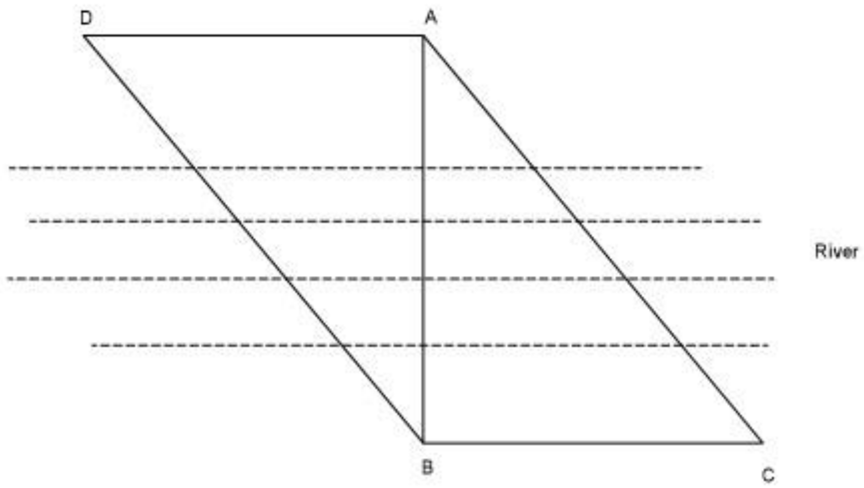


Figure 12: Triangulation

Reciprocal levelling:

It is better to keep distance of fore sight and back sight equal in levelling the following errors are eliminated by doing so:

-Error which occurs due to non-parallelism of line of collimation and axis of bubble tube. - Errors which are occur due to curvature and refraction.

But in levelling across obstacles like ravines and rivers, it is not possible to maintain equal distances for back sight and fore sight. In such case reciprocal levelling as described below is used:

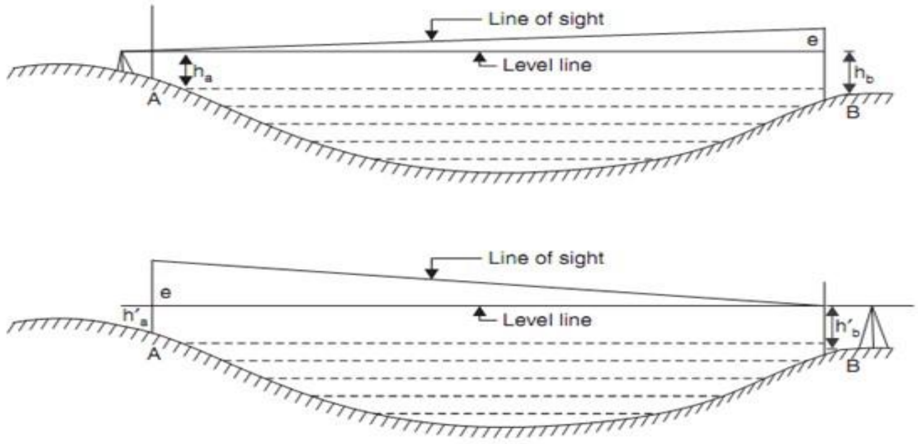


Figure 13: Reciprocal Levelling

Referring to first figure:

Since A is very near, error in reading at A is negligible. Therefore, h_a is accurate reading. Assume error in h_b be 'e',

Then accurate reading at B = h_b - e

∴ Difference in elevations = H = $h_a - (h_b - e)$ ... (i)

(ii) Referring to second figure, since B is very near to instrument, $h_{b'}$ may be taken as accurate reading.

Accurate reading at A = $h_{a'} - e$

Difference in elevations H = $(h_{a'} - e) - h_{b'}$ ... (ii)

From equations (i) and (ii) we obtain,

$2H = h_a - (h_b - e) + (h_{a'} - e) - h_{b'}$

$= (h_a + h_{a'}) - (h_b + h_{b'})$

Therefore, $H = ((h_a + h_{a'}) - (h_b + h_{b'})/2)$

Therefore, the true difference in the elevations of the 2 points is equal to the mean of the 2 apparent differences in the elevations.

Tacheometry:
Tacheometry is a branch of angular surveying in which the horizontal and vertical distances of points are obtained by optical means. Though it has less accuracy, it is faster and convenient than the measurements by tape or chain. It is very suitable for steep or broken ground, deep ravines, and stretches of water or swam where taping is impossible.

The objective of the tacheometric survey is to prepare contoured maps or plans with both horizontal and vertical controls. For the survey of high accuracy, it provides a check on the distances measured by tape. The formula for the horizontal distance is,

$H = K \times S \times \text{Cos}^2\Theta + C \times \cos\Theta$

Where S = Staff intercept = T - B

K = Multiplying constant = 100

C = additive factor = 0 (For analytical lens).

The formula for the vertical distance is,

$V = (½)\times K \times S \times \text{Sin}2\Theta + C \times \sin\Theta$

Where, S = staff intercept

And Θ = Vertical Angle

Thus, knowing the V value, reduced level (R. L.) of instrument station, Height of instrument (H. I.) and central wire reading (h) the R. L. of any point under observation can be calculated as:

R. L. of point = R. L. of instrument station + H. I. ± V- h

Paper works:
Finally, the reduced levels of all the staff positions were determined using tacheometry. Knowing chainage and elevations, contour map was drawn on scale 1:500 with contour interval 1 m. longitudinal section of river was drawn on graph paper indicating high flood level and existing flood levels. Cross sections at each 25 m interval were drawn on a scale of vertical 1:100 and horizontal 1:500 on graph papers.

Result:
The smallest RL was found to be 953.43 along downstream at the chainage of (0+020) and the highest RL at the bed level was found to be 988.12 along upstream at the chainage of (0+120) by tacheometry. By reciprocal leveling the leveling difference of the of the station of bridge was found to be 1.9795.

Comments and conclusion:
Hence, in this way, bridge site survey was carried out across Kali Stream and length of bridge axis was determined by triangulation, reduced level of one of the stations by reciprocal levelling, reduced level across different intervals upstream and downstream were determined by tacheometry and finally these data were plotted in the form of longitudinal section, cross-sections and contour maps to decide the feasibility of bridge site selection. The data agrees to feasibility of the bridge site selection as high flood level determined is not that high, also the length of bridge axis is not that high. No meandering of river also hints feasibility for the bridge construction.

Recommendation:

Since, survey is not the work to be done by single individual, team work is the must in the survey field and in our project work. In each and every task whenever there is confusion it’s better to ask for teacher’s help rather them assuming the conclusion by oneself. We should be careful on selecting the proper and least control stations for the topographic maps. We should be careful so that we make mistakes at least as possible. Division of work and management of time is must. Afterall, we should have fun along with our work.

In our road site survey, we should take the proper care while selecting the curves so as not to form the reverse curve. We should be skillful on using all the instruments and also be co-operative in group while and after completion of survey work. In bridge-site survey, fast and careful data observation should be done since there is a lot more chance of error occurrence. We should be prepared for all climatic condition and the situations you didn’t hope for. In conclusion, survey is not just a work to be done, it is the skill to be learnt, team work to be done to move forward to know little more about the real field.

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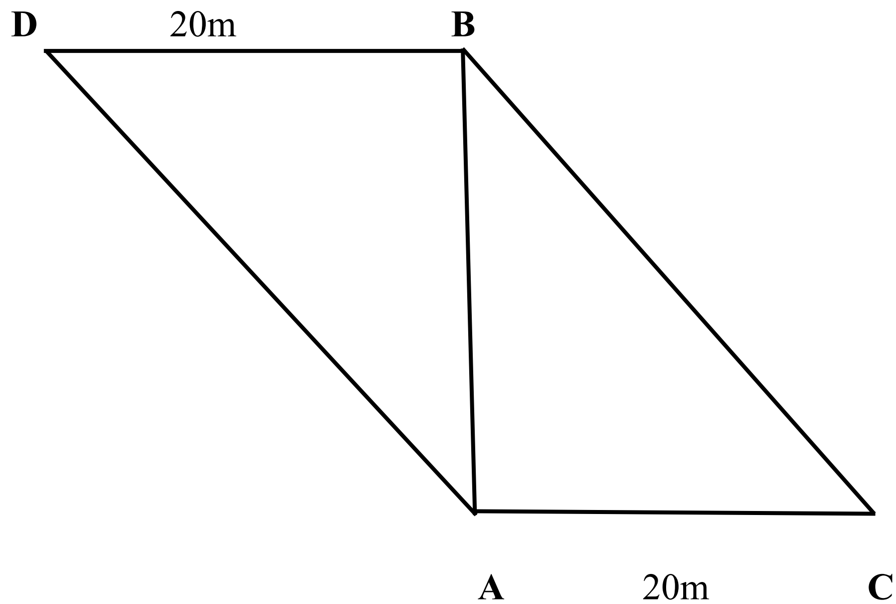
BRIDGE SITE SURVEY

Reciprocal Levelling

Reading at A			Reading at B			Mean Central Value(a1)		Mean Central Value (b1)	
T	M	B	T	M	B				
0.812	0.787	0.762	2.9	2.77	2.64	0.787		2.77	
Level difference=h=a1-b1=1.983									
Second Set (Instrument at another bank)									
Reading at A			reading at B			Mean Central Value(a2)		Mean Central Value(b2)	
T	M	B	T	M	B				
2.962	2.928	2.894	1.075	0.952	0.829	2.928		0.952	
Level difference=h'=a2-b2=1.976									
True level difference between two points (H)=(h+h')/2=1.9795									



Here,

From△ ABC, AB= 21.7406m

From△ ABD, AB= 21.8255m

Span of bridge= 21.78305m

TRIANGULATION TABLE

<table>
<tr><th rowspan="2">Inst. Stn.</th><th rowspan="2">Sighted To</th><th colspan="3">HCR</th><th colspan="3">Angle</th><th colspan="3">Mean</th><th colspan="3">Horizontal Angle</th><th rowspan="2">Remarks</th></tr>
<tr><th>D</th><th>M</th><th>S</th><th>D</th><th>M</th><th>S</th><th>D</th><th>M</th><th>S</th><th>D</th><th>M</th><th>S</th></tr>
<tr><td rowspan="4">A</td><td rowspan="2">B</td><td>0</td><td>0</td><td>0</td><td rowspan="2">96</td><td rowspan="2">40</td><td rowspan="2">50</td><td rowspan="4">96</td><td rowspan="4">40</td><td rowspan="4">49</td><td rowspan="8">96</td><td rowspan="8">40</td><td rowspan="8">46.5</td><td rowspan="4">Set - 1</td></tr>
<tr><td>180</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">D</td><td>96</td><td>40</td><td>50</td><td rowspan="2">96</td><td rowspan="2">40</td><td rowspan="2">48</td></tr>
<tr><td>276</td><td>40</td><td>48</td></tr>
<tr><td rowspan="4">A</td><td rowspan="2">B</td><td>60</td><td>0</td><td>0</td><td rowspan="2">96</td><td rowspan="2">40</td><td rowspan="2">8</td><td rowspan="4">96</td><td rowspan="4">40</td><td rowspan="4">44</td><td rowspan="4">set-2</td></tr>
<tr><td>240</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">D</td><td>116</td><td>41</td><td>8</td><td rowspan="2">96</td><td rowspan="2">41</td><td rowspan="2">20</td></tr>
<tr><td>376</td><td>41</td><td>20</td></tr>
<tr><td rowspan="4">D</td><td rowspan="2">A</td><td>0</td><td>0</td><td>0</td><td rowspan="2">41</td><td rowspan="2">7</td><td rowspan="2">24</td><td rowspan="4">41</td><td rowspan="4">7</td><td rowspan="4">35.5</td><td rowspan="8">41</td><td rowspan="8">7</td><td rowspan="8">29</td><td rowspan="4">set-1</td></tr>
<tr><td>180</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">B</td><td>41</td><td>7</td><td>24</td><td rowspan="2">41</td><td rowspan="2">7</td><td rowspan="2">47</td></tr>
<tr><td>221</td><td>7</td><td>47</td></tr>
<tr><td rowspan="4">D</td><td rowspan="2">A</td><td>60</td><td>0</td><td>0</td><td rowspan="2">41</td><td rowspan="2">7</td><td rowspan="2">25</td><td rowspan="4">41</td><td rowspan="4">7</td><td rowspan="4">22.5</td><td rowspan="4">set-2</td></tr>
<tr><td>240</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">B</td><td>101</td><td>7</td><td>25</td><td rowspan="2">41</td><td rowspan="2">7</td><td rowspan="2">20</td></tr>
<tr><td>281</td><td>7</td><td>20</td></tr>
<tr><td rowspan="4">A</td><td rowspan="2">C</td><td>0</td><td>0</td><td>0</td><td rowspan="2">56</td><td rowspan="2">34</td><td rowspan="2">44</td><td rowspan="4">56</td><td rowspan="4">34</td><td rowspan="4">45.5</td><td rowspan="4">56</td><td rowspan="4">34</td><td rowspan="4">45.5</td><td rowspan="4">set-1</td></tr>
<tr><td>180</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">B</td><td>56</td><td>34</td><td>44</td><td rowspan="2">56</td><td rowspan="2">34</td><td rowspan="2">47</td></tr>
<tr><td>236</td><td>34</td><td>47</td></tr>
</table>

A	C	60	0	0	56	34	46	56	34	45				set-2
		240	0	0										
	B	116	34	46	56	34	44							
		296	34	44										
B	A	0	0	0	92	2	39	92	2	39.5	92	2	40.5	set-1
		180	0	0										
	C	92	2	39	92	2	40							
		272	2	40										
B	A	60	0	0	92	2	40	92	2	41.5				set-2
		240	0	0										
	C	152	2	44	92	2	43							
		332	2	43										
B	D	0	0	0	42	12	55	42	12	54	42	12	53	set-1
		180	0	0										
	A	42	12	55	42	12	53							
		222	12	56										
B	D	60	0	0	42	12	53	42	12	52				set-2
		240	0	0										
	A	102	12	55	42	12	51							
		312	12	57										

ROAD-SITE SURVEY

ROAD ALIGNMENT TABLE

IP	Distance Between IP	Deflection Angle(Δ)	Radius(R)	Tangent Length(TL)	Curve Length(L)	Mid Ordinate	Apex Distance	Chainage of IP	Chainage of BOC	Chainage of MOC	Chainage of EOC	Remarks
SP	-	Bearing = 38.0194										
IP1	40.297	17.7125	50	7.791	15.457	0.596	0.603	40.297	32.506	40.235	47.963	Right
IP2	41.344	49.62	20	9.246	17.321	1.846	2.034	81.517	72.271	80.932	89.592	Right
IP3	30.05	96.178	15	16.711	25.179	4.980	7.456	110.396	93.685	106.275	118.864	Left
IP4	63.72	52.436	30	14.774	27.455	3.086	3.440	165.873	151.099	164.827	178.555	Right
IP5	91.693	71.206	30	21.480	37.283	5.608	6.897	255.474	233.994	252.636	271.277	Right
IP6	71.08	27.809	40	9.902	19.414	1.172	1.207	320.877	310.975	320.682	330.389	Left
IP7	66.64	44.358	35	14.268	27.097	2.590	2.797	387.127	372.859	386.407	399.955	Right
IP8	69.595	17.217	50	7.569	15.025	0.563	0.570	455.282	447.713	455.225	462.737	Right
IP9	47.5	28.63	40	10.207	19.988	1.242	1.282	502.668	492.461	502.455	512.448	Right
IP10	31.06	47.438	35	15.378	28.978	2.956	3.229	533.301	517.924	532.413	546.902	Left(37.06)
IP11	41.004	17.999	50	7.919	15.707	0.616	0.623	572.528	564.609	572.463	580.316	Left
IP12	25.82	37.563	35	11.902	22.946	1.864	1.968	598.218	586.315	597.788	609.261	Right
IP13	52.89	38.309	35	12.157	23.402	1.938	2.051	650.249	638.092	649.793	661.493	Left
IP14	44.2	20.911	50	9.227	18.248	0.830	0.844	693.536	684.309	693.434	702.558	Right
IP15	53.64	24.4925	40	8.682	17.099	0.910	0.931	746.971	738.289	746.838	755.388	Left
IP16	24.25	49.266	20	9.171	17.197	1.820	2.002	770.956	761.785	770.384	778.982	Left
IP17	35.04	16.466	50	7.235	14.369	0.515	0.521	804.852	797.617	804.802	811.986	Left
IP18	50.92	13.599	50	5.962	11.867	0.352	0.354	855.672	849.710	855.644	861.577	Right
IP19	34.68	22.304	40	7.885	15.571	0.755	0.770	890.296	882.410	890.196	898.331	Left

CROSS SECTION LEVELING TABLE

Chainage	Distance			BS	IS	FS	HI	RL	Remark
	Left	Center	Right						
				0.725			897.725	897	B.M
0+000		0			1.384			896.341	Starting point
	3.5				1.406			896.319	
	7				0.901			896.824	
			2.5		1.35			896.375	Vertical Cliff
0+020		0			0.78			896.945	
			3.5		1.51			896.215	
			7		1.61			896.115	
	2.5				1.686			896.039	Slope=36.430 %
0+032.507		0			0.532			897.093	B.O.C(I)
				3.5	1.102			896.623	
				7	1.524			896.201	
	3.5				1.206			896.519	
0+040.235		0			0.505			897.22	M.O.C(I)
			3.5		0.745			896.98	
			7		1.29			896.435	
	5				0.445			897.28	Sloppe=35.5376%
			1.445			0.725	898.445	897	
0+047.964		0			1.178		898.445	897.267	E.O.C(I)
	3.5				1.51			896.935	
			3.5		0.675			897.77	
			7.5		0.594			897.851	
0+060		0			1.391			897.054	
	3.5				1.676			896.769	
			3.5		1.2			897.245	
			9.5		0.771			897.674	
0+072.275		0			1.867			896.578	B.O.C(II)
	3.5				1.929			896.516	
	5.5				2.548			895.897	Vertical Cliff
			3.5		1.446			896.999	
			8.5		1.398			897.047	
0+080.733		0			2.17			896.275	M.O.C(II)
	3.5				1.851			896.594	

	5.5				1.711			896.734	Vertical Cliff
			3.5		2.039			896.406	
			7		2.388			896.057	
0+089.598		0			2.66			895.785	E.O.C(II)
	3.5				2.439			896.006	
	5.5				2.079			896.366	
			3.5		2.875			895.57	
			6.5		2.768			895.677	Vertical Cliff
0+093.689		0			2.195			896.25	B.O.C(III)
	3.5				2.815			895.63	
	6.5				2.521			895.924	
			3.5		3.332			895.113	
			6		2.94			895.505	
0+106.280		0			4.671			893.774	M.O.C(III)
	1.5				4.592			893.853	
			3.5		4.635			893.81	
			7		4.59			893.855	
			9	3.079		4.56	896.964	893.885	
0+118.872		0			2.38			894.584	EOC(iii
0+120		0			2.35			894.614	
0+140		0			2.39			894.574	
0+151.108		0			2.379			894.585	beginning of curve -iv
0+164.835		0			2.104			894.86	
	3.5				2.053			894.911	
	4.5				1.914			895.05	corner of house
			3.5		2.075			894.889	Starting point
			5		2.143			894.821	
					0.468			896.496	pp
	3.5				0.472			896.492	
			3.5		0.457			896.507	
			7	3.865		0.47	900.359	896.494	
0+180		0			3.642			896.717	
	3.5				3.785			896.574	
	7				3.225			897.134	corner of house
			2		3.335			897.025	private property
0+200					0.347			900.012	
			3.5		0.448			899.911	

			5.5		0.425			899.934	private property
	3.5				0.401			899.958	Public heritage
0+201		0				0.234	903.67	900.125	
0+220		0			1.112			902.558	
	3				0.811			902.859	
			3.5	4.071	1.142			902.528	
	3.5		5			1.162		902.508	Public heritage
0+234.003		0			2.7			903.879	beginning of curve -v
	3.5				2.236			901.643	
	5				3.2			903.379	
			3		1.61			904.969	
0+244.003		0		3		1.078	908.501	905.501	CP
0+252.647		0			1.709			906.792	MOC-V
			1.5		1.729			906.772	corner of house
	3.5				2.171			906.339	
	7				2.246			906.255	
0+260		0		2.554		1.847	909.208	906.654	CP
0+271.291		0			1.561			907.647	E0C-V
			3		1.201			908.007	slope=48.690
	3.5				1.631			907.577	
	4.5				1.632			907.576	Vertical Cliff
			5.5		2.106			907.102	
0+280		0			0.73			908.478	
			3.5		0.242			908.966	Vertical Cliff
	3.5				0.805			908.403	
0+285		0		3.698		0.342	912.564	908.866	cp
0+300		0			3.51			909.054	
			3.5		3.190\			909.374	
			6		4.25			908.314	private wall
	3				3.555			909.009	Vertical Cliff
0+310.989		0			2.63			909.934	
			3.5		2.125			910.439	
	4				2.485			910.079	Vertical Cliff
0+320.697		0			1.688			910.876	
			3.5		1.507			911.063	
			6.5		1.276			911.288	slope=58.370%

	2				1.595			910.969	Vertical Cliff
0+330.406		0			0.642			911.922	
			2.5		0.792			911.772	Vertical Cliff
	3.5				0.829			911.735	
	6				0.79			911.774	
0+340		0		3.495		0.156	915.903	912.408	
			2.5		3.19			912.713	Vertical Cliff
	3.5				3.75			912.153	
	5.5				3.86			912.043	Vertical Cliff
0+360		0			2.337			913.566	
	3.5				2.005			913.898	
	5.5				1.912			913.991	Vertical Cliff
			4		2.201			913.701	Vertical Cliff
0+372,87		0	3.5		1.101			914.802	
			7		0.507			915.396	Vertical Cliff
	3			2.759		1.258	917.404	914.645	Vertical Cliff
	6				2.888			914.816	
0+386.48		0			2.206			915.198	
			3.5		2.254			915.15	
			6.5		1.67			915.734	slope=42.177%
	3.5				2.355			915.049	
	5				2.586			914.818	
0+399.966		0			1.325			916.079	
			3.5		1.064			916.34	slope=38.66%
	3.5				1.363			916.041	
	7				1.489			915.915	
0+410		0		3.541		0.293	920.652	917.111	cp
0+420		0			2.67			917.982	
			3.5		2.545			918.107	Vertical Cliff
	3.5				2.741			917.911	
	7				2.676			917.977	Vertical Cliff
0+430		0		3.719		1.382	922.989	919	
0+440		0			2.094			920.895	
			3.5		1.876			921.113	
			7		1.649			921.34	
			10.5		1.225			921.764	
0+447.723		0			0.932			922.057	BOC-8
	3.5				0.759			922.23	
	7				0.482			922.507	
			3.5		1.195			921.794	

			7		1.118			921.871	
0+455.236		0			0.248			922.741	MOC-8
			3.5		0.355			922.634	
			7		0.416			922.573	
	3.5				0.7			922.289	CLIFF
0+462.748		0			0.436			922.559	E0C-8
	1				0.265			922.124	
			3.5		0.531			922.458	
			7	2.344		0.87	924.463	922.119	
0+480		0			1.675			922.778	
			3.5		1.549			922.914	Vertical Cliff
	3.5				1.309			923.154	cliff
		0			2.966			921.497	BOC-9
			2		2.924			921.539	
	3.5				2.805			921.658	
0+502.466		0			3.758			920.905	MOC-9
	3				3.072			921.391	
			3.5	0.431		3.519	921.376	920.944	
0+512.46		0			1.092			920.284	EOC-9
	1.5				0.951			920.425	
			3.5		1.148			920.228	
			5.5		1.054			920.322	CLIFF
0+517.996		0			1.347			920.029	BOC-10
	1				1.107			920.269	cliff
			3.5		1.386			919.99	
			6.5		1.379			919.997	cliff
0+531.481		0			1.601			919.775	MOC-10
	2.5				1.303			920.073	SLOPE=34.786%
			3.5		1.571			919.805	
			4.5		1.582			919.794	CLIFF
0+546.966		0			1.594			919.782	EOC-10
	2				1.56			919.816	BUSHY ROAD
			3.5		1.571			919.805	SLOPE=39.215%
0+560		0			1.493			919.883	Vertical Cliff
			3.5		1.374			920.002	
			7.5		0.988			920.388	
			8.5		0.821			920.555	
0+564.683		0			1.303			920.073	BOC-11

			3.5	1.054		1.085	921.345	920.291	CP
		3			1.15			920.195	Vertical Cliff
0+572.536		0			1.254			920.091	MOC-11
			3.5		1.201			920.144	CLIFF
	1				1.119			920.226	BAR
0+580.390		0			1.369			919.976	EOC-11
			1		0.96			920.385	BAR
	3				1.569			919.776	CLIFF
0+586.398		0			1.808			919.537	BOC-12
			1		1.7111			919.634	WALL
	3				1.589			919.756	
0+597.871		0			2.475			919.87	MOC-12
			1.5		2.082			919.263	WALL
	3.5			0.288		2.24	919.393	919.105	CLIFF
0+609.544		0			1.314			918.079	EOC-12
	2.5				1.17			918.223	WALL
			1.5		1.239			918.154	CLIFF
0+620		0			2.852			916.531	
			3.5		2.582			916.811	
	1.5			0.488		2.69	917.191	916.703	CP
0+640		0		1.278		3.31	915.159	913.881	CP
0+637.3		0			1.939			914.21	BOC-13
			3.5		1.195			913.964	
	3.5				0.948			914.211	
0+649.875		0			1.076			913.083	MOC-13
			3.5		1.854			913.305	
	3.5				1.863			913.296	
0+661.576		0			2.772			913.047	EOC-13
	3				2.565			912.594	
			1.5		2.615			912.544	ROAD
0+684.392		0			2.936			912.223	BOC-14
	2				2.66			912.499	Vertical Cliff
			3	1.597		3.121	913.635	912.038	
0+693.516		0			1.534			912.101	NOT VISIBLE
			3.5		1.254			912.381	
	1.5				1.544			912.091	
0+702.64		0			1.07			912.565	
			3.5		0.939			912.696	
			5		0.614			913.021	
0+720		0			1.063			912.572	

	2				0.935			912.7	
			2		0.689			912.946	
0+738.371		0			2.434			911.201	
	2				2.048			911.587	
			3		1.874			911.761	
0+746.92		0			3.334			910.301	
	2				3.049			910.586	
			3.5	0.595		3.165	911.065	910.47	
0+755.469		0			1.674			909.391	
	2				0.752			910.313	
			2.5		1.439			909.626	
			5.5		1.173			909.892	
0+762.137		0			2.129			908.936	BOC-15
	3				1.371			909.694	
			3.5		2.068			908.993	
			5		2.001			909.064	
0+770.736		0			2.81			908.255	MOC-15
			3		2.814			908.251	
	3				1.614			909.424	
0+779.934		0			3.27			907.795	
			2		3.23			907.835	
	3			0.369		2.574	908.86	908.491	
0+797.972		0			3.487			905.373	
	2				3.195			905.665	
			3.5		3.483			905.377	
			5.5	0.936		3.611	906.185	905.249	
0+805.154		0			1.541			905.644	
	2.5				1.106			905.079	
			3.5		1.398			904.787	
0+812.339		0			2.22			903.965	
			3.5		2.294			903.891	
	1.5				2.111			904.074	
0+820		0			3.099			903.086	
			3.5		3.095			903.09	
			4.5		3.096			903.089	
	1			1.106		3.097		903.088	
0+840		0			1.693			902.501	
	1.5				1.642			902.552	
			3		1.71			902.484	BOC-16
0+850.061		0			1.686			902.508	

			3		1.787			902.407	
	1.5				1.534			902.66	
0+855.994		0			1.416			902.778	
	2.5			3.647		1.247		902.947	
	5			3.645		1.14		905.454	
			2.5		3.884			905.215	
			5	3.883		3.886		905.213	
0+882.761		0			2.945			906.151	
	3.5				2.73			905.366	
0+890.546		0			1.566			907.53	
	3.5				1.83			907.266	
	5				1.717			907.379	
0+898.331		0			1.612			907.484	
	3.5					1.901		907.195	

FLY LEVELLING TABLE OF ROAD

S. No	Back Sight(BS)			Fore Sight (FS)			Rise	Fall	Reduced Level(RL)	Distance		Remarks
	T	M	B	T	M	B				BS	FS	
1	3.805	3.659	3.514						920.705	10		B.M
2	0.358	0.31	0.264	1.145	1.19	1.235	2.469	0	923.174	10	10	
3	0.201	0.161	0.119	2.803	2.76	2.713	0	2.45	920.724	10	10	
4	0.26	0.2	0.14	2.813	2.764	2.726	0	2.603	918.121	10	10	
5	0.515	0.57	0.635	2.226	2.183	2.134	0	1.983	916.138	10	10	
6	0.702	0.656	0.61	2.365	2.31	2.255	0	1.74	914.398	10	10	
7	0.655	0.599	0.541	2.288	2.245	2.201	0	1.589	912.809	10	10	
8	0.515	0.459	0.401	2.466	2.411	2.356	0	1.812	910.997	10	10	
9	0.482	0.421	0.36	2.572	2.516	2.46	0	2.057	908.94	10	10	
10	0.828	0.772	0.716	3.164	3.095	3.025	0	2.674	906.266	10	10	
11	0.412	0.35	0.288	3.225	3.197	3.14	0	2.425	903.841	10	10	
12	0.275	0.225	0.175	2.876	2.821	2.762	0	2.471	901.37	10	10	
13	0.495	0.447	0.4	3.401	3.343	3.286	0	3.118	898.252	10	10	
14	0.372	0.336	0.3	3.224	3.163	3.102	0	2.716	895.536	10	10	
15	0.384	0.32	0.256	2.835	2.8	2.765	0	2.464	893.072	10	10	
16	1.621	1.561	1.502	1.792	1.721	1.656	0	1.401	891.671	10	10	
17	1.861	1.775	1.689	1.66	1.601	1.547	0	0.04	891.631	10	10	
18	2.89	2.945	2.005	0.865	0.807	0.75	0.968	0	892.599	10	10	
19	2.021	1.955	1.889	0.87	0.81	0.75	2.135	0	894.734	10	10	
20	1.501	1.442	1.385	1.276	1.211	1.148	0.744	0	895.478	10	10	
21	1.19	1.111	1.031	2.196	2.136	2.074	0	0.694	894.784	10	10	
22	1.666	1.605	1.544	1.555	1.475	1.395	0	0.364	894.42	10	10	
23				1.049	0.993	0.94	0.612	0	895.032		10	Check Stn.

S. No	Back Sight(BS)			Fore Sight (FS)			Rise	Fall	Reduced Level(RL)	Distance		Remarks
	T	M	B	T	M	B				BS	FS	
1	1.572	1.473	1.374						907.195	20		B M
2	0.962	0.862	0.762	3.712	3.612	3.512		2.139	905.056	20	20	
3	1.651	1.5985	1.546	2.389	2.3355	2.282	0	1.4735	903.5825	10	10	
4	1.783	1.733	1.683	1.128	1.076	1.024	0.5225	0	904.105	10	10	
5	2.057	2.0565	2.056	0.67	0.621	0.572	1.112	0	905.217	10	10	
6	2.494	2.446	2.398	0.27	0.218	0.166	1.8385	0	907.0555	10	10	
7	2.687	2.633	2.579	0.924	0.872	0.82	1.574	0	908.6295	10	10	
8	2.397	2.343	2.289	0.635	0.581	0.527	2.052	0	910.6815	10	10	
9	1.594	1.5465	1.499	1.273	1.218	1.163	1.125	0	911.8065	10	10	
10	1.791	1.741	1.691	1.722	1.672	1.622	0	0.1255	911.681	10	10	
11	1.795	1.746	1.697	1.759	1.709	1.659	0.032	0	911.713	10	10	
12	2.316	2.2645	2.213	0.912	0.857	0.802	0.889	0	912.602	10	10	
13	1.823	1.6715	1.52	0.666	0.611	0.556	1.6535	0	914.2555	10	10	
14	2.553	2.5015	2.45	0.304	0.253	0.202	1.4185	0	915.674	10	10	
15	2.05	2.002	1.954	0.65	0.598	0.546	1.9035	0	917.5775	10	10	
16	1.398	1.345	1.292	1.225	1.1705	1.116	0.8315	0	918.409	10	10	
17	1.054	1.0555	1.057	1.912	1.8595	1.807	0	0.5145	917.8945	10	10	
18	1.542	1.493	1.444	1.665	1.615	1.565	0	0.5595	917.335	10	10	
19	1.983	1.9295	1.876	1.344	1.292	1.24	0.201	0	917.536	10	10	
20	2.369	2.319	2.269	0.787	0.7355	0.684	1.194	0	918.73	10	10	
21	1.668	1.608	1.548	0.575	0.525	0.475	1.794	0	920.524	10	10	
22				1.475	1.414	1.353	0.194	0	920.718		10	Check stn.

TOPOGRAPHICAL SURVEY

DIFFERENTIAL LEVELLING OF COLLEGE

S.No	BS			FS			Rise	Fall	RL	Distance		Remarks
	T	M	B	T	M	B				BS	FS	
1	1.355	1.305	1.255	-	-	-	-	-	957.55	10		
2	1.614	1.564	1.514	1.279	1.229	1.179	0.076		957.626	10	10	
3	1.646	1.5975	1.549	1.26	1.21	1.16	0.354		957.98	10	10	
4	1.5	1.4745	1.449	1.343	1.293	1.243	0.3045		958.285	10	10	
5	1.807	1.783	1.759	1.145	1.12	1.095	0.3545		958.639	5	10	
6	1.859	1.838	1.817	1.11	1.0855	1.061	0.6975		959.337	5	5	
7	1.728	1.7035	1.679	1.156	1.131	1.106	0.707		960.044	5	5	
8	1.735	1.71	1.685	1.056	1.031	1.006	0.6725		960.716	5	5	
9	1.596	1.5715	1.547	1.128	1.073	1.018	0.637		961.353	20	5	
10	1.667	1.616	1.565	1.101	1.1245	1.148	0.447		961.8	10	20	
11	1.341	1.2915	1.242	1.428	1.376	1.324	0.24		962.04	10	10	
12	1.416	1.366	1.316	1.48	1.43	1.38		0.1385	961.902	10	10	
13	1.466	1.416	1.366	1.684	1.604	1.524		0.238	961.664	15	10	STN.3
14	1.8	1.725	1.65	1.191	1.116	1.041	0.3		961.964	10	15.63	
15	1.62	1.598	1.576	1.326	1.281	1.236	0.444		962.408	10	10	
16	1.636	1.595	1.554	1.444	1.3925	1.341	0.2055		962.613	10	10	
17	1.6	1.55	1.5	1.36	1.307	1.254	0.288		962.901	10	10	
18	1.556	1.526	1.496	1.271	1.241	1.211	0.309		963.21	6.1	10	STN.4
19	1.528	1.4785	1.429	1.309	1.259	1.209	0.267		963.477	10	6.1	
20	1.63	1.58	1.53	1.236	1.1875	1.139	0.291		963.768	10	10	
21	1.615	1.57	1.525	1.267	1.218	1.169	0.362		964.13	10	10	
22	1.5	1.481	1.462	1.172	1.119	1.066	0.451		964.581	10	10	

23	1.656	1.605	1.554	1.219	1.17	1.121	0.311		964.892	10	10	
24	1.682	1.6325	1.583	1.174	1.1235	1.073	0.4815		965.374	10	10	
25	1.599	1.5485	1.498	1.166	1.1175	1.069	0.515		965.889	10	10	
26	1.668	1.6035	1.539	1.324	1.274	1.224	0.2745		966.163	13	10	STN.5
27	1.556	1.503	1.45	1.226	1.177	1.128	0.4265		966.59	10	8.97	
28	1.56	1.51	1.46	1.191	1.141	1.091	0.362		966.952	10	10	
29	1.524	1.473	1.422	1.233	1.1825	1.132	0.3275		967.279	10	10	
30	1.544	1.4935	1.443	1.161	1.1125	1.064	0.3605		967.64	10	10	
31	1.556	1.506	1.456	1.184	1.134	1.084	0.3595		967.999	10	10	
32	1.589	1.5385	1.488	1.172	1.124	1.076	0.382		968.381	10	10	
33	1.7	1.65	1.6	1.252	1.202	1.152	0.3365		968.718	10	10	
34	1.488	1.4705	1.453	1.661	1.634	1.607	0.016		968.734	4.5	10	STN.6
35	1.77	1.7205	1.671	1.438	1.388	1.338	0.0825		968.816	10	4.5	
36	1.332	1.378	1.424	1.379	1.328	1.277	0.3925		969.209	10	10	
37	1.455	1.405	1.355	1.37	1.32	1.27	0.058		969.267	10	10	
38	1.473	1.426	1.379	1.296	1.247	1.198	0.158		969.425	10	10	
39	1.492	1.4415	1.391	1.415	1.365	1.315	0.061		969.486	10	10	
40	1.469	1.42	1.371	1.435	1.385	1.335	0.0565		969.542	10	10	
41	1.474	1.424	1.374	1.431	1.381	1.331	0.039		969.581	10	10	
42	1.394	1.344	1.294	1.485	1.435	1.385		0.011	969.57	10	10	
43	1.431	1.3555	1.28	1.716	1.6535	1.591		0.3095	969.261	15	10	STN.1
44	1.358	1.303	1.248	2.11	2.055	2		0.6995	968.561	11	12.616	
45	1.246	1.1975	1.149	3.024	2.975	2.926		1.672	966.889	10	11	
46	0.386	0.337	0.288	1.375	1.325	1.275		0.1275	966.762	10	10	
47	1.42	1.37	1.32	1.951	1.905	1.859		1.568	965.194	12.9	10	
48	1.262	1.1975	1.133	1.485	1.421	1.357		0.051	965.143		12.9	STN.2
										467.5	461.716	

FLY LEVELLING OF COLLEGE

S.No	BS			FS			Rise	Fall	RL	Distance		Remarks
	T	M	B	T	M	B				BS	FS	
1	1.366	1.316	1.266	-	-	-	-	-	965.143	10	-	STN.2
2	2.09	2.04	1.99	1.131	1.08	1.029	0.236		965.379	11	10	
3	1.561	1.5155	1.47	1.546	1.5005	1.455	0.5395		965.918	10	11	
4	3.225	3.185	3.145	1.477	1.4265	1.376	0.089		966.007	10	10	
5	2.015	1.948	1.881	0.544	0.497	0.45	2.688		968.695	13	10	STN.1
6	1.669	1.622	1.575	1.245	1.165	1.085	0.783		969.478	10	15	
7	1.385	1.34	1.295	1.359	1.309	1.259	0.313		969.791	10	10	
8	1.413	1.3645	1.316	1.36	1.315	1.27	0.025		969.816	10	10	
9	1.396	1.3185	1.241	1.395	1.3415	1.288	0.023		969.839	10	10	
10	1.371	1.2805	1.19	1.479	1.402	1.325		0.0835	969.756	16	10	
11	1.315	1.215	1.115	1.555	1.4605	1.366		0.18	969.576	19	16	STN.6
12	1.109	1.004	0.899	1.486	1.3825	1.279		0.1675	969.408	20	19	
13	1.107	0.9835	0.86	1.97	1.87	1.77		0.866	968.542	20	20	
14	1.235	1.132	1.029	1.927	1.825	1.723		0.8415	967.701	20	20	
15	1.321	1.2725	1.224	1.884	1.774	1.664		0.642	967.059	10	20	STN.5
16	1.421	1.313	1.205	1.72	1.665	1.61		0.3925	966.666	20	10	
17	0.941	0.837	0.733	2.181	2.08	1.979		0.767	965.899	20	20	
18	1.078	0.9755	0.873	1.912	1.812	1.712		0.975	964.924	13	20	
19	1.213	1.1495	1.086	1.896	1.7885	1.681		0.813	964.111	20	13	STN.4

20	1.054	0.9465	0.839	1.509	1.4465	1.384		0.297	963.814	20	20	
21	1.17	1.0625	0.955	1.652	1.547	1.442		0.6005	963.214	10	20	
22	1.293	1.2445	1.196	1.901	1.801	1.701		0.7385	962.475	20	14	STN.3
23	1.376	1.2785	1.181	1.676	1.606	1.536		0.3615	962.114	20	20	
24	1.271	1.1785	1.086	1.644	1.544	1.444		0.2655	961.848	20	20	
25	1.506	1.4585	1.411	1.483	1.3865	1.29		0.208	961.64	10	20	
26	1.403	1.362	1.321	1.329	1.287	1.245	0.1715		961.812	10	10	
27	1.213	1.17	1.127	1.556	1.5125	1.469		0.1505	961.661	10	10	
28	0.931	0.888	0.845	1.791	1.747	1.703		0.577	961.084	10	10	
29	0.877	0.834	0.791	2.015	1.9705	1.926		1.0825	960.002	10	10	
30	0.822	0.777	0.732	1.946	1.901	1.856		1.067	958.935	10	10	
31	1.179	1.0825	0.986	1.59	1.496	1.402		0.719	958.216	20	10	
32	1.324	1.283	1.242	1.789	1.698	1.607		0.6155	957.6	10	20	
33	-	-	-	1.422	1.354	1.286		0.071	957.529		10	BM
										452	458	

TRAVERSE DISTANCE TABLE

Distance Between	Forward Distance(m)	Backward Distance(m)	Mean(M)	Discrepancy(D)	Precision (D/M)(1:2000)	Remarks
S1-S2	106.018	106.037	106.028	0.019	0.00018	Under Precision
S2-S3	150.335	150.362	150.349	0.027	0.00018	Under Precision
S3-S4	99.830	99.853	99.842	0.023	0.00023	Under Precision
S4-S5	150.007	150.013	150.010	0.006	0.00004	Under Precision
S5-S6	140.714	140.727	140.721	0.013	0.00009	Under Precision
S6-S1	186.116	186.12	186.118	0.004	0.00002	Under Precision

TOTAL STATION DATA TABLE

Points	Northing	Easting	Z - Value	Remarks
1000	3128832	792100	965.142	STN-2
1001	3128859	791997	969.258	STN-1
1002	3128851	792030	968.553	BC
1003	3128854	792035	968.652	BC
1004	3128859	792044	968.964	BC
1005	3128858	792047	968.753	BC
1006	3128873	792048	968.86	BC
1007	3128880	792050	969.376	TREE
1008	3128870	792064	968.225	BP
1009	3128885	792081	968.179	BP2
1010	3128875	792084	967.475	LT1
1011	3128871	792088	967.465	LT2
1012	3128873	792091	967.476	LT3
1013	3128876	792092	967.453	LT4
1014	3128869	792092	967.638	SH
1015	3128865	792090	967.415	SH
1016	3128867	792096	967.219	ROAD
1017	3128867	792095	967.223	ROAD
1018	3128864	792094	966.457	ROAD-STEP
1019	3128865	792095	966.441	ROAD-STEP
1020	3128862	792096	964.956	ROAD-STEP
1021	3128863	792097	964.96	ROAD-STEP
1022	3128863	792090	966.4	FP
1023	3128860	792086	965.902	FP
1024	3128862	792086	966.379	TREE
1025	3128864	792087	967.365	SH
1026	3128856	792081	965.221	SH
1027	3128857	792077	965.433	TREE
1028	3128842	792068	965.41	FP
1029	3128837	792076	965.53	GESS
1030	3128837	792082	965.409	GESS
1031	3128834	792081	965.577	GESS
1032	3128834	792076	965.394	GESS
1033	3128843	792087	965.328	FP
1034	3128836	792088	965.076	FP
1035	3128840	792094	965.136	TREE
1036	3128844	792093	964.916	TREE

1037	3128854	792098	964.695	DB
1038	3128841	792110	964.72	DB
1039	3128833	792114	964.472	FP
1040	3128837	792112	964.616	SH
1041	3128830	792127	964.12	SH
1042	3128847	792132	963.998	TREE
1043	3128839	792153	963.55	POLE
1044	3128849	792150	963.398	SH
1045	3128831	792159	963.599	SH
1046	3128854	792174	962.904	TT
1047	3128855	792176	962.885	TT
1048	3128853	792178	962.922	TT
1049	3128852	792177	962.888	TT
1050	3128846	792180	963.045	TREE
1051	3128850	792187	962.394	ROAD
1052	3128813	792164	962.651	ROAD
1053	3128815	792137	961.585	ROAD
1054	3128818	792138	961.696	ROAD
1055	3128838	792165	963.091	ROAD
1056	3128847	792158	963.628	SH
1057	3128852	792154	963.442	SH
1058	3128858	792143	963.506	FP
1059	3128817	792160	962.722	FP
1060	3128852	792135	963.875	FP
1061	3128837	792117	964.404	FP
1062	3128877	792198	962.346	AD
1063	3128883	792192	962.756	AD
1064	3128883	792190	962.969	AD
1065	3128882	792187	963.037	AD
1066	3128896	792175	965.307	AD
1067	3128888	792177	964.481	SH
1068	3128884	792165	965.383	SH
1069	3128876	792169	963.283	SH
1070	3128874	792153	963.773	SH
1071	3128876	792163	963.235	TREE
1072	3128877	792151	964.35	TC
1073	3128859	792139	964.544	SH
1074	3128864	792137	963.548	SH
1075	3128846	792056	965.678	SH
1076	3128839	792094	964.983	TREE
1077	3128844	792093	964.759	TREE

1078	3128849	792090	964.822	TREE
1079	3128854	792086	965.208	TREE
1080	3128845	792081	965.36	TREE
1081	3128849	792081	965.222	SH
1082	3128848	792093	964.685	SH
1083	3128833	792091	965.244	SH
1084	3128830	792087	965.227	SH
2000	3128859	791997	969.258	STN-1
2001	3128832	792100	965.142	STN-2
2002	3128860	792022	968.625	BC
2003	3128862	792024	968.722	BC
2004	3128867	792020	968.769	BC
2005	3128885	792015	969.396	BC
2006	3128877	792031	969.355	BC
2007	3128879	792029	969.357	BC
2008	3128876	792024	969.372	BC
2009	3128873	792018	969.148	POLE
2010	3128886	792006	969.595	POLE
2011	3128869	792011	969.149	POLE
2012	3128889	792002	969.598	POLE
2013	3128887	791998	969.78	TREE
2014	3128851	792014	969.075	TREE
2015	3128851	792014	969.132	GYM
2016	3128848	792015	968.953	GYM
2017	3128845	791998	969.044	GYM
2018	3128848	791998	969.123	GYM
2019	3128849	791996	968.987	GYM-P
2020	3128875	791995	969.411	GYM-P
2021	3128891	792012	969.589	TREE
2022	3128879	791992	969.513	R.D
2023	3128889	791991	969.548	R.D
2024	3128889	791986	969.579	R.D
2025	3128849	792026	968.455	R.D
2026	3128848	792023	968.527	R.D
2027	3128895	792015	969.474	POLE
2028	3128897	792018	969.421	POLE
2029	3128889	792002	969.676	POLE
2030	3128901	792025	969.479	S.Z
2031	3128908	792031	969.319	S.Z
2032	3128825	791985	966.106	R.D
2033	3128827	791981	966.11	R.D

2034	3128849	791987	968.252	POLE
2035	3128844	791987	967.812	S.H
2036	3128858	791988	968.634	S.H
2037	3128868	791987	969.111	S.H
2038	3128884	792006	969.712	S.H
2039	3128872	792018	969.083	R.D
2040	3128868	792013	968.848	R.D
2041	3128897	792023	969.521	R.D
2042	3128863	792005	969.365	R.D
2043	3128856	792011	969.046	S.H
2044	3128880	792008	969.549	S.H
2045	3128876	792012	969.366	S.H
2046	3128940	792048	968.057	OFFSET
3000	3128940	792048	968.957	OFFSET
1	3128859	791997	969.258	OFFSET
2	3128910	792038	970.249	B.C
3	3128901	792046	970.237	B.C
4	3128897	792054	969.591	TAP
5	3128886	792049	969.466	BP
6	3128894	792054	969.545	POLE
7	3128903	792068	969.264	BP
8	3128904	792068	969.346	BP
9	3128905	792070	969.249	TL-PARK
10	3128914	792079	969.269	TL-PARK
11	3128895	792079	969.061	TL-PARK
12	3128920	792079	968.728	TAP
13	3128905	792090	968.852	TL-PARK
15	3128915	792082	968.339	FSU
16	3128921	792085	968.077	FP
17	3128919	792082	968.449	FP
18	3128906	792069	969.322	FP
19	3128923	792082	968.13	BC
20	3128930	792076	968.923	BC
21	3128936	792083	968.972	BC
22	3128942	792077	968.641	BC
23	3128946	792081	968.643	BC
24	3128949	792079	968.637	BC
25	3128960	792090	968.621	BC
26	3128965	792097	968.535	BC
27	3128971	792104	968.067	BC
28	3128904	792031	970.264	BC

29	3128896	792027	970.259	BC
30	3128900	792057	969.752	BEST
31	3128905	792063	969.4	BEST
32	3128909	792059	969.481	BEST
33	3128918	792065	969.171	BEST
34	3128921	792065	969.11	POLE
35	3128931	792070	968.909	POLE
36	3128905	792066	969.443	OFFSET-2
500	3128940	792048	968.057	OFFSET
501	3128892	792037	970.366	BC
502	3128888	792037	970.154	BC
503	3128881	792032	970.33	BC
504	3128874	792036	970.33	BC
505	3128879	792042	969.731	BC
506	3128882	792041	969.745	POLE
507	3128886	792045	969.733	POLE
508	3128880	792088	968.29	LT
509	3128884	792088	968.95	GEO
510	3128878	792094	968.109	GEO
511	3128891	792095	968.118	GEO
512	3128894	792091	968.126	GEO
513	3128908	792108	968.13	GEO
514	3128923	792090	968.29	FSU
515	3128928	792095	968.102	FSU
516	3128927	792095	968.091	BC
517	3128931	792091	968.171	BC
518	3128934	792095	968.054	BC
519	3128930	792098	968.048	BC
520	3128936	792097	968.09	BC
521	3128934	792102	968.038	BC
522	3128938	792107	968.313	OFS-3
600	3128905	792066	969.443	OFFSET2
601	3128943	792090	968.158	BC
602	3128950	792098	968.136	BC
603	3128943	792104	968.148	BC
604	3128950	792111	968.17	BC
605	3128952	792114	968.176	BC
606	3128959	792121	967.993	BC
607	3128948	792117	968.253	POLE
608	3128949	792120	968.623	TREE
609	3128935	792099	968.095	FP

610	3128962	792127	967.985	FP
611	3128963	792128	967.873	POLE
612	3128934	792108	968.145	ROCK
613	3128957	792131	968.449	TREE
614	3128952	792124	968.433	SH
615	3128940	792122	968.471	POLE
616	3128943	792123	967.946	MEC
617	3128930	792135	967.986	MEC
618	3128926	792139	967.994	MEC
619	3128928	792141	968.018	MEC
620	3128917	792147	967.97	MEC
621	3128926	792134	968.081	SH
622	3128924	792131	968.097	GEO
623	3128914	792120	968.122	GEO
624	3128925	792129	968.443	TREE
625	3128926	792114	968.089	TREE
626	3128929	792135	968.087	POLE
627	3128920	792120	968.2	TREE
628	3128940	792122	968.45	POLE
629	3128941	792111	968.472	TREE
630	3128942	792100	968.433	SH
631	3128963	792133	967.625	OFFSET-4
632	3128909	792160	967.092	OFFSET-5
633	3128963	792133	967.625	OFFSET-4
700	3128938	792107	968.313	OFFSET-3
701	3128960	792122	968.014	B.C
702	3128963	792125	968.122	B.C
703	3128966	792122	968.113	B.C
704	3128952	792131	967.933	MEC
705	3128948	792136	967.921	MEC
706	3128950	792138	967.949	MEC
707	3128941	792146	967.962	MEC
708	3128937	792150	967.961	MEC
709	3128923	792163	967.975	MEC
710	3128922	792172	966.8	POLE
711	3128924	792172	966.776	F.P
712	3128972	792121	967.961	F.P
713	3128968	792116	968.106	F.P
714	3128977	792125	967.594	F.P
715	3128936	792157	967.502	POLE
716	3128946	792152	967.568	POLE

717	3128973	792127	967.362	TOILET
718	3128969	792131	967.286	TOILET
719	3128975	792138	967.318	TOILET
720	3128980	792115	968.631	TCC
721	3128983	792111	968.177	TCC
722	3128978	792111	968.237	TCC
723	3128977	792117	968.193	TCC
724	3128985	792111	968.093	TFM
725	3128984	792117	968.148	TCC
726	3128965	792133	967.922	TREE
727	3128963	792135	968.107	TREE
728	3128962	792137	967.963	TREE
729	3128960	792139	967.995	TREE
730	3128955	792144	967.779	TREE
731	3128954	792145	967.844	TREE
732	3128950	792148	967.879	TREE
733	3128946	792153	967.709	TREE
734	3128933	792165	967.298	TREE
735	3128889	792200	965.959	USELESS
736	3128977	792143	967.678	ROCK
737	3128983	792156	966.511	ROCK
738	3128987	792165	966.881	MEC-D
739	3128970	792148	966.263	MEC-D
740	3128954	792157	966.63	MEC-D
741	3128949	792163	966.482	MEC-D
742	3128997	792152	966.635	S.H
743	3128986	792147	966.76	S.H
744	3128967	792137	967.68	S.H
745	3128998	792174	966.194	OFFSET-6
746	3128909	792160	967.092	OFS-5
2500	3128938	792107	968.313	OFFSET-3
2501	3128919	792150	967.963	MEC
2502	3128915	792154	967.945	MEC
2503	3128911	792158	967.161	F.P
2504	3128923	792170	966.766	F.P
2505	3128935	792176	966.263	MEC-D
2506	3128952	792195	966.369	MEC-D
2507	3128955	792198	966.213	MEC-D
2508	3128950	792196	966.316	FP
2509	3128917	792137	968.047	GEO
2510	3128903	792121	968.312	GEO

2511	3128902	792116	967.994	GEO
2512	3128898	792120	968.003	GEO
2513	3128888	792109	968.114	GEO
2514	3128876	792121	967.167	SH
2515	3128882	792119	967.387	F.P
2516	3128876	792125	967.036	F.P
2517	3128873	792129	966.332	F.P
2518	3128871	792131	965.337	F.P
2519	3128877	792144	965.936	F.P
2520	3128877	792144	965.936	TOILET
2521	3128882	792150	966.525	TOILET
2522	3128877	792143	966.018	FP
2523	3128884	792122	967.564	FP
2524	3128877	792152	965.008	TOILET
2525	3128894	792163	966.485	TREE
2526	3128896	792164	966.408	TREE
2527	3128896	792158	966.552	TREE
2528	3128894	792159	966.431	TREE
2529	3128883	792155	966.548	TREE
2530	3128887	792154	966.331	TREE
2531	3128892	792147	966.548	TREE
2532	3128883	792144	966.538	TREE
2533	3128886	792135	966.995	TREE
2534	3128890	792137	966.912	TREE
2535	3128887	792123	967.508	TREE
2536	3128880	792129	966.826	TREE
2537	3128868	792108	969.373	DB
2538	3128862	792102	969.386	DB
2539	3128873	792140	966.243	TREE
2540	3128891	792120	968.409	TREE
2541	3128894	792123	968.37	TREE
2542	3128905	792134	968.205	TREE
2543	3128907	792138	968.316	TREE
2544	3128905	792149	966.707	TREE
2545	3128907	792155	966.995	TREE
2546	3128904	792163	966.777	TREE
2547	3128894	792170	966.268	TREE
2548	3128889	792171	966.062	TREE
2549	3128887	792170	966.005	TREE
2550	3128884	792165	966.046	TREE
2551	3128906	792176	966.672	TREE

2552	3128909	792179	967.049	TREE
2553	3128910	792176	966.805	TREE
2554	3128911	792178	966.879	TREE
2555	3128913	792173	966.9	TREE
2556	3128919	792170	967.172	TREE
2557	3128922	792172	967.094	POLE
2558	3128924	792176	966.926	TREE
2559	3128921	792179	966.855	TREE
2560	3128909	792185	966.422	POLE
2561	3128929	792177	966.689	OFFSET-7
2562	3128929	792177	966.689	OFS-7
2600	3128909	792160	967.092	OFFSET-5
2601	3128925	792211	965.969	CAFE
2602	3128912	792196	966.162	CAFE
2603	3128888	792200	966.193	CAFE
2604	3128896	792209	966.152	CAFE
2605	3128903	792175	966.155	CAFE
2606	3128896	792175	966.049	CAFE
2607	3128945	792200	966.458	TREE
2608	3128937	792199	966.503	ROCK
2609	3128937	792194	966.498	ROCK
2610	3128933	792188	966.727	ROCK
2611	3128940	792205	966.23	CTN
2612	3128942	792208	966.084	CTN
2613	3128945	792208	966.019	CTN
2614	3128940	792211	966.027	CTN
2615	3128935	792210	966.26	TREE
2616	3128934	792206	966.297	SH
2617	3128928	792197	966.766	SH
2618	3128924	792177	966.824	TREE
2619	3128922	792179	966.683	TREE
2620	3128920	792170	967.094	TREE
2621	3128913	792173	966.865	TREE
2622	3128910	792176	966.771	TREE
2623	3128912	792178	966.854	TREE
2624	3128911	792180	966.922	TREE
2625	3128909	792185	966.393	POLE
2626	3128906	792192	966.363	SH
2627	3128916	792196	966.587	SH
2628	3128920	792196	966.601	TREE
2629	3128951	792217	965.889	BC

2630	3128958	792211	966.079	BC
2631	3128956	792209	966.205	BC
2632	3128957	792208	966.444	BC
2633	3128944	792154	967.602	OFFSET-8
2634	3128944	792154	967.602	OFS-8
2700	3128929	792177	966.689	OFFSET-7
2701	3128958	792152	966.643	MEC-D
2702	3128970	792176	966.245	MEC-D
2703	3128966	792181	966.223	MEC-D
2704	3128960	792171	966.465	S.H
2705	3128953	792162	966.556	TREE
2706	3128948	792161	966.59	S.H
2707	3128934	792147	967.944	MEC
2708	3128938	792144	967.942	MEC
2709	3128932	792137	967.95	MEC
2710	3128937	792146	967.949	F.P
2711	3128942	792151	967.43	F.P
2712	3128998	792174	966.193	OFFSET-6
3500	3128963	792133	967.625	OFFSET-4
3501	3128989	792174	966.214	S.H
3502	3128985	792170	966.51	R.D
3503	3129012	792198	965.166	R.D
3504	3128992	792181	966.001	POLE
3505	3129007	792202	965.442	POLE
3506	3128979	792176	966.411	B.C
3507	3128997	792195	966.417	B.C
3508	3128999	792194	966.334	TREE
3509	3129001	792196	966.238	TREE
3510	3129005	792199	964.716	NALI
3511	3128992	792184	965.744	NALI
3512	3129004	792195	965.611	S.H
3513	3128998	792188	965.806	S.H
3514	3128990	792179	966.103	S.H
3515	3128983	792234	963.21	STN-4
4000	3128884	792241	961.664	STN-3
4001	3129015	792199	963.861	R.D.
4002	3128976	792234	962.984	R.D.
4003	3128974	792230	962.597	NALA
4004	3128973	792229	963.411	POLE
4005	3128945	792232	962.652	R.D
4006	3128931	792214	964.369	R.D

4007	3128989	792203	964.922	BC
4008	3128972	792185	965.012	BC
4009	3128922	792212	964.754	CAFE
4010	3128979	792217	964.739	B.C
4011	3128977	792218	964.629	B.C
4012	3128969	792225	964.562	B.C
4013	3128976	792224	964.648	SH
4014	3128979	792221	964.776	SH
4015	3128983	792215	964.988	TREE
4016	3128984	792210	964.722	TREE
4017	3128923	792225	964.617	CAFE.P
4018	3128937	792226	964.677	CAFE.P
4019	3128929	792218	964.605	CAFE.P
4020	3128936	792211	964.569	POLE
4021	3128946	792219	964.527	SH
4022	3128955	792226	964.639	SH
4023	3128972	792227	964.677	SH
4024	3128974	792232	963.26	SH
4025	3128976	792238	963.454	POLE
4026	3128980	792237	963.113	SH
4027	3128884	792241	961.664	STN-3
8000	3128983	792234	963.21	STN4
8001	3128894	792234	962.249	POLE
8002	3128890	792236	961.97	TREE
8003	3128887	792234	961.907	TREE
8004	3128885	792232	961.979	TREE
8005	3128876	792224	962.057	TREE
8006	3128874	792226	961.901	TREE
8007	3128896	792232	961.949	RD
8008	3128896	792227	961.685	NALI
8009	3128884	792217	961.93	NALI
8010	3128892	792217	962.659	MSC
8011	3128897	792217	963.993	MSC
8012	3128900	792215	964.617	MSC
8013	3128903	792213	965.431	MSC
8014	3128902	792217	965.703	CAFE.B
8015	3128911	792217	965.688	CAFE.B
8016	3128913	792215	965.755	CAFE.B
8017	3128866	792174	962.629	OFFSET-9
8500	3128884	792241	961.664	STN-3
8501	3128841	792118	966.288	D.B

8502	3128843	792117	966.294	D.B
8503	3128847	792124	966.269	D.B
8504	3128854	792130	966.277	D.B
8505	3128866	792118	966.258	D.B
8506	3128825	792102	966.748	STN-2

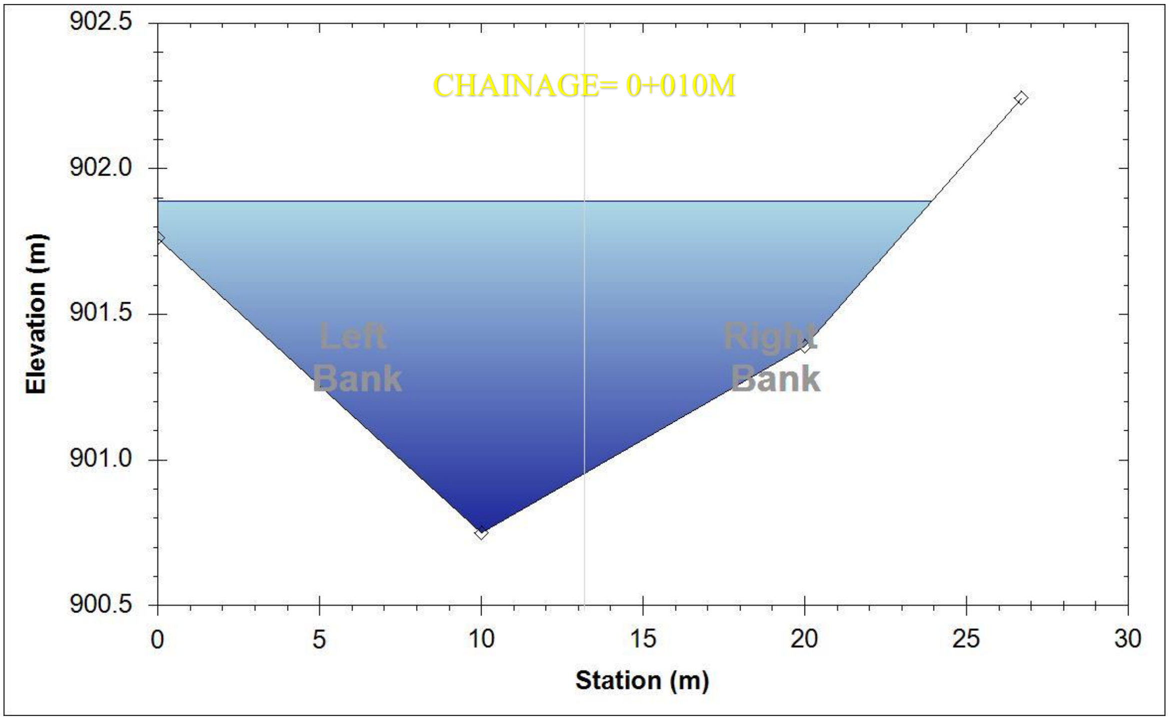
MAJOR TRAVERSE TABLE

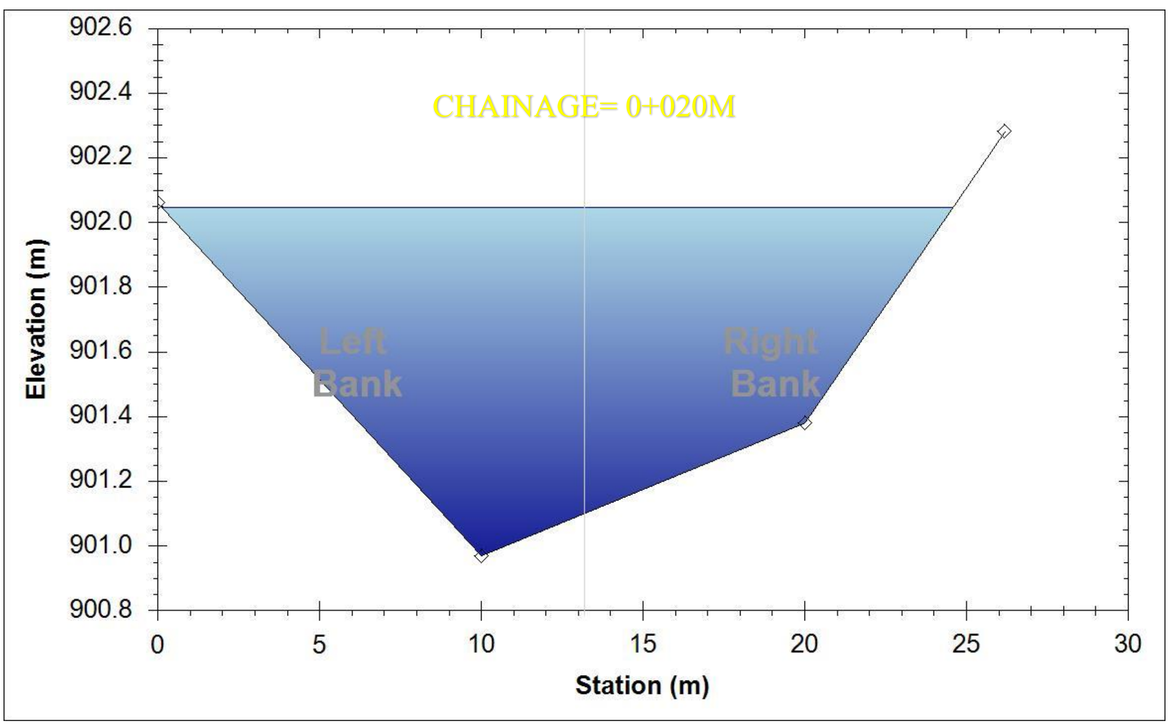
Line	Length	Station	H. Angle			Corrected H.Angle			WCB			Consecutive Co-ordinate	
			D	M	S	D	M	S	D	M	S	Latitude	Longitude
S1S2	106.089	S2	144	44	58.25	144	44	51.5417	105	6	6.46	-27.63987068	102.4251603
S2S3	150.496	S3	105	56	17.25	105	56	10.5417	69	50	58	51.84409325	141.2842384
S3S4	100.062	S4	132	13	24.75	132	13	18.0417	355	47	8.54	99.7914498	-7.353257191
S4S5	149.779	S5	129	24	17.25	129	24	10.5417	308	0	26.54	92.22834589	-118.0155967
S5S6	140.076	S6	96	57	30.25	96	57	23.5417	257	24	37.12	-30.53203081	-136.7080132
S6S1	186.607	S1	110	44	12.5	110	44	5.7917	174	22	0.67	-185.7058336	18.31709129
	833.109											-0.013846111	-0.05037705

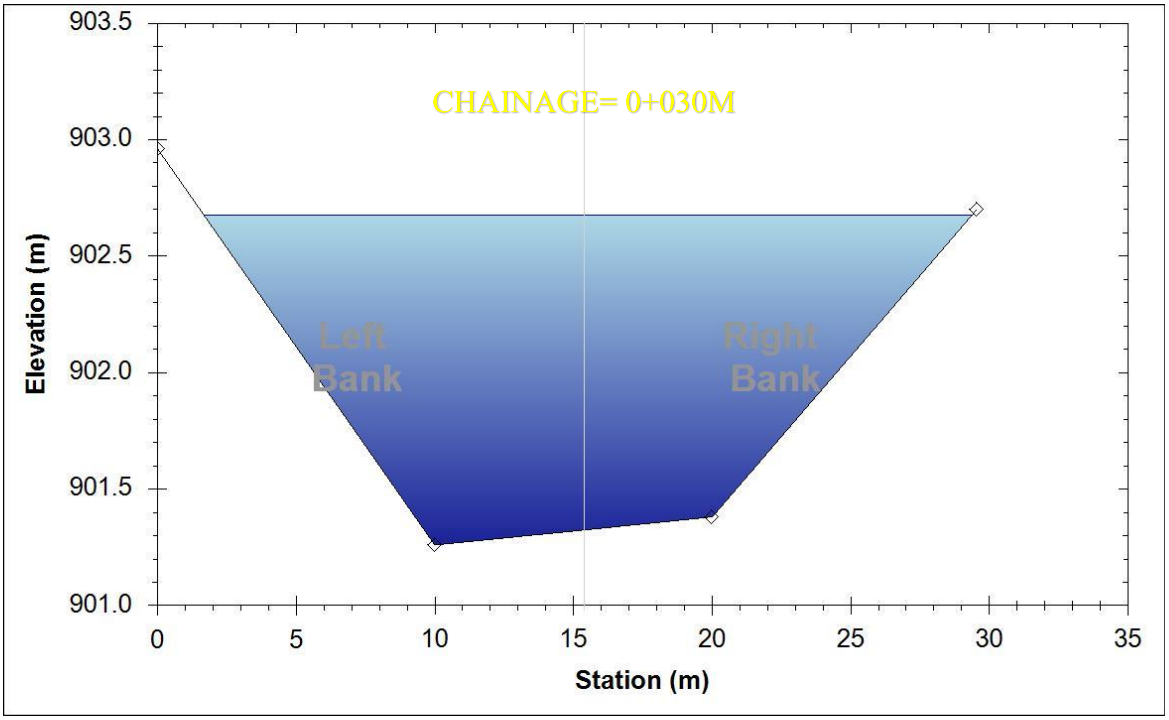
Correction		Corrected Consecutive Coordinate		Independent Coordinate	
Latitude	Longitude	Latitude	Longitude	Northing	Easting
-0.001763179	-0.006415068	-27.64163386	102.4187453	3128831.679	792099.672
-0.002501215	-0.009100303	51.84159204	141.2751381	3128883.521	792240.9471
-0.001663011	-0.006050623	99.78978679	-7.359307814	3128983.31	792233.5878
-0.001663011	-0.009056947	92.22668288	-118.0246536	3129075.537	792115.5632
-0.002328036	-0.008470219	-30.53435885	-136.7164834	3129045.003	791978.8467
-0.003101372	-0.01128389	-185.7089349	18.3058074	3128859.294	791997.1525
-0.013019824	-0.05037705	-0.026865935	-0.1007541		

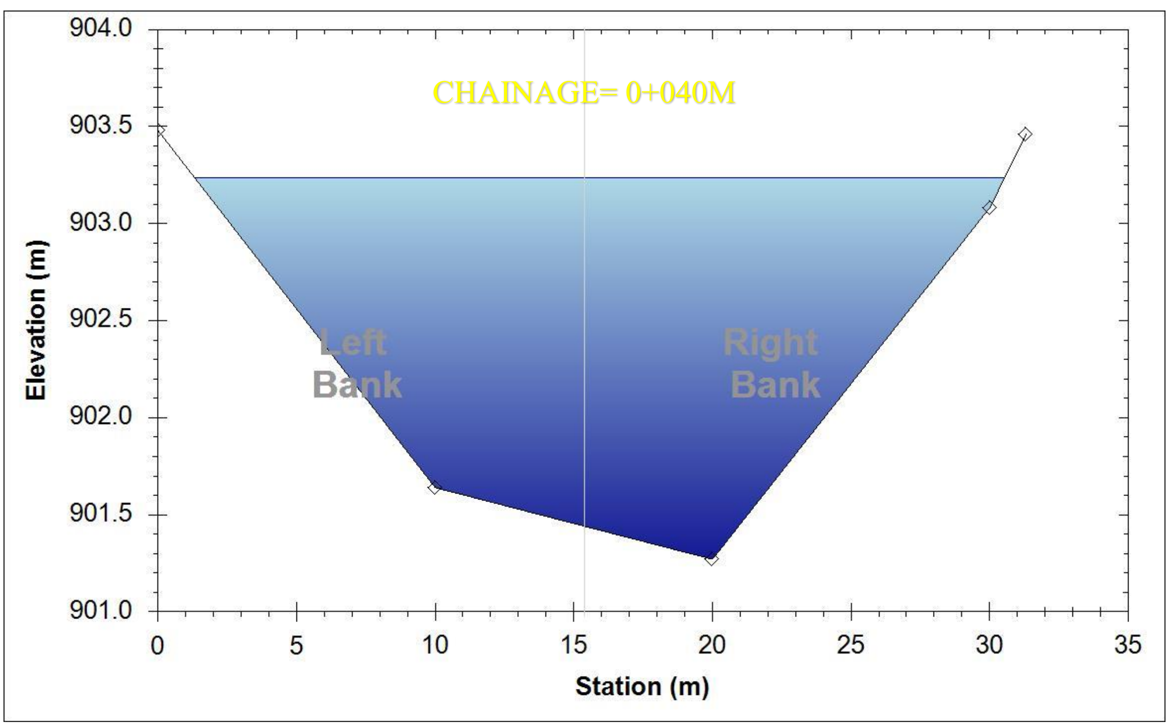
BRIDGE SITE SURVEY GRAPH

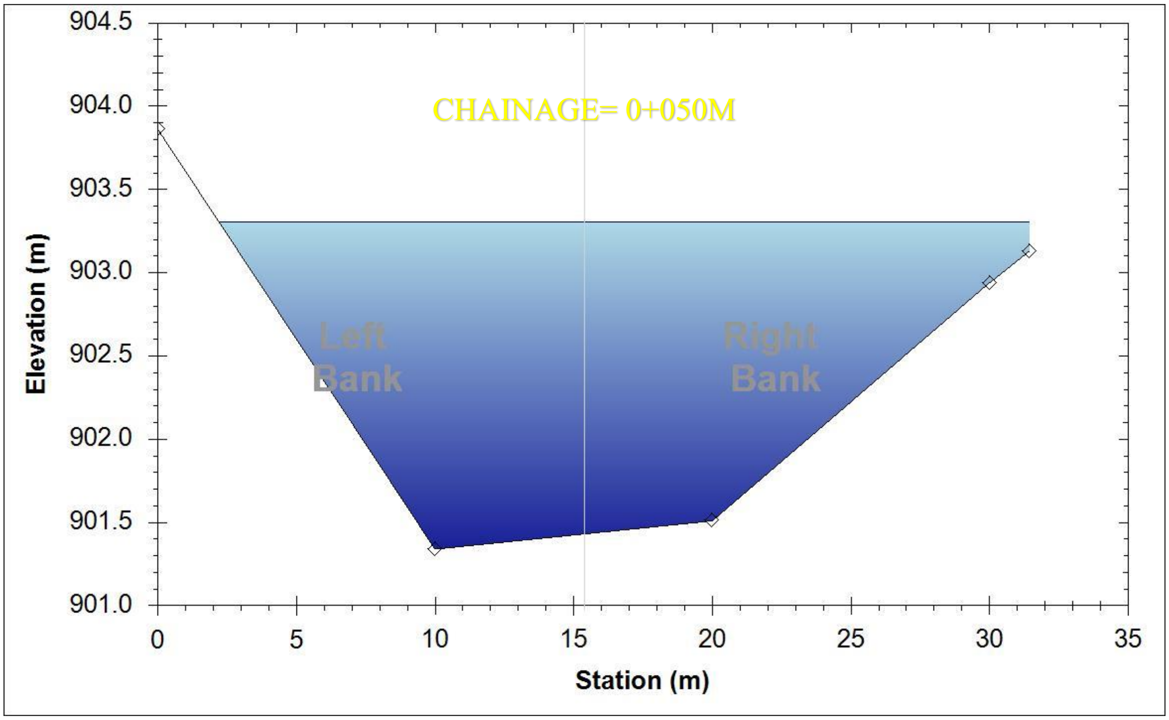
UPSTREAM

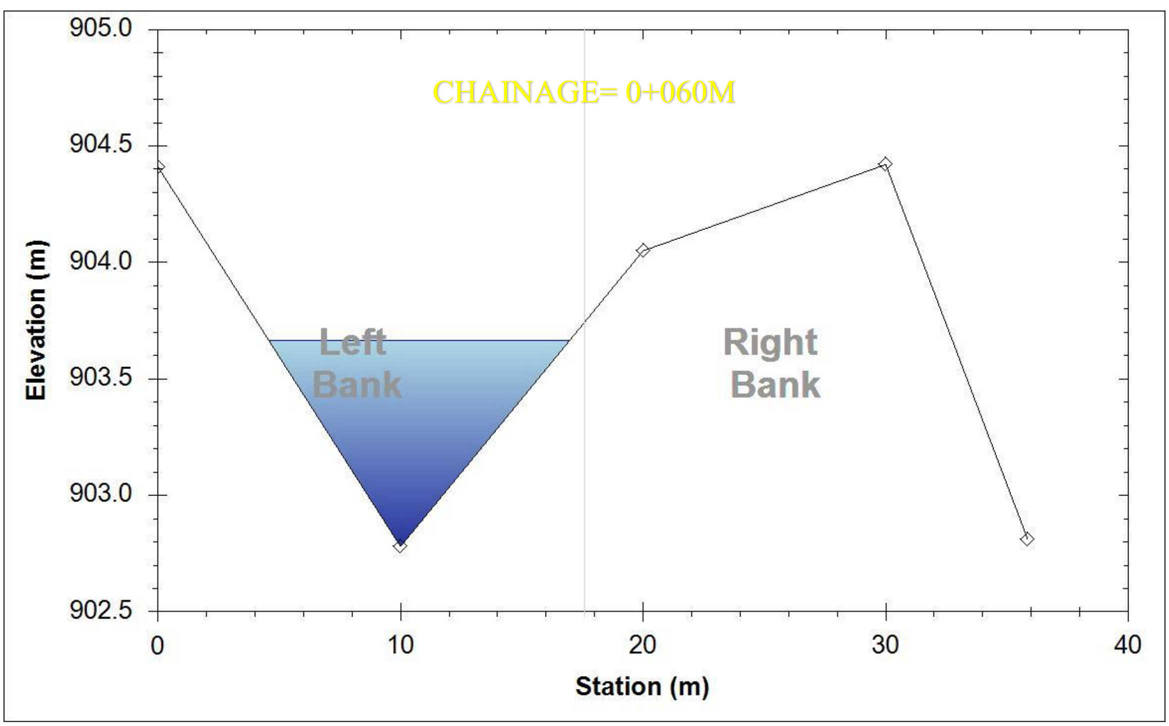


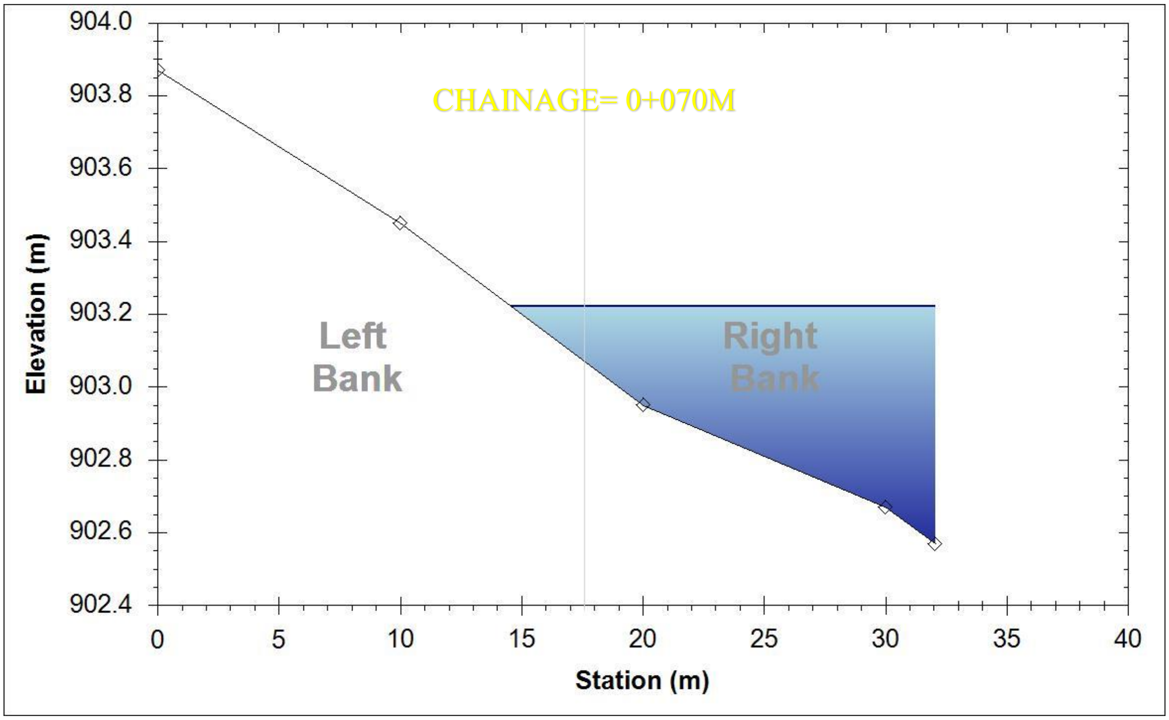


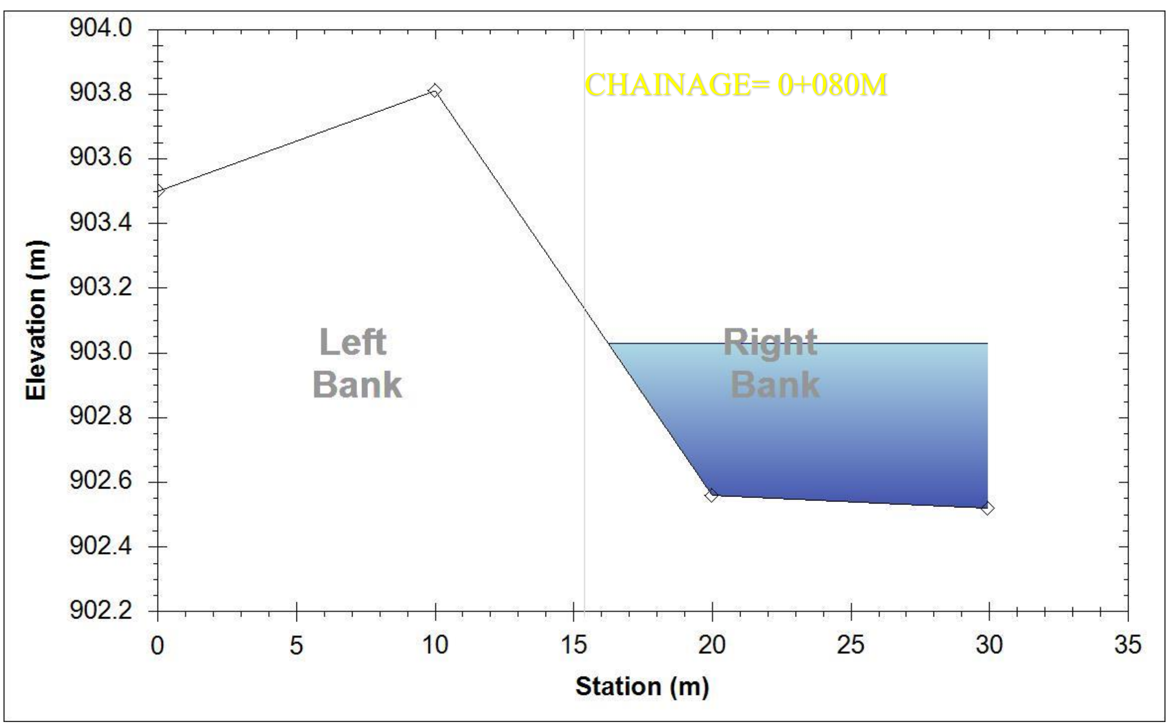

CHAINAGE= 0+030M
Left Bank
Right Bank
Elevation (m)
Station (m)
903.5
903.0
902.5
902.0
901.5
901.0
0
5
10
15
20
25
30
35

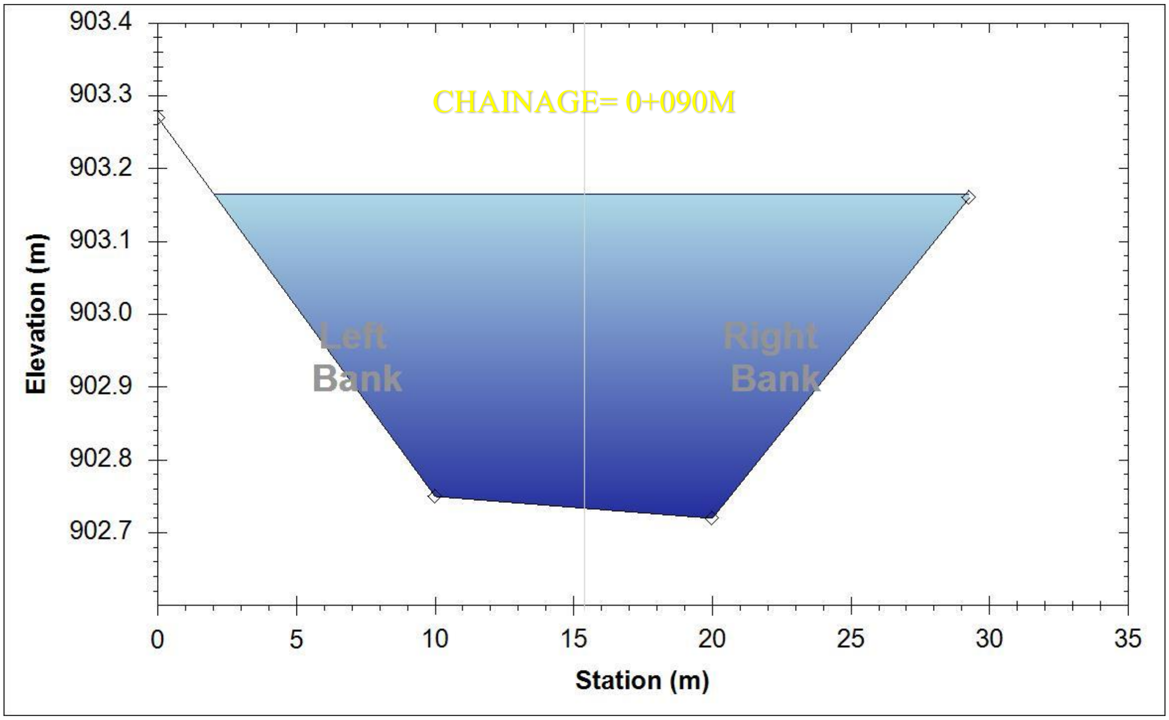

CHAINAGE= 0+040M
Left Bank
Right Bank
Elevation (m)
Station (m)
904.0
903.5
903.0
902.5
902.0
901.5
901.0
0
5
10
15
20
25
30
35

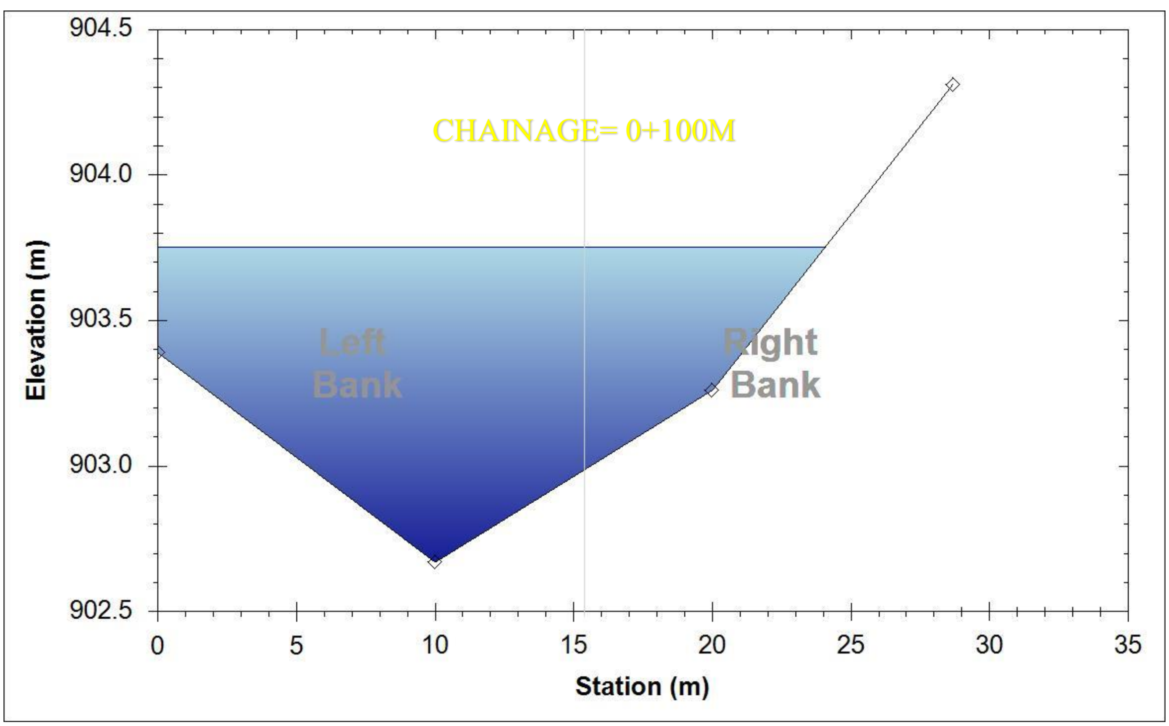

CHAINAGE= 0+050M
Left
Bank
Right
Bank
Elevation (m)
Station (m)
904.5
904.0
903.5
903.0
902.5
902.0
901.5
901.0
0
5
10
15
20
25
30
35

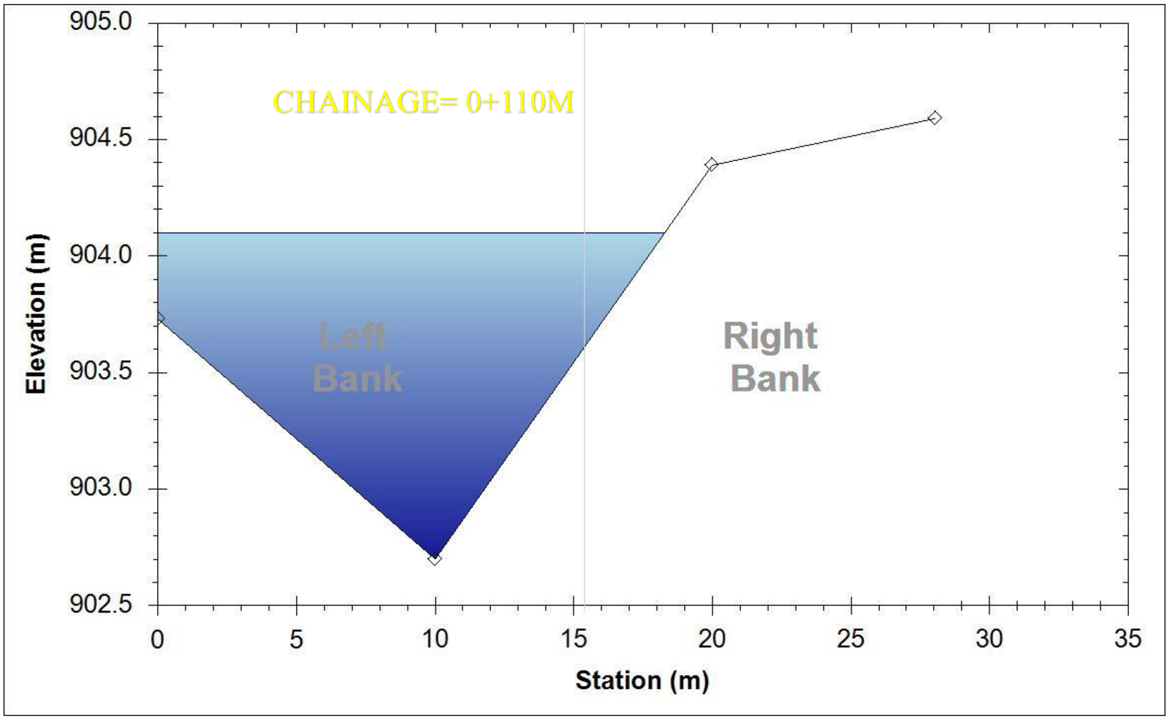

CHAINAGE= 0+060M
Left
Bank
Right
Bank
Elevation (m)
Station (m)
905.0
904.5
904.0
903.5
903.0
902.5
0
10
20
30
40

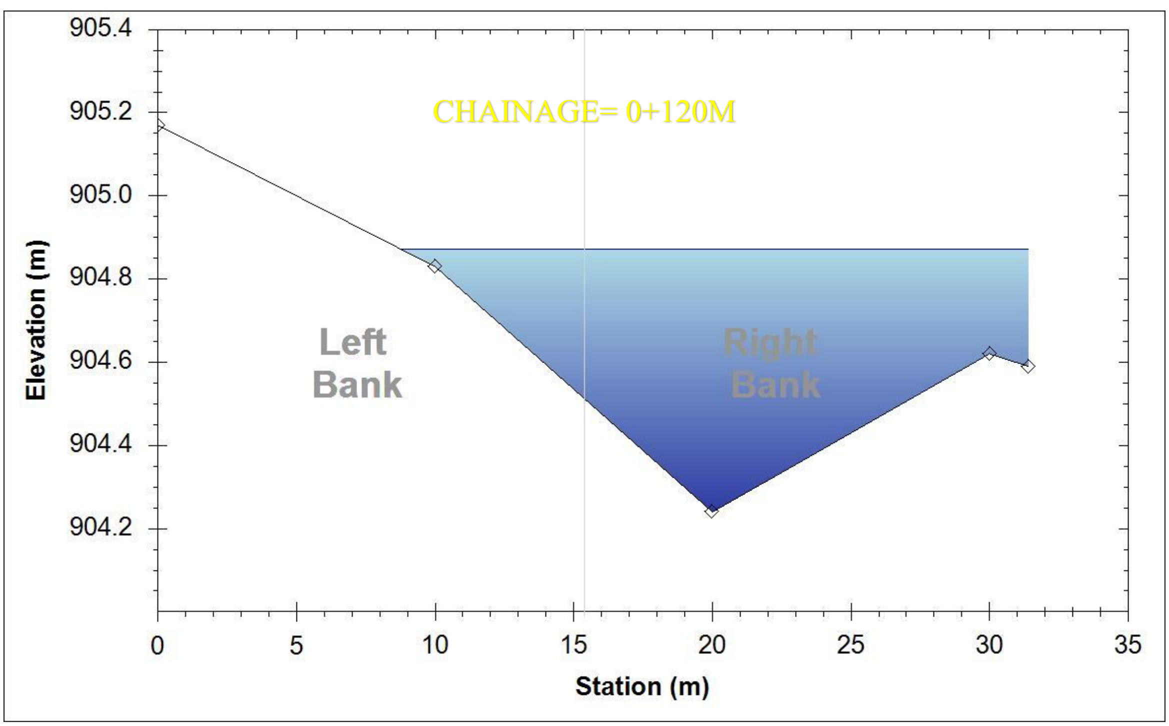

CHAINAGE= 0+070M
Left Bank
Right Bank
Elevation (m)
Station (m)
904.0
903.8
903.6
903.4
903.2
903.0
902.8
902.6
902.4
0
5
10
15
20
25
30
35
40

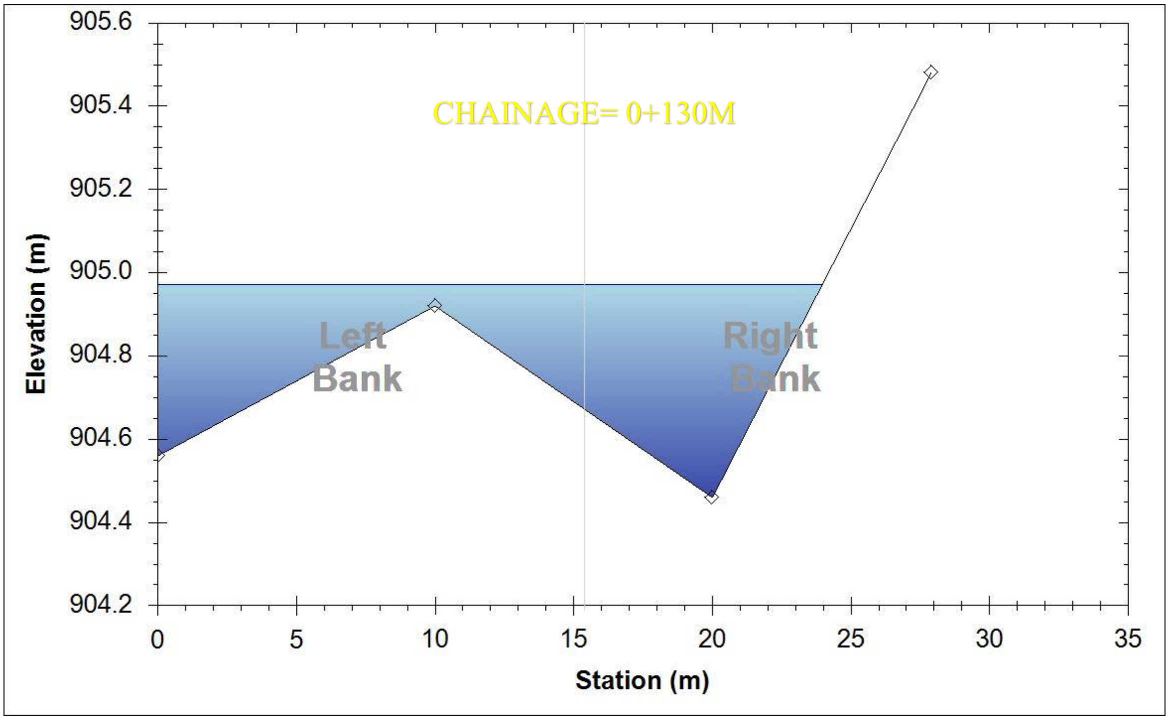

CHAINAGE= 0+080M
Left Bank
Right Bank
Elevation (m)
Station (m)
904.0
903.8
903.6
903.4
903.2
903.0
902.8
902.6
902.4
902.2
0
5
10
15
20
25
30
35

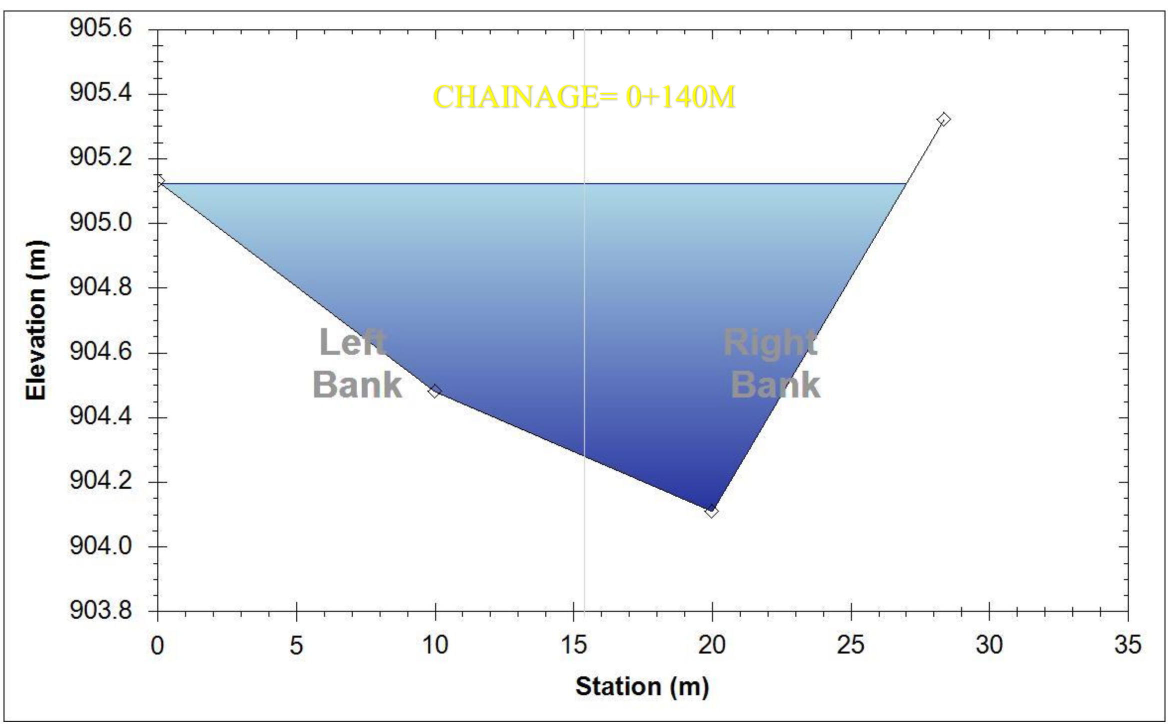

CHAINAGE= 0+090M
Elevation (m)
Station (m)
Left Bank
Right Bank
903.4
903.3
903.2
903.1
903.0
902.9
902.8
902.7
0
5
10
15
20
25
30
35

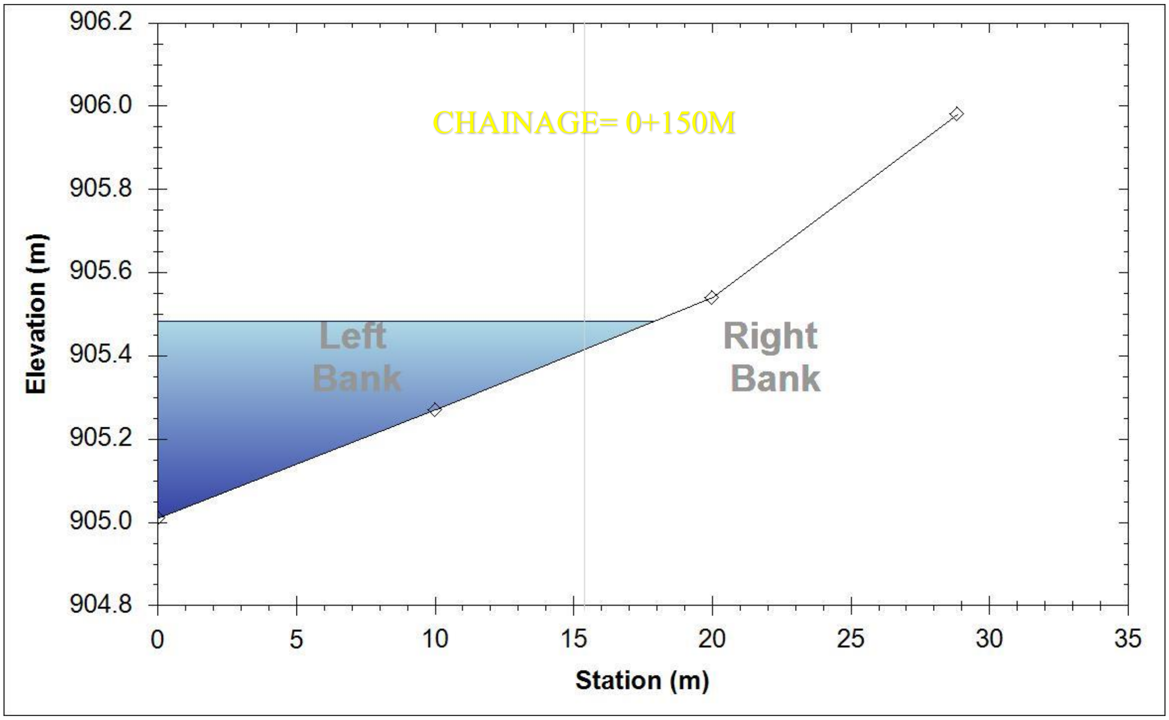

CHAINAGE= 0+100M
Elevation (m)
Station (m)
Left Bank
Right Bank
904.5
904.0
903.5
903.0
902.5
0
5
10
15
20
25
30
35


CHAINAGE= 0+110M
Left Bank
Right Bank
Elevation (m)
Station (m)
905.0
904.5
904.0
903.5
903.0
902.5
0
5
10
15
20
25
30
35

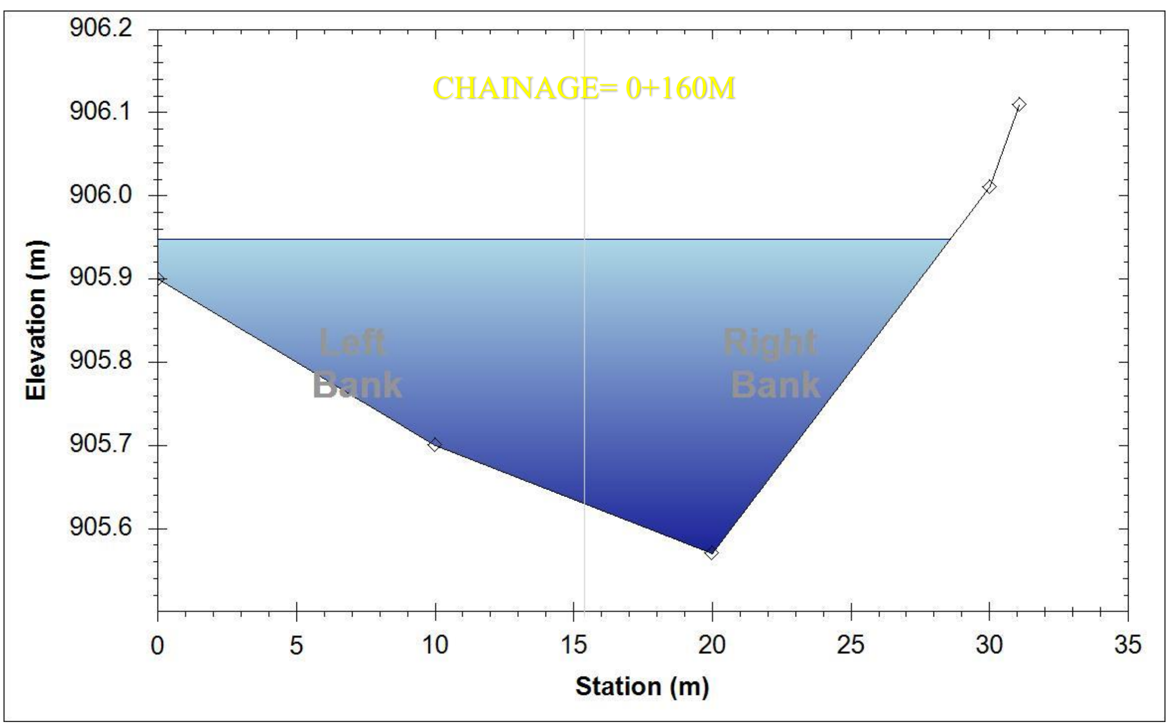

CHAINAGE= 0+120M
Left Bank
Right Bank
Elevation (m)
Station (m)
905.4
905.2
905.0
904.8
904.6
904.4
904.2
0
5
10
15
20
25
30
35


CHAINAGE= 0+130M
Left Bank
Right Bank
Elevation (m)
Station (m)
905.6
905.4
905.2
905.0
904.8
904.6
904.4
904.2
0
5
10
15
20
25
30
35

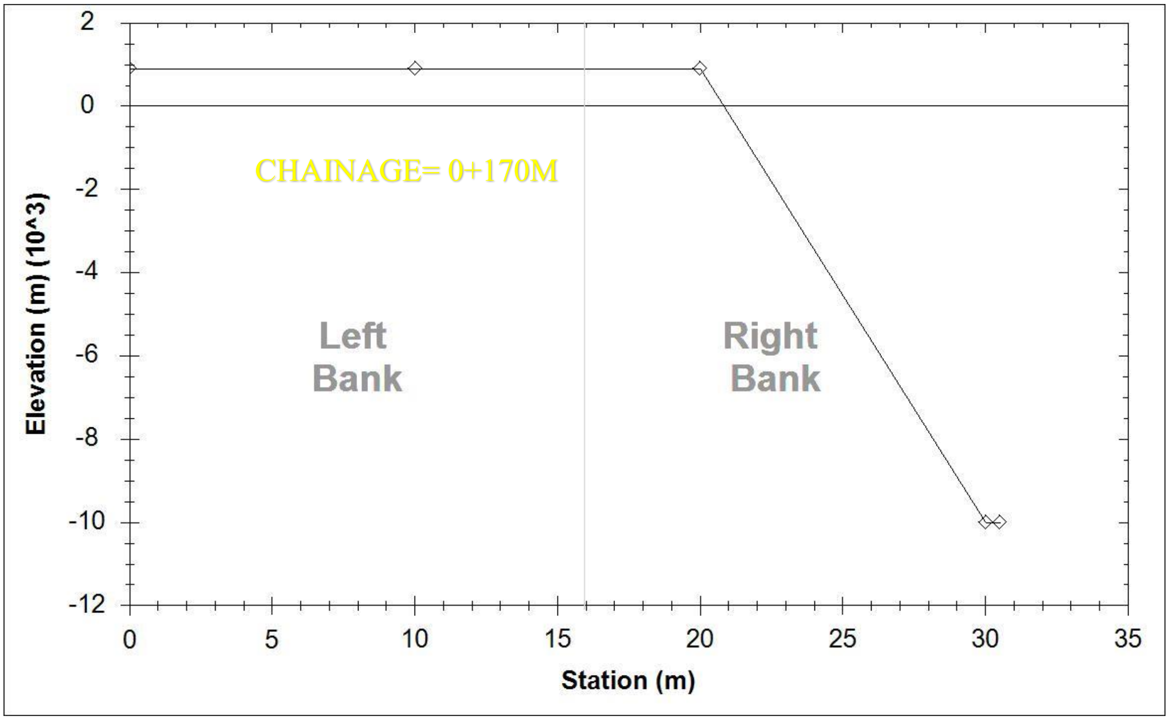

CHAINAGE= 0+140M
Left Bank
Right Bank
Elevation (m)
Station (m)
905.6
905.4
905.2
905.0
904.8
904.6
904.4
904.2
904.0
903.8
0
5
10
15
20
25
30
35

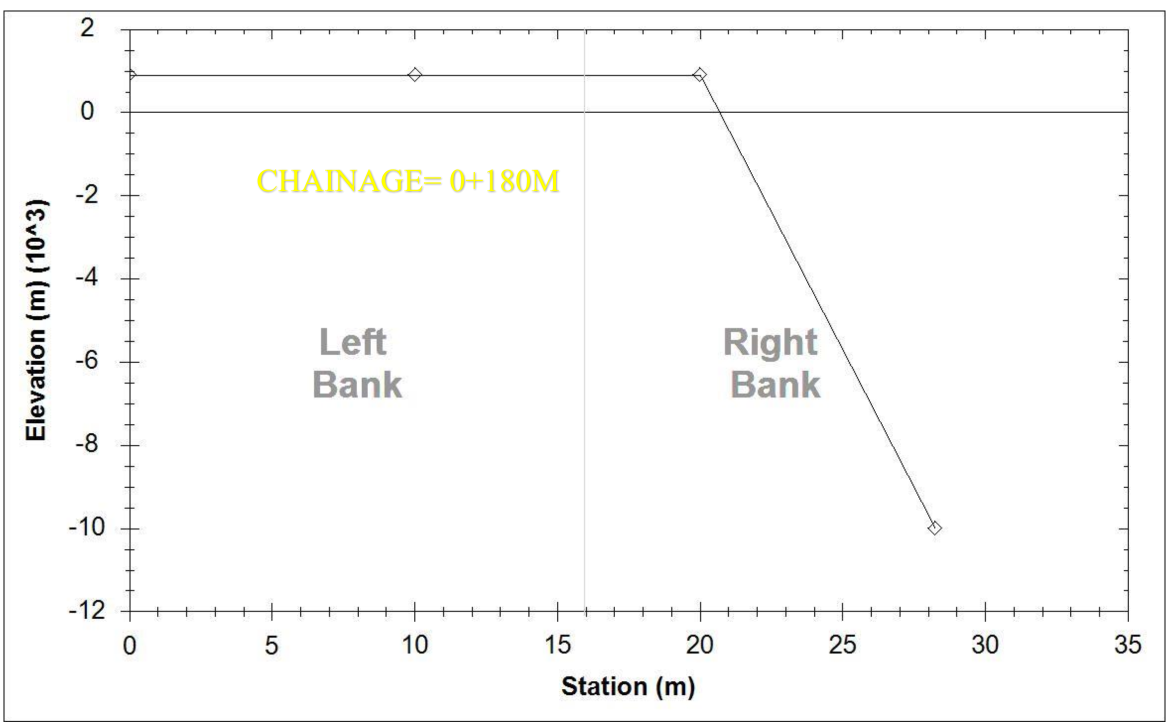


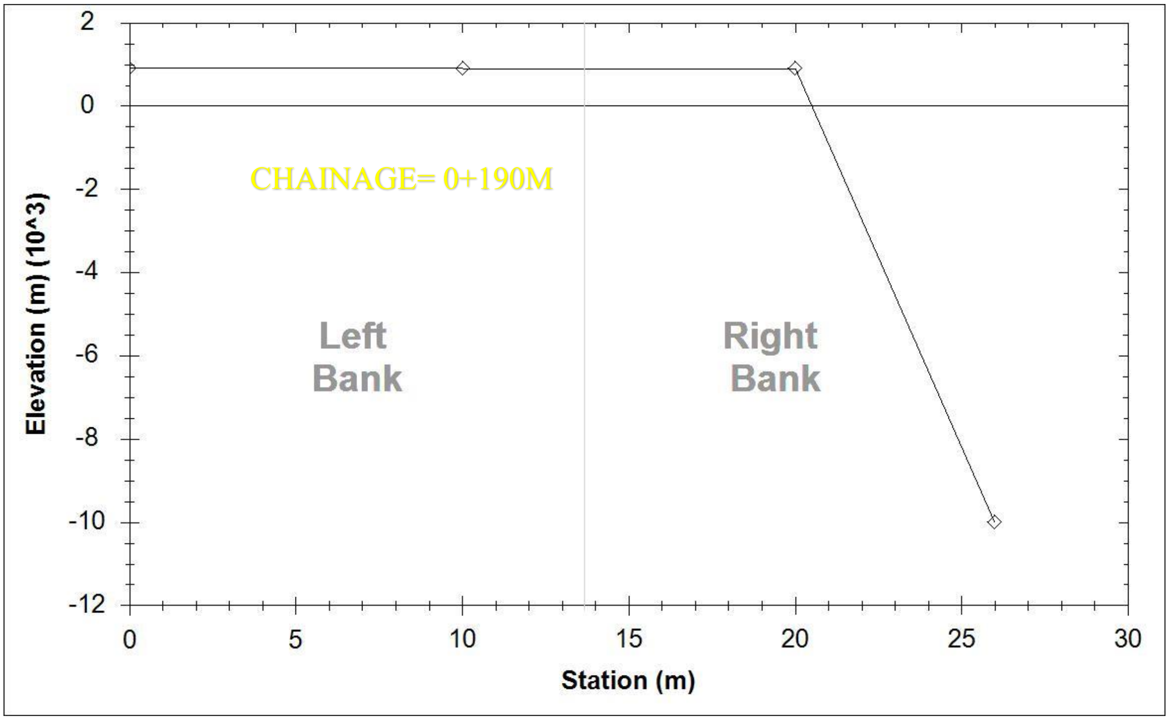
CHAINAGE= 0+150M
Left Bank
Right Bank
Elevation (m)
Station (m)
906.2
906.0
905.8
905.6
905.4
905.2
905.0
904.8
0
5
10
15
20
25
30
35

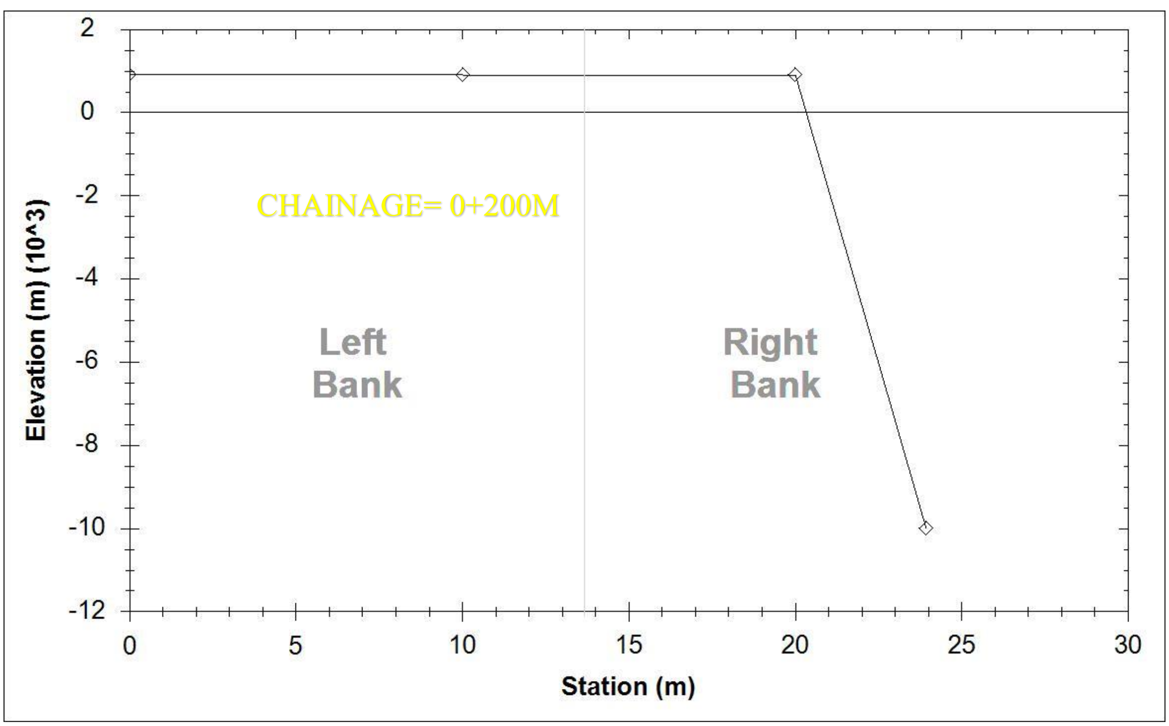


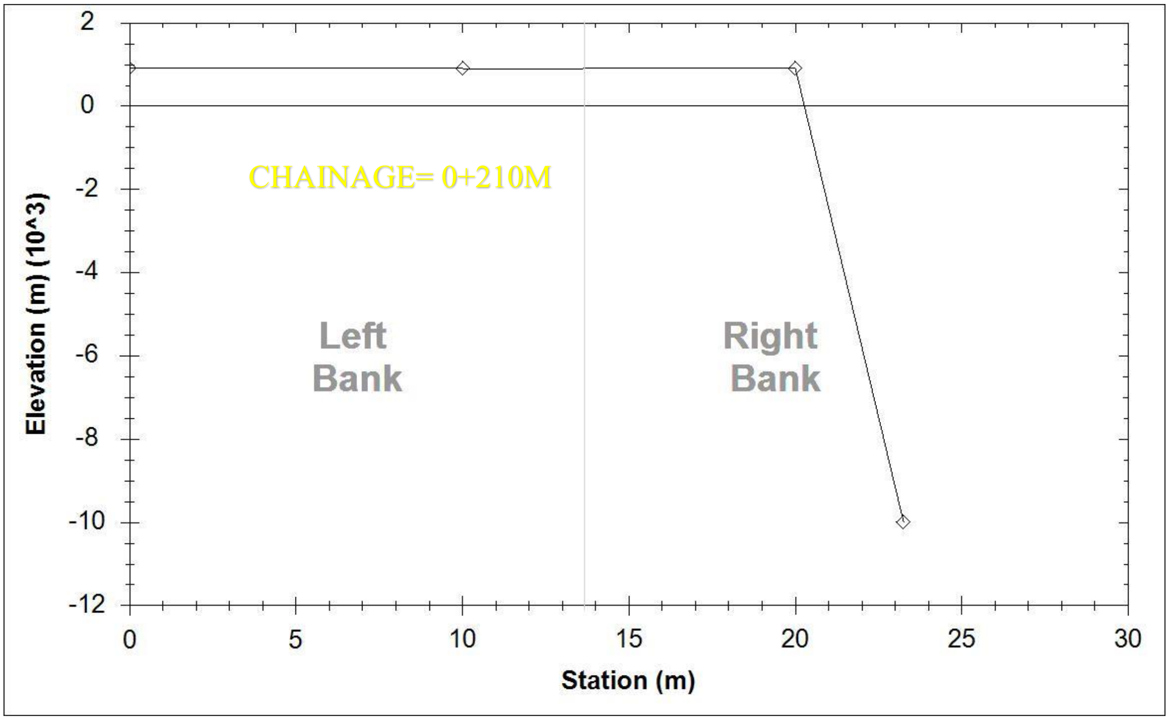
CHAINAGE= 0+160M
Left Bank
Right Bank
Elevation (m)
Station (m)
906.2
906.1
906.0
905.9
905.8
905.7
905.6
0
5
10
15
20
25
30
35


CHAINAGE= 0+170M
Left Bank
Right Bank
Elevation (m) (10^3)
Station (m)
2
0
-2
-4
-6
-8
-10
-12
0
5
10
15
20
25
30
35

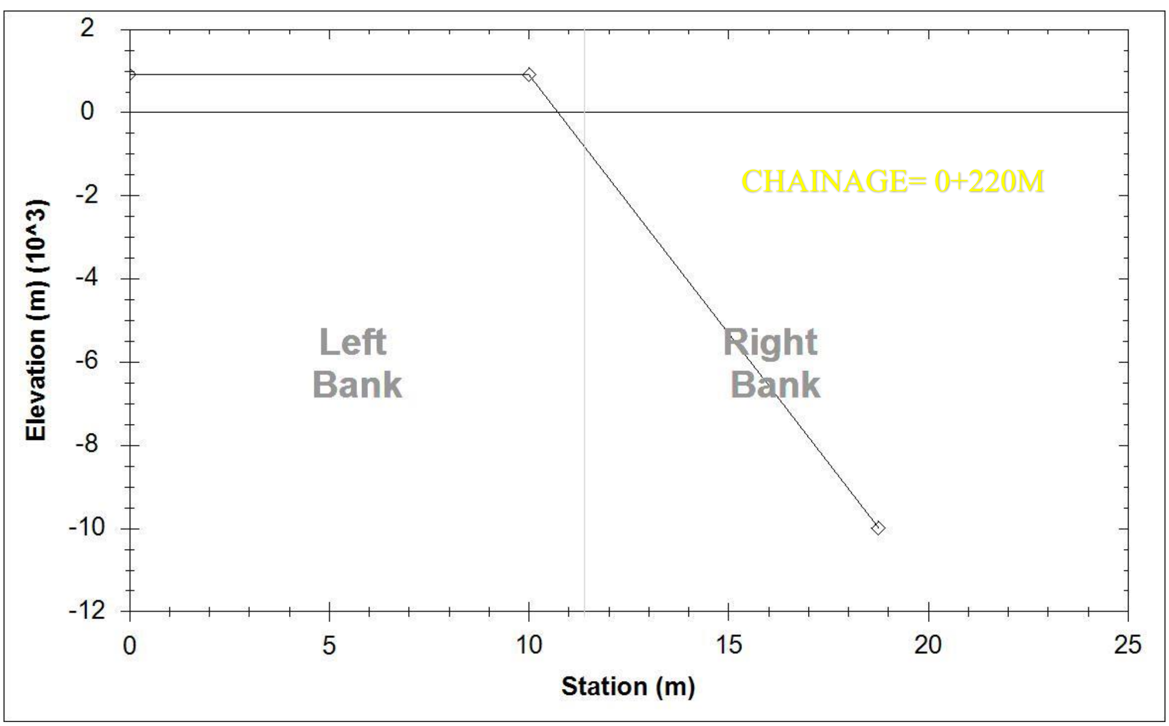

CHAINAGE= 0+180M
Left Bank
Right Bank
Elevation (m) (10^3)
Station (m)
2
0
-2
-4
-6
-8
-10
-12
0
5
10
15
20
25
30
35


CHAINAGE= 0+190M
Left Bank
Right Bank
Elevation (m) (10^3)
Station (m)
2
0
-2
-4
-6
-8
-10
-12
0
5
10
15
20
25
30

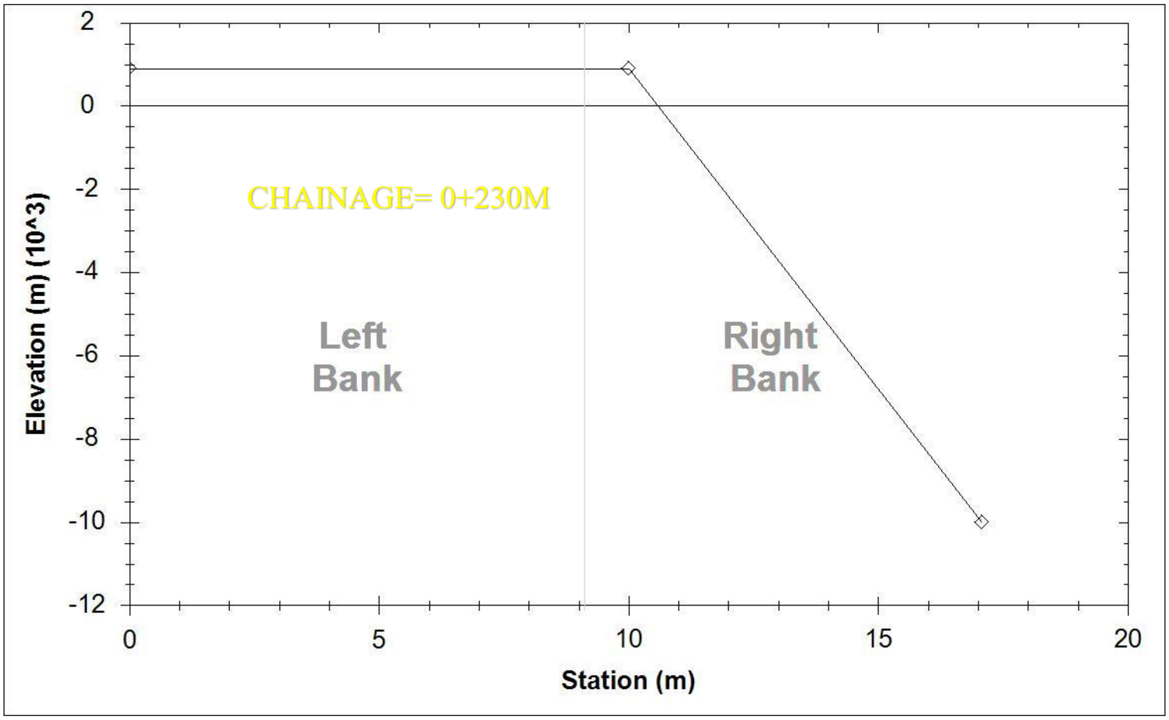

CHAINAGE= 0+200M
Left Bank
Right Bank
Elevation (m) (10^3)
Station (m)
2
0
-2
-4
-6
-8
-10
-12
0
5
10
15
20
25
30



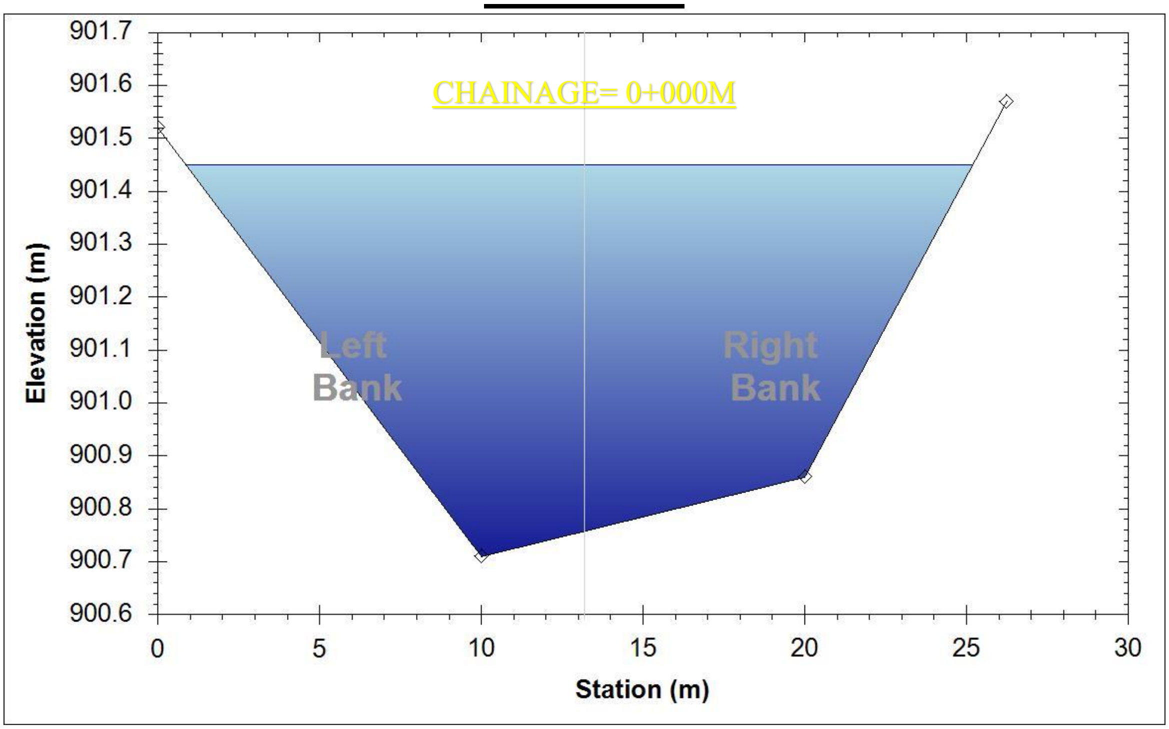
CHAINAGE= 0+210M
Left Bank
Right Bank
Elevation (m) (10^3)
Station (m)



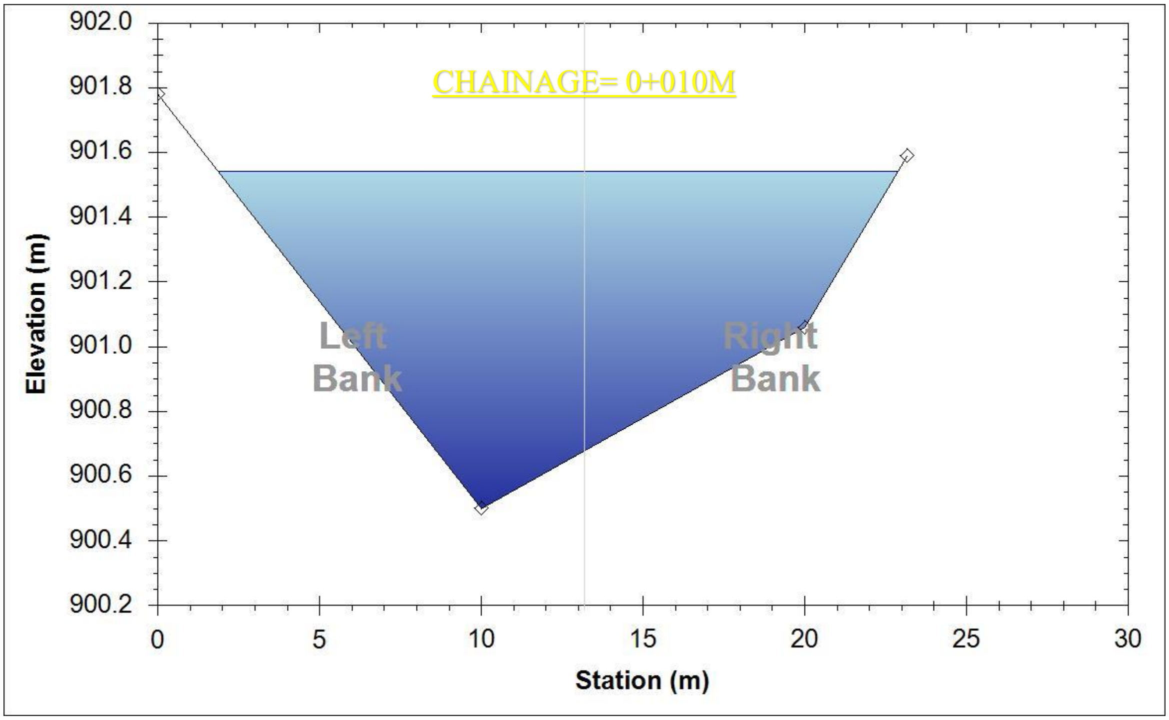
CHAINAGE= 0+220M
Left Bank
Right Bank
Elevation (m) (10^3)
Station (m)

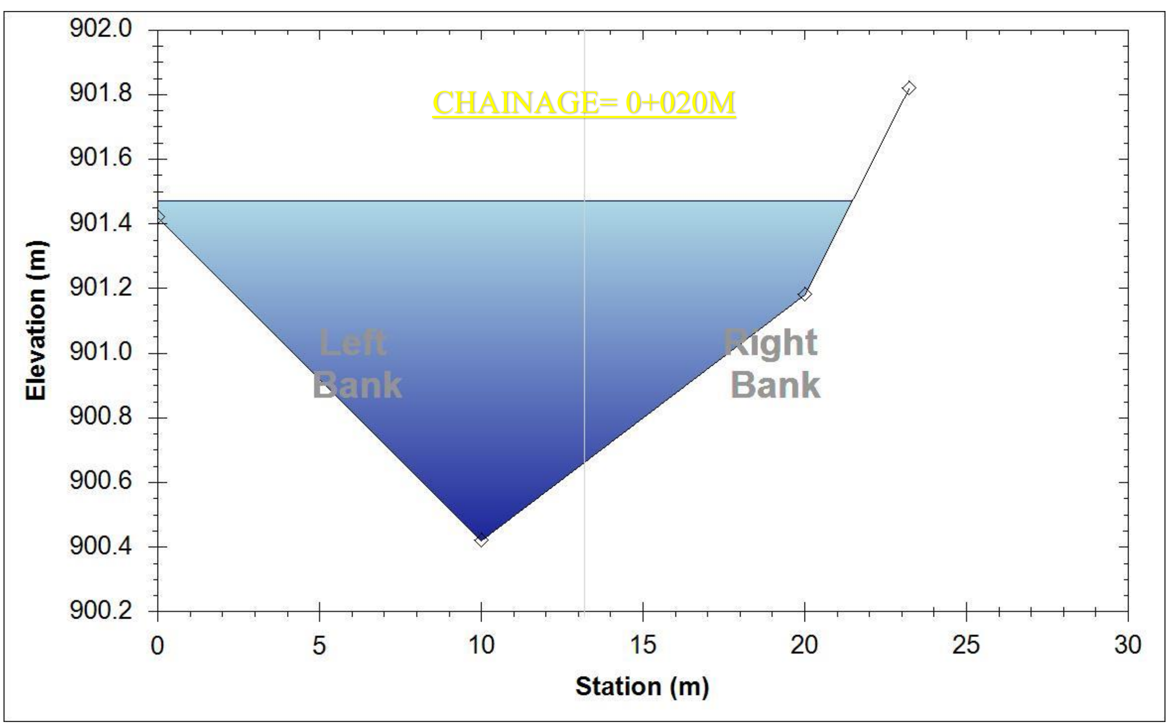

CHAINAGE= 0+230M
Left Bank
Right Bank
Elevation (m) (10^3)
Station (m)

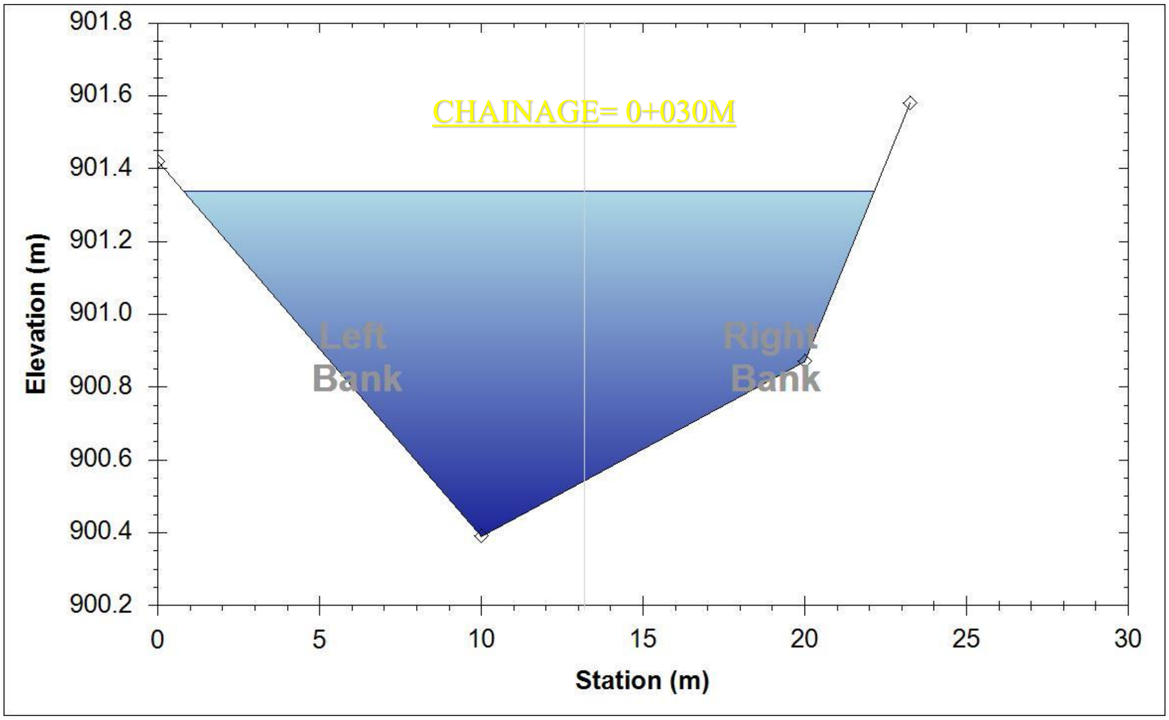
CENTER

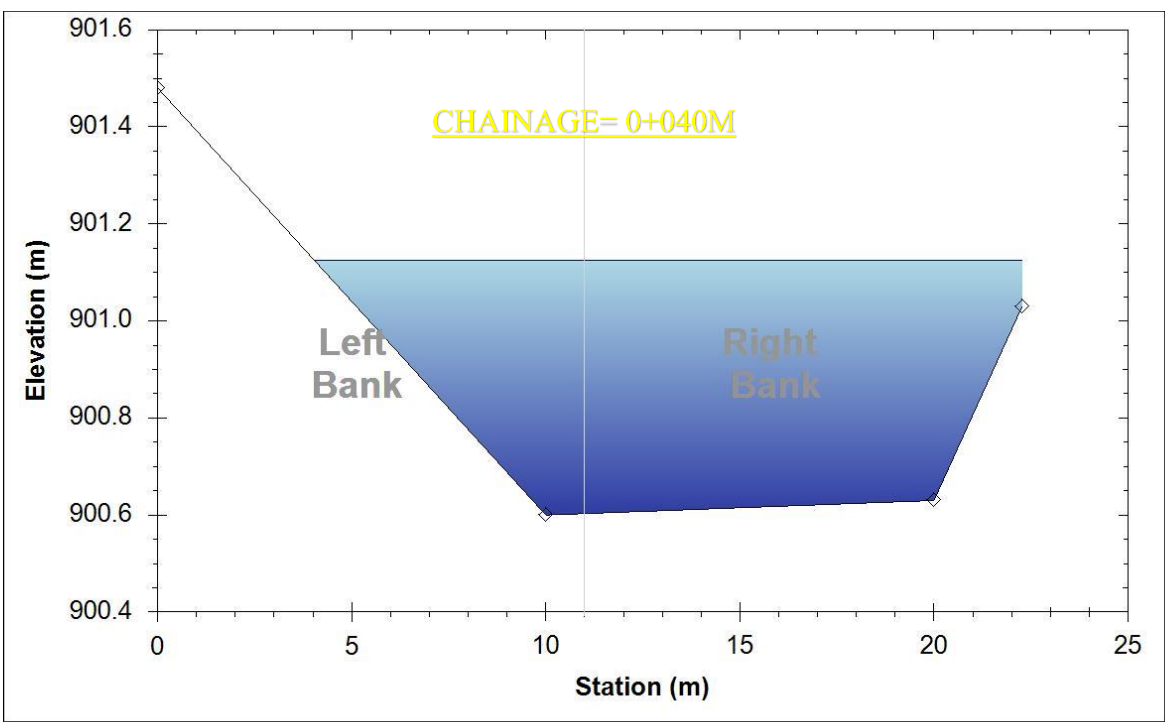

CHAINAGE= 0+000M
Left Bank
Right Bank
Elevation (m)
Station (m)

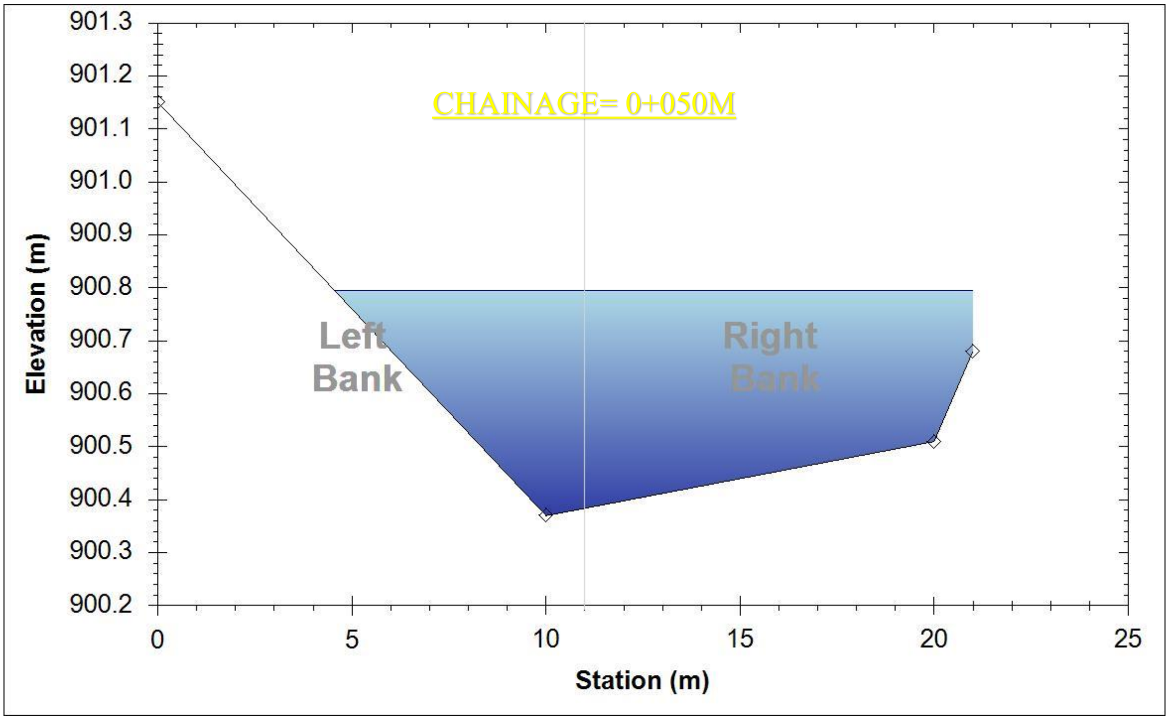
DOWN STREAM

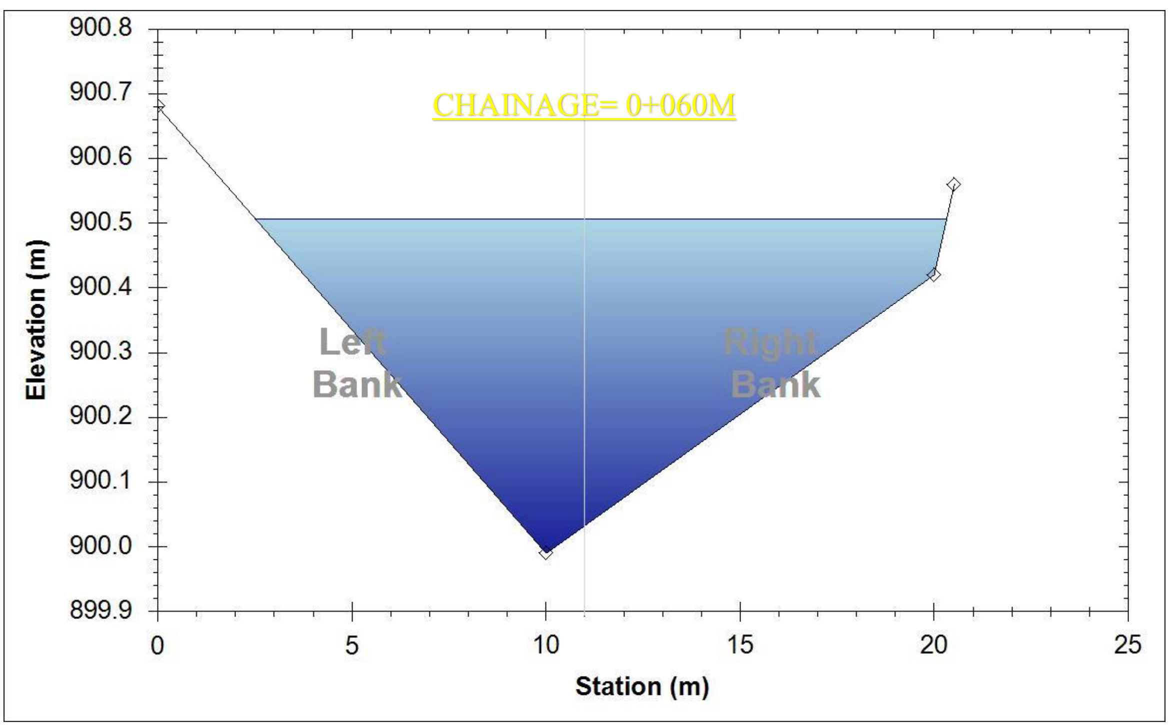

CHAINAGE= 0+010M
Elevation (m)
Station (m)
Left Bank
Right Bank
902.0
901.8
901.6
901.4
901.2
901.0
900.8
900.6
900.4
900.2
0
5
10
15
20
25
30

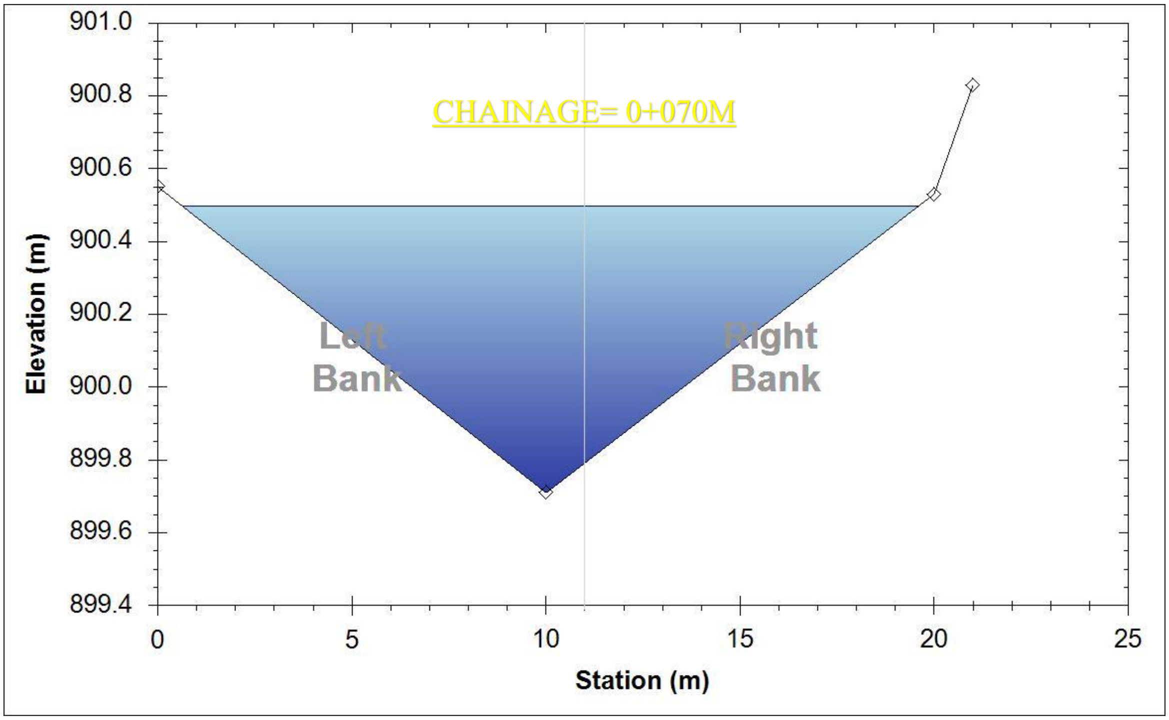

CHAINAGE= 0+020M
Elevation (m)
Station (m)
Left Bank
Right Bank
902.0
901.8
901.6
901.4
901.2
901.0
900.8
900.6
900.4
900.2
0
5
10
15
20
25
30


CHAINAGE= 0+030M
Left Bank
Right Bank
Elevation (m)
901.8
901.6
901.4
901.2
901.0
900.8
900.6
900.4
900.2
0
5
10
15
20
25
30
Station (m)

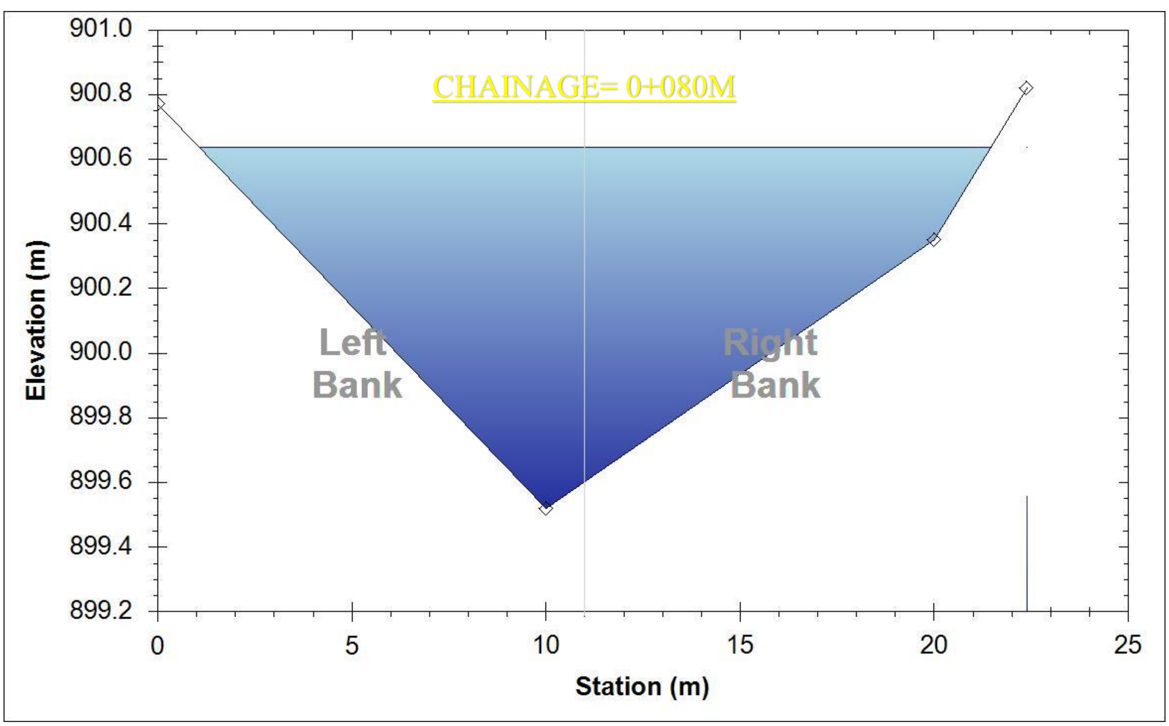

CHAINAGE= 0+040M
Left Bank
Right Bank
Elevation (m)
901.6
901.4
901.2
901.0
900.8
900.6
900.4
0
5
10
15
20
25
Station (m)


CHAINAGE= 0+050M
Left Bank
Right Bank
Elevation (m)
Station (m)
901.3
901.2
901.1
901.0
900.9
900.8
900.7
900.6
900.5
900.4
900.3
900.2
0
5
10
15
20
25

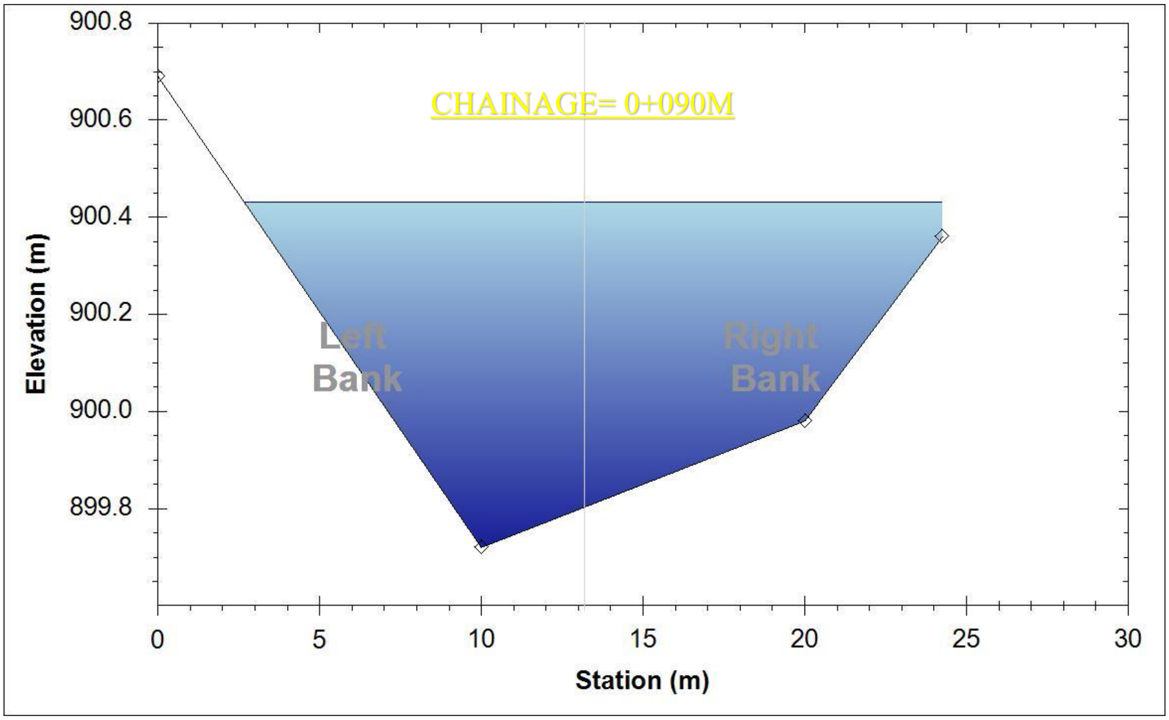

CHAINAGE= 0+060M
Left Bank
Right Bank
Elevation (m)
Station (m)
900.8
900.7
900.6
900.5
900.4
900.3
900.2
900.1
900.0
899.9
0
5
10
15
20
25

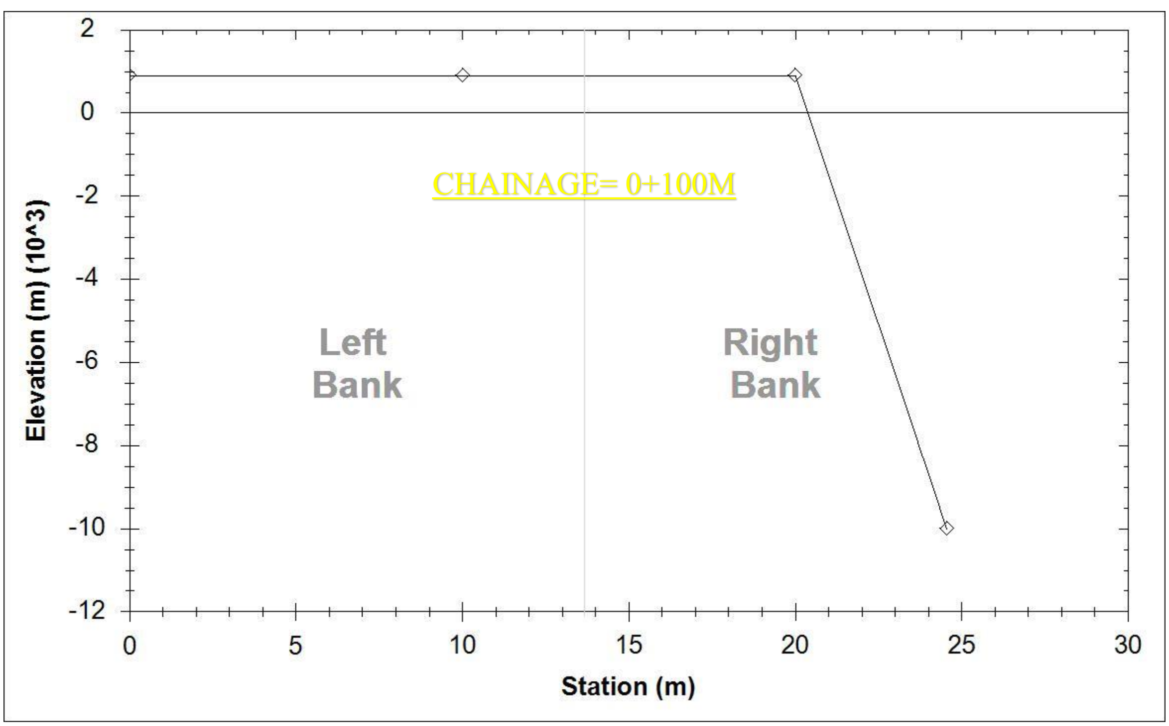


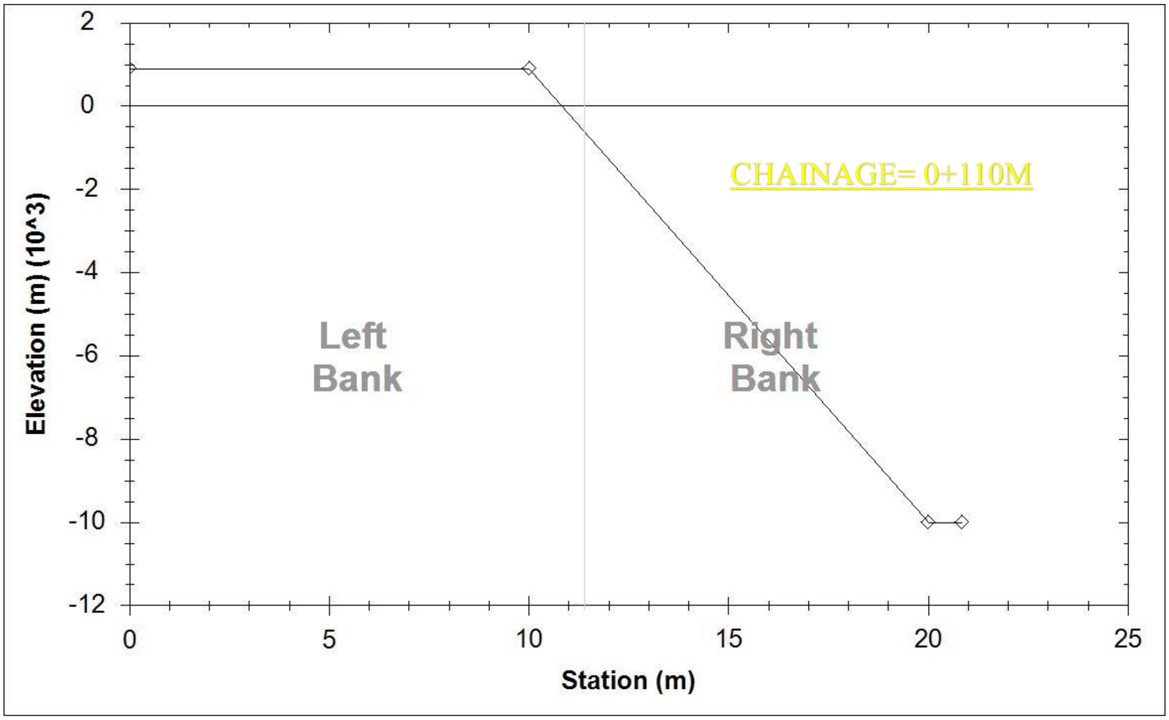
CHAINAGE= 0+070M
Elevation (m)
Station (m)
Left Bank
Right Bank
901.0
900.8
900.6
900.4
900.2
900.0
899.8
899.6
899.4
0
5
10
15
20
25

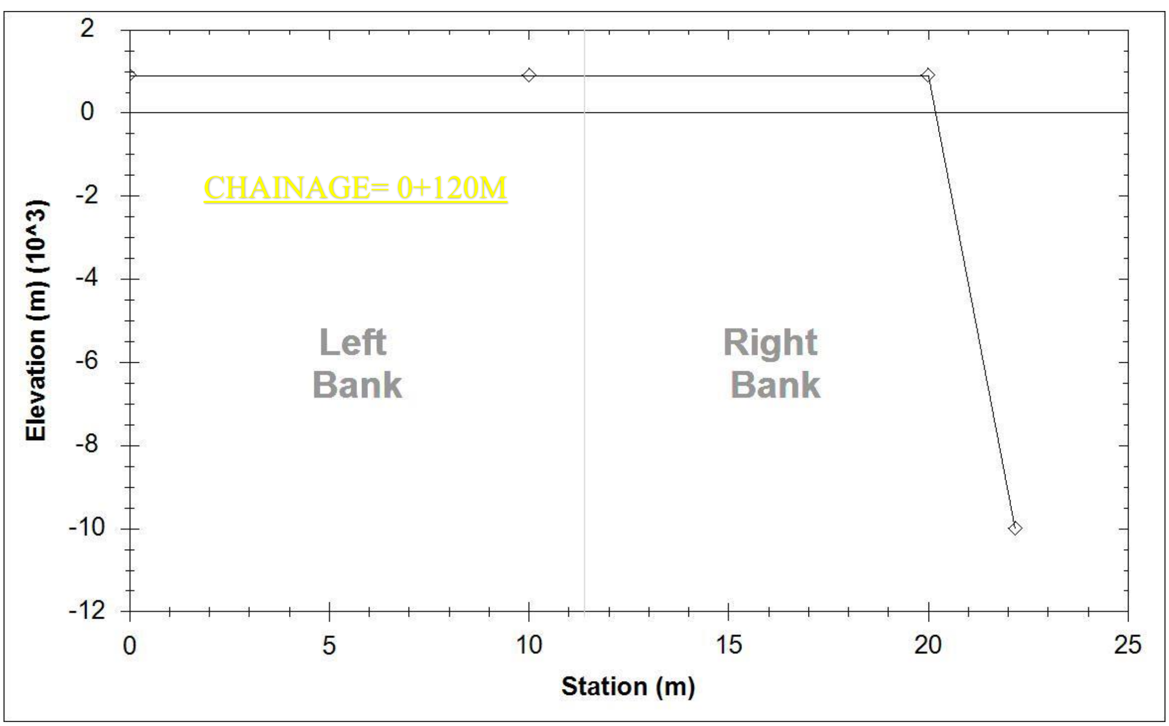


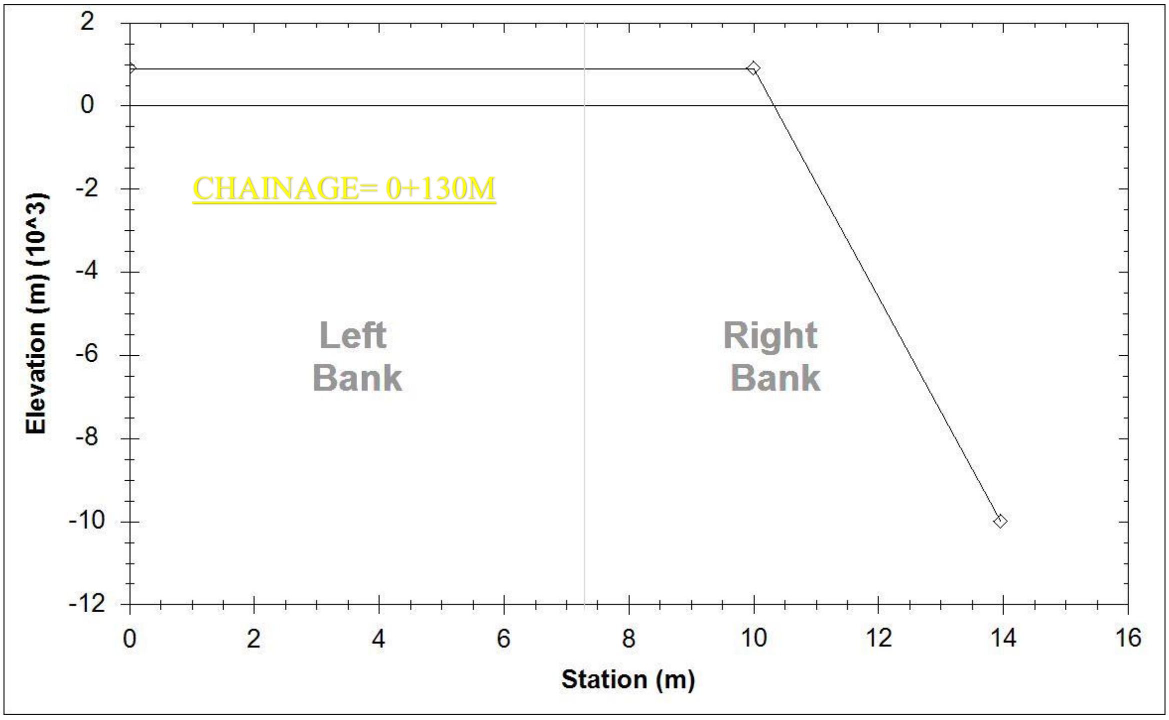
CHAINAGE= 0+080M
Elevation (m)
Station (m)
Left Bank
Right Bank
901.0
900.8
900.6
900.4
900.2
900.0
899.8
899.6
899.4
899.2
0
5
10
15
20
25


CHAINAGE= 0+090M
Left Bank
Right Bank
Elevation (m)
Station (m)
900.8
900.6
900.4
900.2
900.0
899.8
0
5
10
15
20
25
30


CHAINAGE= 0+100M
Left Bank
Right Bank
Elevation (m) (10^3)
Station (m)
2
0
-2
-4
-6
-8
-10
-12
0
5
10
15
20
25
30


CHAINAGE= 0+110M
Left Bank
Right Bank
Elevation (m) (10^3)
Station (m)
2
0
-2
-4
-6
-8
-10
-12
0
5
10
15
20
25


CHAINAGE= 0+120M
Left Bank
Right Bank
Elevation (m) (10^3)
Station (m)
2
0
-2
-4
-6
-8
-10
-12
0
5
10
15
20
25



CHAINAGE= 0+130M
Left Bank
Right Bank
Elevation (m) (10^3)
Station (m)
2
0
-2
-4
-6
-8
-10
-12
0
2
4
6
8
10
12
14
16