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PASCHIAMANCHAL CAMPUS
DEPARTMENT OF GEOMATICS ENGINEERING
LAMACHAUR-16, POKHARA

A REPORT ON SURVEY CAMP 2080

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Submitted to:-

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GROUP-01

Acknowledgements:

We would like to express our sincere appreciation to the **Department of Geomatics Engineering at Paschimanchal Campus** for providing us opportunity to submit our Report titled "A REPORT ON SURVEY CAMP-2080". We have thoroughly reviewed its contents and would like to acknowledge our hard work and dedication in compiling such a comprehensive document.

We are truly grateful to the Department of Geomatics Engineering, Paschimanchal Campus for providing us with the opportunity to apply our theoretical surveying expertise in a practical setting. This year's successful conduct of the survey camp, within the scheduled timeframe and in a pleasant environment, sets it apart from previous years. Such achievement was made possible by the persistent efforts of our Department.

The dedication and tireless contributions of our mentors, **Er. Pradip Aryal, Er. Umesh Bhurtel, Er. Roshan Poudel, Er. Netra Bahadur Katuwal, Er. Saurav Gautam**, and other teachers, deserve credit for the successful completion of the Survey camp. They guided us through every step, from initiation to conclusion, and provided assistance in overcoming various challenges encountered during the fieldwork. Additionally, we extend our appreciation to other teachers and colleagues for their continued support and cooperation throughout the survey camp on campus.

The topographical survey of the college premises, Road Alignment Survey, and Bridge Site Survey conducted in Kali Khola were carried out based on the parameters specified in the field book. While we made our best efforts to adhere to the criteria, it is possible that the report may contain some mistakes. Therefore, we welcome any feedback and recommendations we may have regarding the report, as they will greatly assist us in improving its accuracy and quality.

Once again, we express our sincere appreciation to the Department of Geomatics Engineering, Paschimanchal Campus for your remarkable work and dedication in completing this report. The knowledge and experience gained through the survey camp will undoubtedly contribute to our future endeavors in the field of Geomatics Engineering.

Thank you for your valuable contribution.

Abstract:

The Survey Camp 2080 organized by the **Department of Geomatics Engineering, IOE Paschimanchal Campus,** aimed to provide students from the 077-BGE Batch with an opportunity to enhance their theoretical and practical knowledge of Engineering Surveying in real field conditions. The camp was conducted at two locations: Kali-khola and its surroundings in Pokhara, as well as Paschimanchal Campus in 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.

The students formed groups and carried out fieldwork, enabling them to actively participate in the planning and execution of field tasks. The primary goals were to create a topographical map and conduct a detailed survey of the road and bridge. The survey camp significantly contributed to building the students' confidence in conducting Engineering Surveys with accuracy and professionalism.

The report has been prepared using the recorded data and calculations from the survey camp. While efforts were made to ensure accuracy, we acknowledge that errors or mistakes may exist within the document. We kindly request readers to provide constructive feedback upon reviewing the report.

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Abbreviations:

- RL-Reduced Level
- BM-Bench Mark
- TBM- Temporary Benchmark
- TL-Tangent length
- TMB-Top Middle Bottom
- U/S-Upstream
- D/S-Downstream
- HCR-Horizontal Circle Reading
- VCR- Vertical Circle Reading
- WCB- Whole Circle Bearing
- W.T-Water Tank
- BS-Back Sight
- IS-Intermediate Sight
- FS-Fore Sight
- BC-Beginning of Curve
- MC-Middle of Curve
- EC-End of Curve
- RB-Reduced Bearing
- GL-Ground Level
- FL-Formation Level
- RBL-River Bed Level
- LFLR-Low Flood Level Right
- LFLL- Low Flood Level Right
- HFLR-High Flood Level Right
- HFLL- High Flood Level Left
- TT- Table Tennis Board
- OFF-Offset
- BC-Building Corner
- BTOL-Boys Toilet
- SH-Spot Height

CHAPTER-1

INTRODUCTION

Background

Surveying is the process of determining the relative positions of natural and manmade features on or beneath the Earth's surface. This information is presented graphically through plans or statistically through tables. Surveying involves measurements, computations, plan creation, and executing location determinations. Surveyors employ various tools such as total stations, retroreflectors, 3D scanners, robotic total stations, GPS receivers, drones, GIS, radios, handheld tablets, digital levels, and subsurface locators. They also utilize software designed specifically for surveying purposes.

Surveying has played a crucial role in the development of industries and the human environment throughout history. For Geomatics engineering students, surveying courses aim to teach the fundamental techniques of surveying. These techniques are essential in their professional practice for engineering tasks. The completion of all surveying courses, including a 10-day survey camp, is a requirement for Geomatics engineering students. The Department of Geomatics Engineering at Paschimanchal Campus coordinates this camp, which is designed to enhance students' proficiency in various surveying methods. Lecture classes also cover these techniques in detail.

This report provides a comprehensive overview of the work carried out by Group-1 during the survey camp. It is divided into six sections, each describing the functioning of different methods and techniques employed by the group. The report includes observations, computations, error correction methods, encountered challenges, solutions, and outcomes related to the group's work during the camp.

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 us 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.
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.
   To compute and manipulate observed data with the needed accuracy, and todisplay it in diagrammatic and tabular form so that others can understand it.
f. To deal with errors and missing data from the field during office work.
g. To prepare for the final report.

Classification of Surveying:

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

- Based on nature of field
  - Land Survey: includes topographical, cadastral and city survey.
  - Hydrographic Survey
  - Astronomical Survey
- Based on object of survey
  - Engineering Survey
  - Military Survey
  - Mine Survey
  - Geological Survey
  - Archaeological Survey
- Based on instruments used
  - 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 includedthe 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 pointsin bridge site survey, depending on the instrument employed.

Principles of surveying:

While surveying, we became careful about the different principles of surveying. 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 repeatedobservations 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 thetrue value. Precision instruments, precise processes, and good planning are all required foraccuracy.

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:
  - Instrumental error: E.g. a tape too short
  - Personal error: E.g. error while taking staff reading
  - Natural error: errors due to different natural phenomenon such as temperature,refraction, etc.

- Types of errors:

  Mistakes
  Systematic errors
  Accidental errors

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:

- Road Alignment in Kali Khola premises:
- Fixing the stations IP0, IP1….
- Computation of chainages for each beginning, middle and end of curves withthe help of theodolite for total length of about 1037.06 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.
- Topographical Survey in Pashchimanchal Campus:
- Reconnaissance survey
- Fixing major stations and forming the major traverse covering the project area.
- Measuring distance by using tape along ranging method in 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.
- 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 Detailing Topographic Map: 1:500
- Paper size: A1
- Contour interval: 1 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

Road Alignment Survey:

- Chainage should be at least 1000 m & deflection angle not too low.
- Preparing plan of road in scale 1:500.
- Preparing L-section of road with scale 1:200 for vertical and 1:1000 for horizontal.
- Preparing cross-section graphs of road in scale 1:100 for vertical and 1:20 for horizontal.

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.
- L-section of river.
- Cross-section graphs of river in ArcMap.

Survey Camp Area:

Figure 1: Paschimanchal Campus Area

Figure 2: Kali- Khola Area

Source: Google Earth

CHAPTER-2

TOPOGRAPHIC SURVEY

Introduction:

Topography is indeed a field of geoscience and planetary science that deals with the detailed study and description of the features and configuration of the Earth's surface. It encompasses various aspects, including relief (variations in elevation), natural features (such as mountains, rivers, and valleys), artificial features (such as buildings and roads), and even local history and culture.

Topographic surveying is the process of accurately determining the positions, both horizontally (plan) and vertically (elevation), of natural and artificial features in a particular area. The purpose of topographic surveying is to create a detailed representation of the terrain, which is typically done by creating a topographic map. This map uses conventional signs and symbols to depict the three-dimensional relationships of the land, showing both horizontal and vertical information.

Topographic maps are essential tools in various fields, including urban planning, engineering, geology, environmental studies, and military operations. They provide valuable information about the shape of the land, the location and characteristics of features, and the spatial relationships between different elements. By accurately representing the topography, these maps allow for better understanding, analysis, and decision-making related to land use, infrastructure development, resource management, and other related activities

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:

To prepare the topographic map of the given area with horizontal and vertical control at required degree accuracy.

Brief description of the area:

Topographic survey was carried out at Pashchimanchal Campus, Lamachaur, Pokhara. Themajor traverse was run covering a major portion of campus area while offset was run through the area where our detailing work was assigned. Our objective was to prepare a topographic map of the given area. Therefore, our major task was to prepare thetopographic map of the area including Mechanical and Automobile Workshops, D/Civil Block, Auditorium hall, MSc Hostel, Cafeteria, Mechanical Workshops, Library, different parks, Roads Boundary wall and so on.

Norms (Technical specifications):

- Reconnaissance survey of the area to be surveyed: A closed traverse (major) 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 thelongest traverse leg to the length of the smallest leg should be less than or equal to 1:2 formajor traverse. References were taken for the major traverses.

- Two-way measurement of the traverse legs: Discrepancy (Accuracy of two-way measurement in the case of major 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 observationshould 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 ofback sight and fore sight is necessary for the elimination of different types of errors including collimation error. The permissible error of fly levelling is ± 25$\sqrt{K}$ mm, where Kis 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. For 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.

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Instruments used:

The following are the instruments used for topographic survey:

- Measuring tape
- Pegs
- Ranging rods
- Tripod stand
- Auto level
- Levelling Staff
- Total Station
- Clampers
- Reflectors (Target prisms with stands and levelling bubble provided)
- Hammer
- Marker pen
- Field books

Figure 3: Measuring Tape

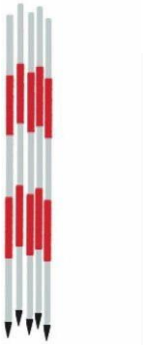

Figure 4: Ranging Rods

Figure 5: Tripod Stand

Figure 6: Level Machine

Figure 7: Levelling Staff

Figure 8: Pegs

Total Station:

A total station is an optical instrument commonly used in modern surveying. It combines the functionality of an electronic theodolite, an electronic distance meter (EDM), and software running on an external computer called a data collector. This instrument allows surveyors to determine both angles and distances from the total station to the points being surveyed.

To calculate the distance, the total station emits and receives multiple frequencies, determining the number of wavelengths to the target for each frequency. This allows for the determination of the distance between the total station and the target object.

Most total stations use a purpose-built glass Porro prism as the reflector for the EDM signal. These instruments can measure distances up to a few kilometers. However, some total stations are "reflectorless" and can measure distances to any reasonably light-colored object, typically up to a few hundred meters.

The typical EDM of a total station can measure distances with an accuracy of about 3 millimeters or 1/100th of a foot. In summary, the basic principle of a total station is based on

determining the time it takes for a light wave to travel a known distance and back, utilizing the velocity of light. With this information, distances, angles, and coordinates can be calculated, allowing for precise surveying and positioning.
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.

Advantages of Total Station:

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

a) Quick setup: Total stations are designed for easy and quick setup on a tripod, often aided by a laser plummet. This allows surveyors to start their work promptly, saving time and increasing efficiency
b) On-board area computation: Total stations are equipped with software that can compute the area of a field or land directly within the instrument. This feature eliminates the need for manual calculations and speeds up the surveying process.
c) Language support: Many total stations support multiple languages, allowing surveyors to operate the instrument in their preferred language. This feature enhances ease of use and ensures effective communication.
d) Graphical view: Total stations provide a graphical view of the land and plots being surveyed. This visual representation helps surveyors better understand the terrain and make more informed decisions during the surveying process.
e) Computerization of old maps: Total stations, when used in conjunction with appropriate software, can facilitate the computerization of old maps. This process involves capturing survey data from existing maps and integrating it with digital systems for improved accessibility and analysis.

These advantages collectively contribute to enhanced productivity, accuracy, and efficiency in surveying operations.

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 toconduct a total station survey.

Methodology:

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

1. Working from whole to a part
2. Location of a point with respect to at least two control points
3. Independent check
4. Consistency in work
5. 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 plays a crucial role in surveying as it involves the initial exploration and assessment of the survey area. It provides an overall understanding of the site and helps in

detailed planning by making necessary observations and assessments. Here are the key points to consider during the reconnaissance phase:

1. Exploration and assessment: During reconnaissance, surveyors walk around the survey area to gather information about various aspects such as the total area, type of land, topography, vegetation, climate, geology, and inter-visibility conditions. This helps in gaining a comprehensive understanding of the site.
2. Fixing traverse stations: Based on the observations made during reconnaissance, the positions of traverse stations are planned. The adjacent stations should have clear line-of-sight visibility to ensure accurate measurements and efficient surveying.
3. Minimum number of stations: The aim is to include the least number of stations possible while maintaining the required accuracy. This helps in optimizing resources and reducing surveying time.
4. Traverse leg ratio: The ratio of the minimum traverse leg to the maximum traverse leg is an important consideration. For major traverses, this ratio should be less than 1:2, while for minor traverses, it should be less than 1:3. Maintaining these ratios ensures balanced measurements and accurate traversing.
5. Suitable station locations: Traverse stations should be positioned to provide a minimum level surface for setting up the surveying instrument. This helps in ensuring stability and accuracy during measurements.
6. Avoidance of difficult terrain: Steep slopes and badly broken ground should be avoided as much as possible during the selection of traverse stations. Such terrain can introduce difficulties in measurements and may affect the accuracy of the survey.
7. Atmospheric refraction considerations: The selection of stations should avoid placing the line of sight too close to the ground level. This minimizes the potential errors caused by atmospheric refraction, which can affect measurement accuracy. By taking these points into consideration and fixing the traverse stations accordingly, the reconnaissance phase is completed.

   This preliminary step provides the necessary foundation for the subsequent surveying activities

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 ofeach 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:

$X2 = X1 + L\cos\theta$

$Y2 = Y1 + L\sin\theta$

Where, L=Length of traverse leg, Θ is the bearing of the line and (X1, Y1) is known co-ordinate.

Types of Travers

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 closesat a station i.e. if they form a polygon or it starts and finishes at the points of known co- ordinates, 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.

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.

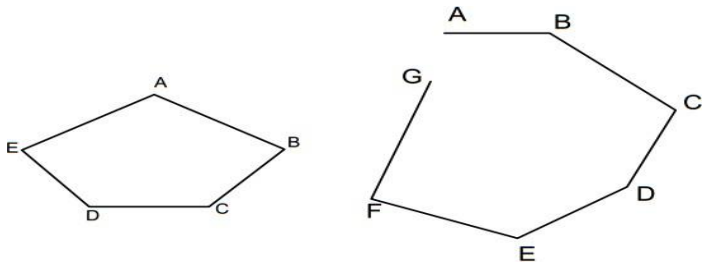

Figure 10: Closed Traverse and Open Traverse

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

bekept 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 within 1:1000.

Discrepancy and linear misclosure:

In order to measure the lengths of the sides of the traverse, two ways of taping (forward and backward) are done. In difficult areas where taping is not possible, other methods like the subtense bar are used. The difference in values obtained by forward and backward taping is called discrepancy. The reciprocal of the 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 traverse angles:

The horizontal angles between the traverse stations were measured by the help of a knownbearing 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'√N, then the error in the sum of internal angles is equally distributed.

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 definedas 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*cosθ

Departure of B = Departure of A + L*sinθ

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) = √ [(ΔL)^2 + (ΔD)^2] And

Direction, tan θ = ((ΔD)/ (ΔL))

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 tozero 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

a. Bowditch's Method:

The method is based on the assumption that errors in the linear measurement are proportional to √L and the errors in the angular measurements are inversely proportional to √L where L is the length of a line. The method is applicable when both the linear as wellas 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(lat= $\sum$(Lat)×L/ $\sum$ Ls)

&(Dep= $\sum$Dep ×L/ $\sum$Ls)

Where,

Lat = Correction to latitude of anyside

Dep = Correction to departure of any side

Σ(Lat) = Total error in latitude

Ls = 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 alongthe 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).

1. **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-levellines. 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 betweentwo points which are visible from a single point. This method is applied when the distancebetween 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 pointsat measured intervals along the given line in order to obtain the profile of the surface alongthat 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 underlyingstrata, or of both.

e) **Reciprocal levelling**

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

2. **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 followingsteps:

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 ofthe 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 setupon the line near B and both staff readings (Top, Middle, and Bottom) were taken. Then, theinstrument was setup at the middle C on the line and again both staff readings on A and Bwas 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

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:

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

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.

$\sum BS - \sum FS = \text{Last R.L.} - \text{First R.L.} = \sum Rise - \sum Fall$

Fly Levelling:

The fly levelling was carried out between TBM1 and TBM2 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) = $\Sigma BS - \Sigma F.S. = \text{Last R.L.} - \text{First R.L.}$ Correction i^{th} leg = $-(e * (L1 + L2 + \ldots + Li)/P$

Where L1, L2, Li = 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.

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 twopoints 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:

i Two contour lines of different elevations cannot cross each other. They can cross each other only in the case of overhanging cliff.

ii Two contour lines of different elevations cannot unite to form a single. If they do, it is only in the case of vertical cliff.

iii 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.

iv A contour line cannot split into two or more contour lines.

v 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.

vi A contour line must close upon itself, though not necessary within the limits of the map.

vii Contour lines cross a watershed or the ridge line at right angles. They form curves of U-shaped round it with the concave side of the curve towards the higher ground.

viii 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.

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:

- Estimation
- Arithmetic calculations
- Graphical method

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.

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 pointsV= Vertical distance between two guide points
Y= Vertical distance between the point to be located and lower elevation point

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 156.3195m and the least distance of the traverse was 90.9275m.

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 1:500.

CHAPTER-3

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 andto 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 topographicsurvey 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 Kalistream flowing beside made the environment cooler. The land was undulated with no largeboulders 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 middleof 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 1:1000.
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

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 rangingbetween IP's. One set of horizontal angles was measured for the deflection angle. The faceleft 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 andprecisely.

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 theinitial line connecting two initial IP's was measured using compass. The interior angle wasmeasured 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 themotion of the vehicle. A curve may be circular, parabolic or spiral and is always tangentialto 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

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 thepassengers 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 = RTanΔ/2

  Where, R= radius of simple circular curve & Δ = deflection angle
- Length of long chord = 2RSinΔ/2
- Apex distance = R (SecΔ/2-1)
- Mid ordinate = R (1- cosΔ/2)
- Length of curve = πRΔ/180
- Chainage of T1= Chainage of IP - RTanΔ/2
- Chainage of T2= Chainage of T1 + πRΔ/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 onlychain 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. Someof 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 likeside 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 leveling 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 inthe 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.

CHAPTER -4

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 infrastructuresin 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 drawingcross-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 ofwater 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 thelayout of river.
- To determine if bridge placed on that axis will be feasible or not in long-term.

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. From these data, reduced levels of all staff positions were calculated and These data were utilized to draw the L-section, cross-section and contour map of riverin 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 trianglesto 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 sidesby observation from this baseline.

Triangulation is preferred for hills and undulating areas, since it is easy to establish stationsat 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 buildingtowers which is quite expensive.

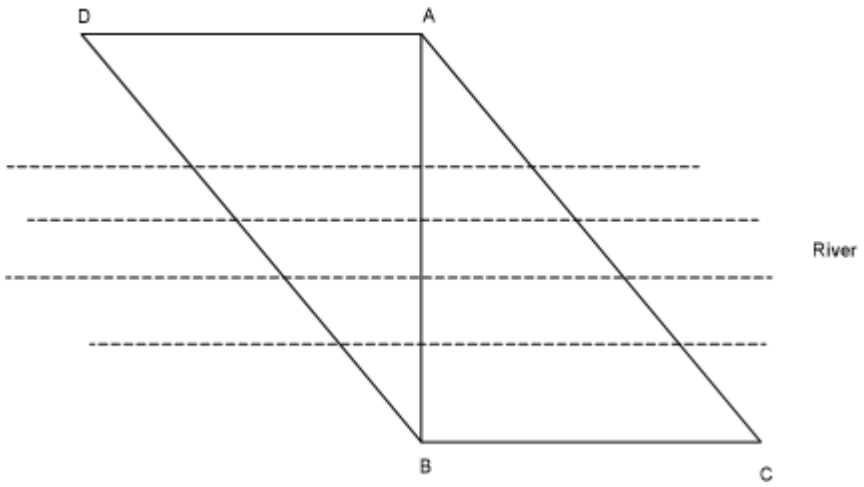

Figure 12: Triangulation

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 equaldistances for back sight and fore sight. In such case reciprocal levelling as described belowis used:

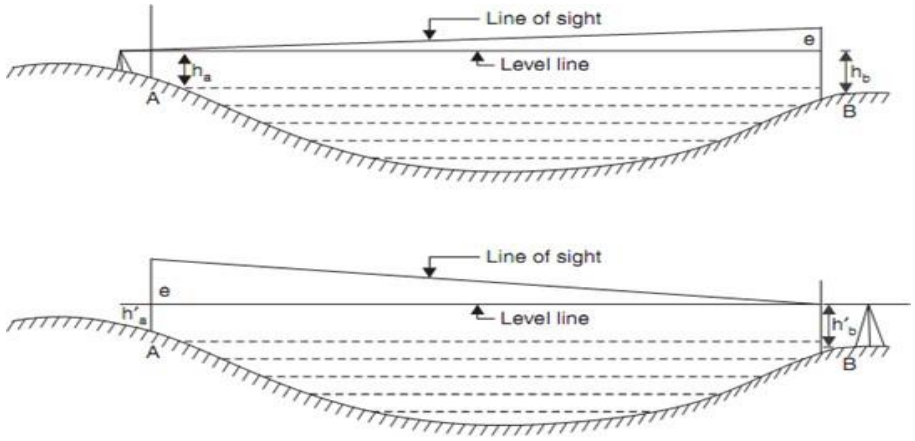

Figure 13: Reciprocal Levelling

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 asaccurate 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 2apparent differences in the elevations.

GIS works:

Finally, the reduced levels of all the staff positions were determined. Knowing chainage and elevations, contour map was drawn on scale 1:500 with contour interval 1 m. longitudinal section of river was drawn indicating high floodlevel and existing flood levels. Cross sections at each 10 m interval were drawn.

Result:

The smallest RL was found to be 899.678 along downstream and the highest RL at the bed level was found to be 904.081 along upstream. By reciprocal leveling the leveling difference of the station of bridge was found to be 0.8775.

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 and finally these data were plotted in the form of longitudinal section, cross-sections and contour maps to decide the feasibility of bridge siteselection. 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 thesurvey 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 workand 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 notto 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'thope for. In conclusion, survey is not just a work to be done, it is the skill to be learnt, teamwork to be done to move forward to know little more about the real field.

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BRIDGE SITE SURVEY

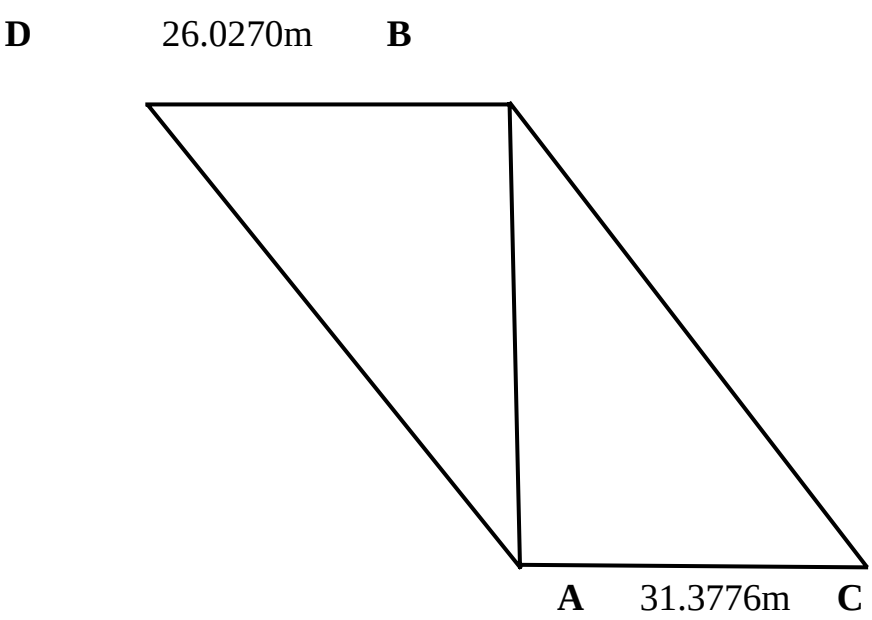
Triangulation Survey

Inst. Stn.	Sighted to	HCR			Angle	Mean	Horiz. Angle
		D	M	S			
A	B	0	0	0	86°30'47"	86°30'44"	86°31'6.75"
		179	59	44			
	C	86	30	47	86°30'41"		
		266	30	25			
	B	60	0	0	86°31'21"	86°31'29.5"	
		240	0	3			
	C	146	31	21	86°31'28"		
		326	31	41			
C	A	0	0	0	50°10'48"	50°10'37.5"	50°10'21.75"
		179	59	57			
	B	50	10	48	50°10'27"		
		230	10	14			
	A	60	0	0	50°10'3"	50°10'6"	
		240	0	17			
	B	110	10	3	50°10'9"		
		290	10	26			
B	A	0	0	0	96°2'37"	96°2'40.5"	96°2'32"
		180	0	5			
	D	96	2	37	96°2'44"		
		276	2	49			
	A	60	0	0	96°2'20"	96°2'23.5"	
		239	59	46			
	D	156	2	20	96°2'27"		
		336	2	13			
D	B	0	0	0	49°36'43"	49°36'45.5"	49°36'41.75"
		180	0	2			
	A	49	36	43	49°36'48"		
		229	36	50			
	B	60	0	0	49°36"21"	49°36'38"	
		239	59	43			
	A	109	36	21	49°36"55"		
		289	36	38			
B	C	0	0	0	43°18'21"	43°18'14.5"	43°18'15.75"

		180	0	22			
	A	43	18	21	43°18'8"		
		223	18	30			
	C	60	0	0	43°18'19"	43°18'17"	
		239	59	57			
	A	103	18	19	43°18'15"		
		283	18	19			
A	D	0	0	0	34°20'14"	34°20'16.5"	34°20'11.25"
		179	59	54			
	B	34	20	14	34°20'19"		
		214	20	13			
	D	60	0	0	34°20'5"	34°20'6"	
		240	0	20			
	B	94	20	5	34°20'7		
		274	20	27			

Reciprocal Leveling

First Set (Instrument at bank A)							
Reading at A			Reading at B			Mean Central Value(a_1)	Mean Central Value (b_1)
T	M	B	T	M	B		
1.038	1.023	1.008	2.065	1.904	1.743	1.023	1.904
Level difference=h=a_1-b_1=-0.881							
Second Set (Instrument at bank B)							
Reading at A			Reading at B			Mean Central Value(a_2)	Mean Central Value(b_2)
T	M	B	T	M	B		
0.62	0.445	0.27	1.339	1.319	1.299	0.445	1.319
Level difference=h'=a_2-b_2=-0.874							
True level difference between two points (H)=(h+h')/2=-0.8775							



Here,
From ABD, AB= 35.144m
From ABC, AB= 35.134
Span of Bridge= 35.1390m

ROAD ALIGNMENT SURVEY

Road Alignment Sheet

IP	Distance between IP	Chainage of IP	Deflection Angle(Degrees)			Radius	Tangent Length	Length of curve	Apex distance	Mid ordinate	Chainage of B.C	Chainage of M.C	Chainage of E.C	Remarks
			Degree	Minutes	Second									
SP		0												
IP1	35.65	35.65	38	7	16	30	10.3698	19.9682	1.74166	1.64609	25.2802	35.2643	45.2484	LHC
IP2	37.011	71.88959	60	4	43	20	11.5709	20.9798	3.10599	2.68847	60.3187	70.8086	81.2985	RHC
IP3	60.37	130.0975	85	12	25	20	18.4042	29.7548	7.17933	5.28293	111.693	126.571	141.448	LHC
IP4	60.67	183.7139	60	49	29	20	11.7455	21.2404	3.19388	2.75407	171.968	182.589	193.209	RHC
IP5	85.32	266.7833	27	7	28	15	3.61993	7.10402	0.43061	0.4186	263.163	266.715	270.267	RHC
IP6	20.44	287.0875	50	17	34	15	7.04456	13.1719	1.57184	1.42275	280.043	286.629	293.215	RHC
IP7	52.33	338.5003	34	32	3	30	9.32905	18.0893	1.41705	1.35314	329.171	338.216	347.261	LHC
IP8	71.35	409.2815	46	46	34	30	12.9806	24.5018	2.68785	2.46683	396.301	408.552	420.803	RHC
IP9	65.46	473.2821	15	32	52	50	6.82872	13.5735	0.46416	0.45989	466.453	473.24	480.027	RHC
IP10	52.74	525.9381	17	7	55	40	6.0276	11.9652	0.4516	0.44656	519.911	525.893	531.876	RHC
IP11	32.651	558.4991	46	40	38	30	12.9498	24.45	2.67566	2.45656	545.549	557.774	569.999	LHC
IP12	61.702	618.7514	27	58	39	30	7.47671	14.6549	0.91765	0.89042	611.275	618.602	625.93	RHC
IP13	46.622	665.0748	30	46	26	30	8.25951	16.1197	1.11623	1.07618	656.815	664.875	672.935	LHC
IP14	79.11	743.7855	21	26	1	30	5.68001	11.2271	0.53297	0.52367	738.105	743.719	749.333	RHC
IP15	48.201	791.8536	39	17	52	30	10.716	20.5846	1.85645	1.74827	781.138	791.43	801.722	LHC
IP16	146.666	937.672	30	45	21	40	11.0059	21.4803	1.4865	1.43324	926.666	937.406	948.146	RHC
IP17	45.31	982.4505	25	19	31	30	6.74304	13.2656	0.74847	0.73025	975.707	982.34	988.973	RHC
IP18	54.83	1037.06												

CROSS SECTION LEVELLING

Chainage	Distance			BS	IS	FS	HI	RL	Remarks
	Left	Centre	Right						
--				0.694			897.694	897	BM
0+000		0			1.193			896.501	CP
			3.5		1.286			896.408	
			5.5		1.491			896.203	
	4				0.952			896.742	
0+020		0			1.42			896.274	CP
			3.5		1.34			896.354	
			7		1.342			896.352	
	4				1.419			896.275	
0+025.285		0			1.371			896.323	BC1
			3.5		1.31			896.384	
			6		1.282			896.412	
	4.5				1.488			896.206	
0+035.265		0			1.1279			896.5661	MC1
	3				1.126			896.568	
	6				1.265			896.429	
			3		1.125			896.569	
0+045.248			3.5		1.27			896.424	EC1
	3.5				0.812			896.882	
	7				0.364			897.33	
		0		1.435		1.05	898.079	896.644	
0+060.319		0			0.78			897.299	BC2
			3.5		0.975			897.104	
			5.5		1.143			896.936	
	5				0.249			897.83	
0+070.809		0			0.845			897.234	MC2
			3.5		1.054			897.025	
			7		1.315			896.764	
	3				0.685			897.394	
	7				0.43			897.649	
0+081.298		0			1.318			896.761	EC2
	3.5				1.196			896.883	
	7				0.955			897.124	
			3.5		1.405			896.674	
0+100	3.5				2.195			895.884	
	7				2.12			895.959	
		0		0.105		2.253	895.931	895.826	CP
0+111.761		0			1.445			894.486	BC3
	3.5				1.265			894.666	
	7				1.085			894.846	
0+126.518		0			2.281			893.65	MC3
	3.5				2.25			893.681	
			3.5		2.215			893.716	

			7		2.335			893.596	
0+141.449		0			2.445			893.486	EC3/Bridge
0+160		0		3.085		2.385	896.631	893.546	CP/Bridge
0+171.987		0			3.205			893.426	BC4/Bridge
0+182.603		0			2.875			893.756	MC4
			3.5		2.85			893.781	
			7		2.629			894.002	
	3.5				2.716			893.915	
	7				2.837			893.794	
0+193.219		0			1.754			894.877	EC4
			3.5		1.805			894.826	
0+200		0		3.65		0.805	899.476	895.826	CP
			3.5		3.715			895.761	
			7		3.295			896.181	
					3.2			896.276	
0+220	3.5				0.375			899.101	CP
	7				0.371			899.105	
			3.5		1.286			898.19	
		0		3.154		0.48	902.15	898.996	
0+240		0			0.277			901.873	CP
	3.5				0.686			901.464	
	7			3.562		0.645	905.067	901.505	
0+263.182	7				0.442			904.625	BC5
	3.5				1.751			903.316	
		0		1.92		0.244	906.743	904.823	
0+266.730		0			1.59			905.153	MC5
	3.5				1.916			904.827	
	7				1.94			904.803	
0+270.253		0			1.282			905.461	
	3.5				1.452			905.291	
	7				1.531			905.212	
			3.5		1.282			905.461	
0+280.034			3.5		0.06			906.683	BC6
	3.5				0.332			906.411	
	7				0.236			906.507	
		0		2.66		0.35	909.053	906.393	
0+286.611		0			2.0225			907.0305	MC6
	2				1.9125			907.1405	
			3.5		1.72			907.333	
			5.5		1.455			907.598	
		0			1.43			907.623	EC6
0+293.201			3.5		1.16			907.893	
			7		0.72			908.333	
0+300			3.5		0.635			908.418	CP
			7		0.14			908.913	
		0		3.865		0.709	912.209	908.344	
0+320		0			1.8925			910.3165	CP

	3.5				1.86			910.349	
			3.5		1.42			910.789	
			5		2.485			909.724	
0+329.165		0			1.047			911.162	BC7
	3.5				1.075			911.134	
	5				0.96			911.249	
			3.5		0.685			911.524	
0+338.206	3.5				0.44			911.769	MC7
	7				0.175			912.034	
		0		2.926		0.25	914.885	911.959	
0+347.247		0			1.903			912.982	EC7
	3.5				2.235			912.65	
	5.5				1.998			912.887	
			2		1.884			913.001	
0+360	3.5				1.206			913.679	CP
	5.5				1.25			913.635	
			5		1.405			913.48	
		0		3.585		0.691	917.779	914.194	
0+380		0			3.055			914.724	CP
	3.5				1.966			915.813	
			3.5		1.797			915.982	
			5		1.184			916.595	
0+396.298			3.5		0.246			917.533	BC8
	3.5				0.689			917.09	
		0		2.56		0.407	919.932	917.372	
0+408.543		0			2.342			917.59	MC8
			3.5		2.275			917.657	
			7		2.074			917.858	
	3.5				2.448			917.484	
	3.5				1.643			918.289	EC8
	7				1.73			918.202	
			3.5		1.425			918.507	
0+420.789		0		3.5125		1.496	921.9485	918.436	
0+440			3.5		0.8525			921.096	CP
			5		0.9775			920.971	
	3.5				1.927			920.0215	
	5				2.277			919.6715	
		0		3.47		1.614	923.8045	920.3345	
0+466.45			3.5		0.124			923.8045	BC9
			7		0.112			923.6925	
		0		2.715		0.131	926.3885	923.6735	
0+473.233		0			1.351			925.0375	MC9
			3.5		1.335			925.0535	
	3.5				0.254			926.1345	
0+480.017			3.5		1.565			924.8235	EC9
		0		0.858		1.643	925.6035	924.7455	
0+500		0			1.168			924.4355	CP

	3.5				0.896			924.7075	
0+519.601		0			3.055			922.5485	BC10
	3.5				2.618			922.9855	
			3		3.055			922.5485	
0+525.886		0		0.874		3.401	923.0765	922.2025	MC10
			3.5		0.851			922.2255	
			5		0.897			922.1795	
0+531.866		0			0.927			922.1495	EC10
			3.5		1.204			921.8725	
			5		1.11			921.9665	
0+545.548		0			1.392			921.6845	BC11
			3.5		1.45			921.6265	
			5		1.804			921.2725	
0+557.768		0			1.501			921.5755	MC11
	3.5				1.444			921.6325	
			3.5		1.507			921.5695	
0+569.988			3.5		1.459			921.6175	EC11
			5		1.676			921.4005	
		0		1.649		1.462	923.2635	921.6145	
0+580		0			1.451			921.8125	CP
			3.5		1.414			921.8495	
			5		0.898			922.3655	
0+600		0			1.749			921.5145	CP
			3.5		1.368			921.8955	
	3.5				1.734			921.5295	
0+611.2725		0			2.576			920.6875	BC12
	2				2.391			920.8725	
			2		2.121			921.1425	
0+618.5925		0		0.491		3.126	920.6285	920.1375	MC12
			3.5		0.317			920.3115	
0+625.9125		0			1.042			919.5865	EC12
			3.5		1.012			919.6165	
0+640		0		0.279		4.062	916.8455	916.5665	CP
			3.5		0.043			916.8025	
			7		0.355			916.4905	
0+656.801		0			1.324			915.5215	BC13
	2				1.15			915.6955	
			3.5		1.141			915.7045	
0+664.8615		0			1.954			914.8915	MC13
	3.5				1.707			915.1385	
			3.5		1.833			915.0125	
0+672.922		0			2.43			914.4155	EC13
	3				2.074			914.7715	
			3		2.786			914.0595	
			5		3.344			913.5015	
0+700		0		1.935		2.682	916.0985	914.1635	CP
	3.5				2.069			914.0295	

	5				1.75			914.3485	
0+720		0			1.67			914.4285	CP
			3.5		1.325			914.7735	
	2				1.339			914.7595	
0+738.777		0			2.09			914.0085	BC14
			2		2.092			914.0065	
0+743.706		0		0.438		2.398	914.1385	913.7005	MC14
			3		0.546			913.5925	
0+749.317		0			0.976			913.1625	EC14
			3.5		0.356			913.7825	
0+760		0			2.0095			912.129	CP
	3				1.592			912.5465	
0+781.13		0			2.397			911.7415	BC15
	3			1.025		3.901	911.2625	910.2375	
0+791.418		0			1.81			909.4525	MC15
	2				1.66			909.6025	
			3		1.662			909.6005	
0+801.706	3				3.075			908.1875	EC15
		0		0.301		3.116	908.4475	908.1465	
			3		0.192			908.2555	
0+820		0			2.251			906.1965	CP
			3		2.252			906.1955	
	1.5				1.972			906.4755	
0+840		0		1.347		4.101	904.3465	904.3465	CP
			3		1.386			902.9605	
	3				1.353			902.9935	
0+860		0			1.612			902.7345	CP
	3				1.55			902.7965	
0+880	3				1.303			903.0435	CP
		0		3.485		1.33	906.5015	903.0165	
0+900		0			1.601			904.9005	CP
	3.5				1.484			905.0175	
0+920	3				1.883			904.6185	CP
		0				1.96		904.5415	

FLY LEVELLING TABLE OF ROAD

S.N	Back Sight (BS)			Fore Sight (FS)			Rise	Fall	Reduced Level (RL)	Distance	
	Top	Middle	Bottom	Top	Middle	Bottom				BS	FS
1	0.972	0.905	0.84						924.737		
2	0.51	0.474	0.439	3.885	3.81	3.73		2.905	921.832	7	7
3	0.555	0.486	0.419	3.206	3.152	3.099		2.678	919.154	7	7
4	0.566	0.484	0.401	2.41	2.335	2.26		1.849	917.305	12	12
5	0.48	0.404	0.326	2.761	2.68	2.6		2.196	915.109	12	12
6	0.24	0.176	0.111	3.205	3.155	3.074		2.751	912.358	12	12
7	0.626	0.576	0.526	2.456	2.41	2.361		2.234	910.124	12	12
8	0.894	0.86	0.896	2.5	2.445	2.392		1.869	908.255	8	8
9	0.44	0.405	0.37	2.136	2.105	2.074		1.245	907.01	6	6
10	0.885	0.849	0.812	2.307	2.272	2.236		1.867	905.143	6	6
11	0.61	0.575	0.54	2.118	2.086	2.056		1.237	903.906	6	6
12	0.491	0.455	0.419	2.441	2.406	2.371		1.831	902.075	6	6
13	0.395	0.36	0.324	2.286	2.54	2.221		2.085	899.99	6	6
14	0.321	0.287	0.254	2.424	2.39	2.355		2.03	897.96	6	6
15	0.471	0.432	0.394	2.804	2.766	2.701		2.479	895.481	6	6
16	1.406	1.285	1.101	2.554	2.51	2.466		2.078	893.403	6	6
17	1.746	1.701	1.655	1.6	1.47	1.4		0.185	893.218	18	18
18	2.501	2.459	2.415	0.9	0.855	0.81	0.846		894.064	6	6
19	2.485	2.375	2.26	0.772	0.724	0.675	1.735		895.799	15	15
20	0.83	0.71	0.6	1.66	1.555	1.45	0.82		896.619	15	15
21	1.526	1.482	1.437	1.536	1.475	1.411		0.765	895.854	15	15
21				0.84	0.76	0.699	0.722		896.576		
	ΣBS=			Σ FS			Σ Rise =	Σ Fall =	Last RL- First RL		
	17.74			45.901			4.123	32.284	-28.161		

TOPOGRAPHICAL SURVEY

Traverse Horizontal Angle

Inst. Stn.	Sighted to	HCR			Angle	Mean	Horiz. Angle
		D	M	S			
A5	A6	0	0	0	132°22'51"	132°22'57"	132°22'55.75"
		179	59	52			
	A4	132	22	51	132°23'3'		
		312	22	55			
	A6	60	0	0	132°22'49"	132°22'54.5"	
		239	59	49			
	A4	192	22	58	132°23'0"		
		372	22	49			
A4	A5	0	0	0	147°47'10"	147°47'7.5"	147°47'6.75"
		179	59	51			
	A3	147	47	10	147°47'5"		
		327	46	56			
	A5	60	0	0	147°47'3"	147°47'6"	
		239	59	54			
	A3	207	47	3	147°47'9"		
		387	47	3			
A3	A4	0	0	0	132°0'33"	132°0'36"	132°0'45.25"
		180	0	4			
	A2	132	0	33	132°0'39"		
		312	0	43			
	A4	60	0	0	132°0'48"	132°0'54.5"	
		239	59	49			
	A2	192	0	48	132°1'1"		
		372	0	50			
A2	A3	0	0	0	115°33'12"	115°33'12"	115°33'17.25"
		180	0	4			
	A1	115	33	12	115°33'12"		
		295	33	16			
	A3	60	0	0	115°33'42"	115°33'22.5"	
		240	0	2			
	A1	175	33	42	115°33'03"		
		355	33	5			
A1	A2	0	0	0	110°5'45"	110°5'46"	110°5'50"
		179	59	55			
	A7	110	5	45	110°5'47"		
		290	5	42			
	A2	60	0	0	110°5'54"	110°5'54"	
		239	59	58			
	A7	170	5	54	110°5'54"		
		350	5	52			

A7	A1	0	0	0	140°28'56"	140°28'54.5"	140°28'54.5"
		179	59	59			
	A6	140	28	56	140°28'53"		
		320	28	52			
	A1	60	0	0	140°28'59"	140°28'54.5"	
		240	0	9			
	A6	200	28	59	140°28'50"		
		380	28	59			
A6	A7	0	0	0	121°38'36"	121°38'35"	121°38'34"
		179	59	58			
	A5	121	38	36	121°38'34"		
		301	38	32			
	A7	60	0	0	121°38'34"	121°38'33"	
		239	59	56			
	A5	181	38	34	121°38'31"		
		361	38	27			

Major Traverse Table

Gales Table

Line	Length	Point	H. Angle			Corrected H.Angle			WCB			Consecutive Co-ordinate	
			D	M	S	D	M	S	D	M	S	Latitude	Longitude
A5A6	91.5265	A5	121	38	34	121	38	56.36	42	32	50.36	67.42932035	61.89012004
A4A5	105.93495	A4	132	22	55.75	132	23	18.11	354	56	8.47	105.5214053	-9.351291745
A3A4	91.0299	A3	147	47	6.75	147	47	29.11	322	43	37.58	72.43795992	-55.12880061
A2A3	120.5336	A2	132	0	45.25	132	1	7.61	274	44	45.19	9.972546637	-120.120344
A1A2	156.52	A1	115	33	17.25	115	33	39.61	210	18	24.8	-135.1291759	-78.98491134
A7A1	125.5546	A7	110	5	50	110	6	12.36	140	24	37.16	-96.75589864	80.01408413
A6A7	123.97535	A6	140	28	54.5	140	29	16.86	100	53	54	-23.43963248	121.739357
SUMMATION	815.0749		897	173	263.5							0.036525172	0.058213451

Correction		Corrected Consecutive Coordinate		Independent Coordinate	
Latitude	Longitude	Latitude	Longitude	Northing	Easting
0.00410149	0.006536913	67.42521886	61.88358313	3128940.92	792226.248
0.004747162	0.007565978	105.5166581	-9.358857724	3129046.437	792216.8891
0.004079236	0.006501445	72.43388068	-55.13530206	3129118.871	792161.7538
0.005401357	0.008608628	9.96714528	-120.1289526	3129128.838	792041.6249
0.007013981	0.011178812	-135.1361899	-78.99609016	3128993.701	791962.6288
0.005626358	0.008967233	-96.761525	80.0051169	3128896.94	792042.6339
0.005555589	0.008854441	-23.44518807	121.7305025	3128873.495	792164.3644
		-3.817E-10	-1.42322E-10		

TRAVERSE DISTANCE TABLE

Line	Forward Distance	Backward Distance	Mean M	Discrepency D	Precision
1-2	156.313	156.326	156.3195	0.013	0.0000831
2-3	121.295	121.311	121.303	0.016	0.0001319
3-4	90.775	90.742	90.7585	0.033	0.0003636
4-5	105.334	105.356	105.345	0.022	0.00020884
5-6	90.936	90.919	90.9275	0.017	0.00018696
6-7	124.662	124.696	124.679	0.034	0.0002727
7-1	125.148	125.189	125.1685	0.041	0.00032756

DIFFERENTIAL LEVELLING OF COLLEGE TRAVERSE

S.N	Back Sight			Fore Sight			Rise	Fall	RL	Distance		Remarks
	Top	Middle	Bottom	Top	Middle	Bottom				BS	FS	
BM	1.095	1.073	1.052						957.55	5		BM
1	1.424	1.374	1.325	1.196	1.171	1.145		0.098	957.452	10	5	
2	1.595	1.545	1.496	1.093	1.043	0.993	0.331		957.783	10	10	
3	1.548	1.498	1.449	1.215	1.166	1.117	0.379		958.162	10	10	
4	1.783	1.759	1.734	1.102	1.052	1.004	0.446		958.608	5	10	
5	1.81	1.785	1.76	1.088	1.063	1.037	0.6965		959.305	5	5	
6	1.756	1.732	1.708	1.124	1.099	1.074	0.686		959.991	5	5	
7	2.425	2.375	2.325	1.67	1.043	1.018	0.689		960.68	10	5	
8	1.612	1.545	1.481	0.212	0.162	0.112	2.213		962.893	12.9	10	
9	1.436	1.387	1.339	1.034	0.97	0.905	0.5755		963.468	10	12.9	A7
10	1.257	1.208	1.157	1.846	1.799	1.748		0.4125	963.056	10	10	
11	1.128	1.076	1.025	1.444	1.394	1.344		0.186	962.87	10	10	
12	1.457	1.408	1.36	1.626	1.578	1.529		0.502	962.368	10	10	
13	1.467	1.423	1.378	2.03	1.98	1.93		0.572	961.796	10	10	
14	1.309	1.245	1.181	1.51	1.461	1.412		0.038	961.758	12.75	10	
15	1.315	1.265	1.215	1.201	1.141	1.081	0.104		961.862	10	12.75	A6
16	1.607	1.558	1.509	1.215	1.166	1.118	0.099		961.961	10	10	
17	1.485	1.435	1.385	1.203	1.153	1.103	0.405		962.366	10	10	
18	1.5	1.45	1.4	1.268	1.218	1.168	0.217		962.583	10	10	
19	1.434	1.404	1.374	1.243	1.188	1.132	0.262		962.845	5.1	11.13	
20	1.315	1.265	1.215	1.127	1.102	1.076	0.302		963.147	10	5.1	A5
21	1.527	1.477	1.427	1.187	1.138	1.09	0.127		963.274	10	10	
22	1.533	1.483	1.433	1.17	1.12	1.071	0.357		963.631	10	10	
23	1.55	1.5	1.45	1.2	1.5	1.1		0.017	963.614	10	10	
24	1.571	1.511	1.451	1.086	1.036	0.986	0.464		964.078	13.13	10	
25	1.192	1.142	1.092	0.65	0.58	0.51	0.931		965.009	10	13.13	A4
26	1.571	1.522	1.474	1.12	1.061	1.011	0.081		965.09	10	10	
27	1.514	1.464	1.414	1.122	1.072	1.022	0.45		965.54	10	10	
28	1.513	1.463	1.412	1.18	1.13	1.08	0.334		965.874	10	10	
29	1.135	1.108	1.079	0.902	0.853	0.804	0.61		966.484	6.3	10	
30	1.474	1.424	1.374	1.146	1.116	1.086		0.008	966.476	10	6.3	A3
31	1.108	1.106	1.007	1.109	1.058	1.008	0.366		966.842	10	10	
32	1.731	1.681	1.63	1.196	1.147	1.098		0.0409	966.801	10	10	
33	1.465	1.415	1.366	0.966	0.917	0.869	0.7635		967.564	10	10	
34	1.474	1.425	1.375	1.065	1.019	0.969	0.3965		967.961	10	10	
35	1.596	1.545	1.495	1.224	1.175	1.125	0.25		968.211	10.25	10	
36	1.442	1.392	1.343	1.223	1.172	1.12	0.373		968.584	10	10.25	A2
37	1.561	1.512	1.462	1.414	1.364	1.314	0.028		968.612	10	10	
38	1.611	1.562	1.512	1.412	1.372	1.323	0.14		968.752	10	10	
39	1.524	1.476	1.424	1.503	1.453	1.404	0.109		968.861	10	10	
40	1.555	1.505	1.456	1.486	1.436	1.386	0.04		968.901	10	10	
41	1.599	1.549	1.499	1.544	1.494	1.444	0.011		968.912	10	10	

42	1.603	1.553	1.504	1.656	1.607	1.559		0.058	968.854	10	10	
43	1.408	1.372	1.334	1.686	1.637	1.588		0.084	968.77	8.5	10	
44				1.66	1.621	1.574		0.249	968.521		8.5	A1

FLY LEVELLING OF COLLEGE TRAVERSE

S.N	Back Sight			Fore Sight			Rise	Fall	RL	Distance		Remarks
	Top	Middle	Bottom	Top	Middle	Bottom				BS	FS	
B.M	1.69	1.64	1.598						968.521			A1
1	1.545	1.44	1.33	1.358	1.304	1.248	0.336		968.857			
2	1.385	1.28	1.175	1.48	1.37	1.26	0.07		968.927			
3	1.272	1.144	1.014	1.463	1.36	1.258		0.08	968.847			
4	1.056	0.946	0.836	1.512	1.389	1.266		0.245	968.602			A2
5	0.745	0.64	0.534	1.704	1.591	1.478		0.645	967.957			
6	1.401	1.323	1.243	1.96	1.852	1.744		1.212	966.745			
7	1.144	1.065	0.986	1.636	1.554	1.471		0.231	966.514			A3
8	1.132	1.015	0.9	1.85	1.805	1.715		0.74	965.774			
9	0.695	0.615	0.535	2.019	1.841	1.665		0.826	964.948			A4
10	1.067	0.992	0.918	1.483	1.415	1.347		0.8	964.148			
11	1.116	1.054	0.989	1.532	1.483	1.424		0.491	963.657			
12	1.278	1.214	1.149	1.626	1.557	1.486		0.503	963.154			
13	1.046	1.961	0.875	1.341	1.29	1.238		0.076	963.078			A5
14	1.185	1.136	0.988	1.746	1.684	1.627	0.2765		963.354			
15	1.008	0.939	0.871	1.881	1.794	1.708		0.658	962.696			
16	1.23	1.158	1.088	1.71	1.699	1.685		0.76	961.936			A6
17	1.183	1.734	1.635	1.333	1.258	1.185		0.1	961.836			
18	1.906	1.802	1.697	1.215	1.141	1.065	0.593		962.429			
19	1.073	1.028	0.983	0.85	0.736	0.624	1.066		963.495			
20	1.865	1.809	1.751	1.034	0.973	0.91	0.0555		963.551			A7
21	0.357	0.326	0.295	2.885	2.805	2.725		0.996	962.555			
22	0.978	0.939	0.9	2.277	2.227	2.177		1.901	960.654			
23	1.019	0.981	0.945	2.038	2.01	1.964		1.071	959.583			
24	1.278	1.19	1.1	2.272	2.218	2.163		1.237	958.346			
25	1.359	1.313	1.267	1.928	1.819	1.707		0.629	957.717			
26				1.635	1.541	1.445		0.2285	957.488			BM

TOTAL STATION DATA TABLE

Point	N	E	Elevation	Feature
BS	3128994	791962.7	968.803	BS1
1001	3128892	792043.3	962.442	SH
1002	3128895	792045.1	963.423	SH
1003	3128900	792047.8	963.604	SH
1004	3128904	792048.9	963.645	SH
1005	3128912	792026.4	964.54	SH
1006	3128911	792049.3	964.065	SH
1007	3128915	792032.5	964.07	SH
1008	3128893	792047.2	963.44	SH
1009	3128887	792052.4	962.878	SH
1010	3128886	792048.9	962.505	SH
1011	3128883	792052.1	962.474	SH
1012	3128887	792046.4	961.638	SH
1013	3128882	792051.5	961.707	SH
1014	3128885	792047.2	961.302	SH
1015	3128880	792051.1	961.184	SH
1016	3128893	792051.2	963.409	SH
1017	3128887	792057.9	963.084	SH
1018	3128896	792052.1	963.465	SH
1019	3128894	792059.6	963.393	SH
1020	3128900	792052.7	963.498	SH
1021	3128899	792068.1	963.123	SH
1022	3128902	792036.3	963.789	SH
1023	3128904	792075.2	962.904	SH
1024	3128903	792037.4	963.906	SH
1025	3128907	792083.3	962.925	SH
1026	3128904	792091.8	962.415	SH
1027	3128902	792099.4	962.507	SH
1028	3128895	792100.7	962.355	SH
1029	3128906	792038.5	963.86	SH
1030	3128910	792035.2	964.073	SH
1031	3128917	792031.6	964.142	SH
1032	3128955	792014.9	965.846	SH
1033	3128957	792018.4	967.091	SH
1034	3128956	792022.8	966.525	SH
1035	3128956	792026.1	966.677	SH
1036	3128938	792031.1	964.466	SH
1037	3128941	792032.6	964.874	SH
1038	3128952	792028.2	966.673	SH
1039	3128953	792023.6	965.568	SH

1040	3128953	792019.5	965.473	SH
1041	3128945	792022.1	964.674	SH
1042	3128954	792014.5	965.487	SH
1043	3128945	792017.9	964.615	SH
1044	3128959	792001.2	967.754	SH
1045	3128947	792009.9	964.618	SH
1046	3128956	791996.6	966.869	SH
1047	3128948	792005.2	964.622	SH
1048	3128953	791993.1	966.319	SH
1049	3128945	792000.7	964.79	SH
1050	3128949	791988.6	965.27	SH
1051	3128953	791993.1	966.327	SH
1052	3128958	791991.2	966.71	SH
1053	3128960	791993.1	967.652	SH
1054	3128970	791983.8	967.968	BC
1055	3128977	792011.3	968.233	BC
1056	3128972	792007	968.183	BC
1057	3128970	792005.6	968.148	BC
1058	3128959	791987	965.995	TRE
1059	3128958	791984.1	965.59	TRE
1060	3128935	792019.8	964.793	TRE
1061	3128946	791982.4	965.294	TRE
1062	3128922	792027.4	964.463	TRE
1063	3128940	791995.3	965.29	TRE
1064	3128926	792029.3	964.246	TRE
1065	3128927	792015.2	964.796	CHAU
1066	3128925	792013.2	964.93	CHAU
1067	3128929	792009.3	964.797	CHAU
1068	3128931	792011.3	964.904	CHAU
1069	3128951	792007.8	964.784	TRE
1070	3128935	792020.4	964.704	TRE
1071	3128893	792070.7	963.11	TRE
1072	3128900	792064.6	963.703	TRE
1073	3128882	792071.5	962.898	TRE
1074	3128884	792072.7	962.931	POL
1075	3128880	792039.9	961.005	POL
1076	3128856	792065.3	962.223	POL
1077	3128862	792098.5	962.224	POL
1078	3128905	792038.4	963.898	PATH
1079	3128923	792019.2	964.43	PATH
1080	3128929	792023.1	964.707	PATH
1081	3128937	792009.5	964.83	PATH

1082	3128941	792006.9	964.817	PATH
1083	3128942	792031.8	964.828	PATH
1084	3128907	792067.9	963.191	PATH
1085	3128907	792076.6	962.907	PATH
1086	3128876	792070.4	962.885	PATH
1087	3128868	792067.3	962.734	PATH
1088	3128887	792007.2	958.137	ROAD
1089	3128889	792003.4	958.163	ROAD
1090	3128893	792014.2	958.383	ROAD
1091	3128895	792020.2	958.769	ROAD
1092	3128900	792019.9	958.805	ROAD
1093	3128890	792030.2	959.57	ROAD
1094	3128893	792034.1	959.764	ROAD
1095	3128883	792038	960.31	ROAD
1096	3128885	792042.4	960.486	ROAD
1097	3128861	792059.4	961.945	ROAD
1098	3128865	792061.4	961.855	ROAD
1099	3128856	792067.5	962.125	ROAD
1100	3128859	792072.4	962.067	ROAD
1101	3128855	792078.4	962.206	ROAD
1102	3128859	792077.1	962.113	ROAD
1103	3128858	792089.3	962.086	ROAD
1104	3128863	792089	962.04	ROAD
1105	3128863	792097.3	961.93	ROAD
1106	3128867	792095.5	961.921	ROAD
1107	3128874	792119.9	961.749	ROAD
1108	3128878	792118	961.705	ROAD
1109	3128883	792100.4	962.385	TT
1110	3128880	792101	962.363	TT
1111	3128880	792099.8	962.322	TT
1112	3128882	792099.2	962.396	TT
1113	3128916	792089.5	963.845	TOL
1114	3128916	792095.2	963.884	TOL
1115	3128920	792089.5	964.544	TOL
1116	3128915	792066.5	964.086	TOL
1117	3128914	792057.3	964.084	TOL
1118	3128916	792057.1	964.103	TOL
1119	3128914	792049.1	964.111	TOL
1120	3128913	792039.8	964.132	TOL
1121	3128916	792125.4	964.724	BC
1122	3128898	792126.2	962.395	BC
1123	3128898	792128	962.282	BC

1124	3128896	792129.5	962.271	BC
1125	3128896	792131.2	962.044	BC
1126	3128895	792131	962.07	BC
1127	3128886	792131.9	961.707	BC
1128	3128944	792121.3	966.619	BC
1129	3128945	792132.6	966.642	BC
1130	3128950	792120.9	966.633	BC
1131	3128950	792116.5	966.61	BC
CP1				CP1
BS-2	3128897	792042.6	963.168	BS-2
2001	3129001	791967.1	968.659	SH
2002	3129008	791970.6	968.804	SH
2003	3129000	791964.2	968.568	SH
2004	3129007	791968.2	968.665	SH
2005	3129002	791963.6	967.882	SH
2006	3129010	791968.2	968.383	SH
2007	3129016	791963.6	968.783	SH
2008	3129011	791972.7	968.713	SH
2009	3129006	791970.3	968.848	SH
2010	3129006	791974	968.497	SH
2011	3128999	791973.8	968.429	SH
2012	3129004	791971.6	968.34	SH
2013	3129004	791979.3	968.737	SH
2014	3129000	791978.1	968.283	SH
2015	3128994	791985.7	968.149	SH
2016	3129008	791985	968.877	SH
2017	3129000	791987.9	968.638	SH
2018	3129006	791987.5	968.866	SH
2019	3129010	791987.3	968.926	SH
2020	3129014	791985.6	968.93	SH
2021	3129019	791984.8	969.069	SH
2022	3129018	791991.7	968.878	SH
2023	3129020	791980.3	969.151	SH
2024	3129022	791978.9	968.913	SH
2025	3129018	792007.5	968.642	SH
2026	3129023	791980.3	968.252	SH
2027	3128970	791915.1	967.987	SH
2028	3128966	791942.4	968.143	SH
2029	3128980	791970.8	969.062	SH
2030	3128971	791972.9	969.243	SH
2031	3128983	791975.8	969.043	SH
2032	3128970	791974.9	969.203	SH

2033	3128984	791986.8	968.676	SH
2034	3128971	791978.9	969.217	SH
2035	3128991	791992.5	968.809	SH
2036	3128994	791983.6	968.081	SH
2037	3129000	791981.5	966.809	SH
2038	3129006	791990.9	965.744	SH
2039	3128990	791970.3	967.748	SH
2040	3128975	791960.1	968.485	SH
2041	3129004	791993.3	965.586	ROAD
2042	3129008	791990.8	965.651	ROAD
2043	3128997	791981.7	966.902	ROAD
2044	3129001	791979.1	966.912	ROAD
2045	3128989	791972.5	967.718	ROAD
2046	3128991	791968.4	967.821	ROAD
2047	3128975	791962.8	968.5	ROAD
2048	3128977	791958.5	968.485	ROAD
2049	3128973	791955.8	968.738	ROAD
2050	3128970	791959.2	968.673	ROAD
2051	3128966	791948.4	968.874	ROAD
2052	3128961	791953.6	968.853	ROAD
2053	3128959	791946.4	968.876	ROAD
2054	3128955	791949.4	968.947	ROAD
2055	3128954	791942.9	968.936	ROAD
2056	3128951	791946.6	968.984	ROAD
2057	3128976	791952.1	968.687	ROAD
2058	3128974	791948	968.653	ROAD
2059	3128982	791951.5	968.463	ROAD
2060	3128981	791947.3	968.473	ROAD
2061	3128989	791951.1	968.222	ROAD
2062	3128990	791947.1	968.205	ROAD
2063	3128997	791949.8	968.004	ROAD
2064	3128997	791945.1	968.001	ROAD
2065	3129008	791949	967.768	ROAD
2066	3129008	791944.3	967.831	ROAD
2067	3128991	791945.7	968.569	POL
2068	3128973	791925.9	968.859	POL
2069	3128960	791953.7	969.108	POL
2070	3128992	791977	967.57	POL
2071	3129001	791970.4	968.285	TRE
2072	3129012	791986.5	966.427	TRE
2073	3129002	791972.3	968.075	TRE
2074	3129009	791984.9	966.383	TRE

2075	3129005	791975.8	967.454	TRE
2076	3129009	791985	966.378	TRE
2077	3128993	791964.4	968.583	TRE
2078	3129007	791954.2	968.387	TRE
2079	3128992	791963.1	968.592	TRE
2080	3128984	791954.7	968.807	TRE
2081	3128969	791944.3	969.155	TRE
2082	3128981	791956.6	968.795	TRE
2083	3128974	791930.3	969.105	TRE
2084	3128981	791956.7	968.805	TRE
2085	3128946	791948.5	969.643	TRE
2086	3128953	791953.4	969.644	TRE
2087	3128962	791961	969.459	TRE
2088	3128965	791963.4	969.485	TRE
2089	3128975	791967.9	969.3	TRE
2090	3128976	791954.4	968.698	PARK
2091	3129001	791971.8	968.101	PARK
2092	3129013	791953	968.171	PARK
2093	3129001	791970.3	968.36	GYM
2094	3129010	791955.5	968.228	GYM
2095	3128999	791968.6	968.349	GYM
2096	3129007	791954.5	968.411	GYM
2097	3129005	791942.3	967.917	BC
2098	3129004	791939.5	968.042	BC
2099	3128998	791940	968.062	BC
2100	3128997	791924.8	968.632	BC
2101	3128993	791931.1	968.682	BC
2102	3128981	791932	968.697	BC
2103	3128994	791943.5	968.078	PATH
2104	3128991	791937.3	968.425	PATH
2105	3128977	791938.3	968.94	PATH
2106	3128976	791920.8	968.82	PATH
2107	3129004	791968	968.307	SH
2108	3129006	791968.6	968.106	SH
2109	3129008	791966.2	968.169	SH
2110	3129009	791966.2	967.585	SH
2111	3129008	791964.2	968.258	SH
2112	3129011	791960.7	968.289	SH
2113	3129012	791960.6	967.657	SH
2114	3128958	791889.4	967.64	OFF-1
BS-3	3128994	791962.6	968.511	BS-3

3001	3128963	791895.9	967.714	SH
3002	3128974	791894.6	967.811	SH
3003	3128976	791891.3	967.985	SH
3004	3128986	791893.9	968.35	SH
3005	3128987	791883.4	967.798	SH
3006	3128979	791880.4	967.479	SH
3007	3128968	791882.5	967.413	SH
3008	3128979	791873.3	967.465	SH
3009	3128969	791875.8	967.374	SH
3010	3128978	791863.6	967.41	SH
3011	3128969	791859.5	967.187	SH
3012	3128984	791867.3	967.443	SH
3013	3128969	791848.6	967.022	SH
3014	3128992	791873.8	967.602	SH
3015	3128982	791848.9	967.338	SH
3016	3128979	791869.8	967.438	TRE
3017	3128995	791895.4	968.087	TRE
3018	3128995	791891.6	968.248	TRE
3019	3128993	791885.3	967.826	TRE
3020	3129005	791869.8	968.058	TRE
3021	3129006	791876.5	967.857	TRE
3022	3129009	791867.4	967.569	TRE
3023	3129001	791882	968.122	TRE
3024	3129002	791888.2	967.632	TRE
3025	3128980	791916.6	968.671	BC
3026	3128980	791914.1	968.674	BC
3027	3128976	791908.2	968.682	BC
3028	3128976	791898.9	968.666	BC
3029	3128988	791897.9	968.634	BC
3030	3128996	791894.6	968.032	TAP
3031	3128982	791870.6	967.522	SU-PARK
3032	3128986	791867.4	967.378	SU-PARK
3033	3128989	791870.2	967.58	SU-PARK
3034	3128988	791874.2	967.534	SU-PARK
3035	3128983	791875	967.632	SU-PARK
3036	3128990	791887.4	967.991	BE-PARK
3037	3128994	791881.3	967.684	BE-PARK
3038	3128996	791884.3	967.777	BE-PARK
3039	3128995	791887.3	967.978	BE-PARK
3040	3128994	791890.6	968.526	BE-PARK
3041	3128991	791890.4	968.451	BE-PARK
3042	3128999	791876.7	967.654	L-PARK

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3046	3128999	791879.4	967.664	B-PARK
3047	3129021	791878.4	967.305	B-PARK
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3064	3128969	791848.6	967.011	PATH
3065	3128997	791871.6	967.737	PATH
3066	3128998	791877.9	967.777	PATH
3067	3128999	791899.2	967.91	PATH
3068	3128996	791879.3	967.808	OFF-2
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4007	3129002	791922	968.636	BC
4008	3129002	791914.5	967.971	BC
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4022	3129036	791877.2	966.526	G-TOL
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4027	3128997	791866.4	967.721	PATH
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4029	3128994	791845.1	966.445	PATH
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4031	3128997	791842.7	967.046	BC
4032	3128996	791827.3	966.651	BC
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5007	3129024	791815.6	966.396	BC
5008	3129025	791809.6	966.326	BC
5009	3129019	791810	966.321	BC
5010	3129025	791806.2	966.347	BC
5011	3129001	791811.4	966.274	BC
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5013	3128988	791801.4	966.406	BC
5014	3128989	791803	966.338	BC
5015	3128989	791803	966.331	BC
5016	3128989	791812.4	966.492	BC
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5027	3128972	791829.6	966.471	TRE
5028	3128973	791837.1	966.733	TRE
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5042	3129002	791851.3	966.502	SH
5043	3129002	791857	966.305	SH
5044	3128998	791857.8	966.622	SH
5045	3129002	791863	966.048	OFF-4
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6025	3129026	791863.6	966.528	TCC
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6029	3129012	791864.8	965.751	BTOL
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6036	3128974	791860	966.316	BC
6037	3128969	791860.4	966.296	BC
6038	3128970	791877.8	964.921	BC
6039	3128972	791865.3	965.819	PATH
6040	3129015	791859.5	966.318	PATH
6041	3128941	791871.7	965.168	OFF-5
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7002	3128952	791903.7	964.689	BC
7003	3128978	791876	964.982	BC
7004	3128922	791901.3	964.347	BC
7005	3128921	791881.1	964.531	BC
7006	3128901	791881.9	964.502	BC
7007	3128900	791869	964.581	BC
7008	3128923	791868.5	964.609	BC
7009	3128947	791868.5	965.141	PATH
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7011	3128946	791868	965.122	PATH
7012	3128926	791871.2	964.774	PATH
7013	3128944	791852.5	965.517	PATH
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7015	3128928	791847.1	964.834	TRE
7016	3128932	791841.2	964.933	TRE

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7023	3128938	791880.5	964.99	SH
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7025	3128935	791883.1	965.212	SH
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7033	3128934	791853.3	964.959	SH
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7037	3128945	791847.5	965.864	SH
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7039	3128946	791814	965.637	SH
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8002	3128959	791816.6	966.433	BC
8003	3128965	791815.4	966.417	BC
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8005	3128956	791813.3	966.398	BC
8006	3128955	791798.4	966.488	BC
8007	3128939	791796	964.329	BC
8008	3128937	791767.9	963.736	BC
8009	3128939	791787	964.322	BC
8010	3128938	791775.4	963.752	BC
8011	3128942	791786.7	964.347	BC
8012	3128940	791775.2	963.766	BC
8013	3128919	791818	962.566	PATH
8014	3128927	791817.3	964.523	PATH
8015	3128950	791802.1	966.461	PATH
8016	3128951	791808.2	966.785	TRE
8017	3128952	791812.8	966.762	TRE
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8019	3128953	791827.2	966.712	TRE
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8022	3128951	791830.2	966.13	SH
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8026	3128942	791833.5	965.126	SH
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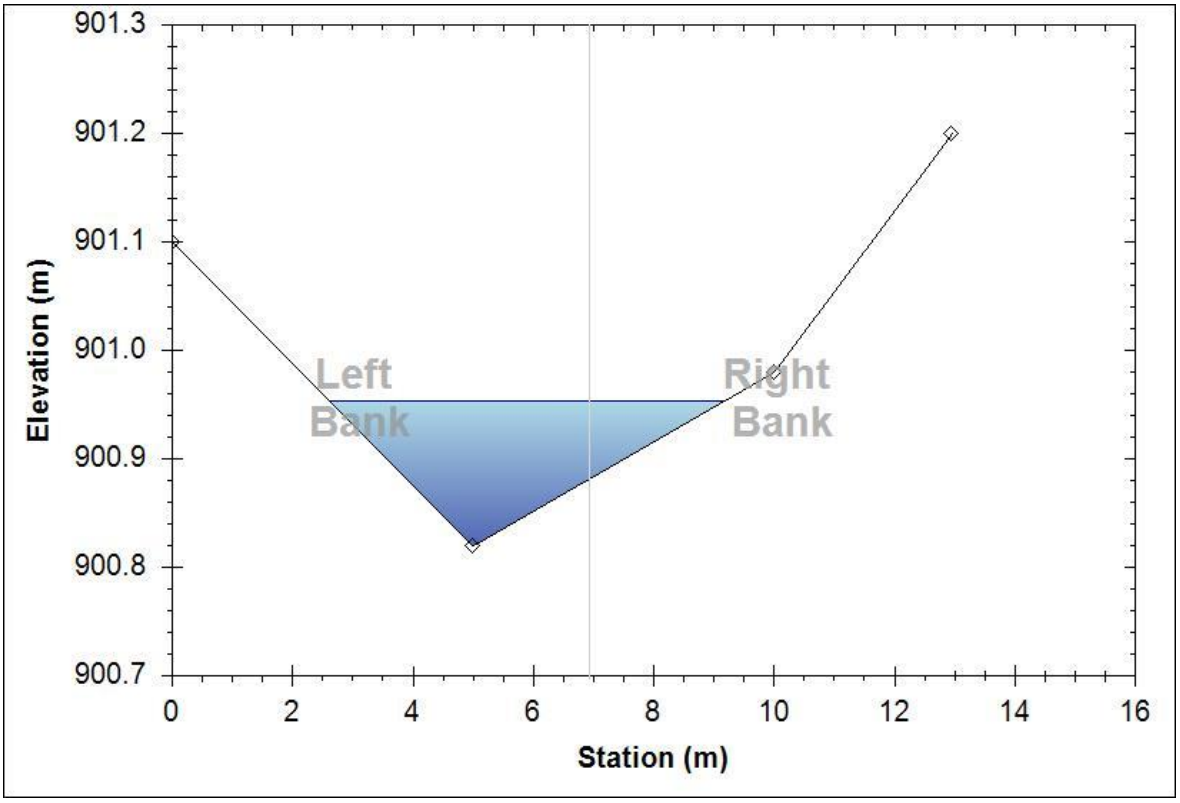
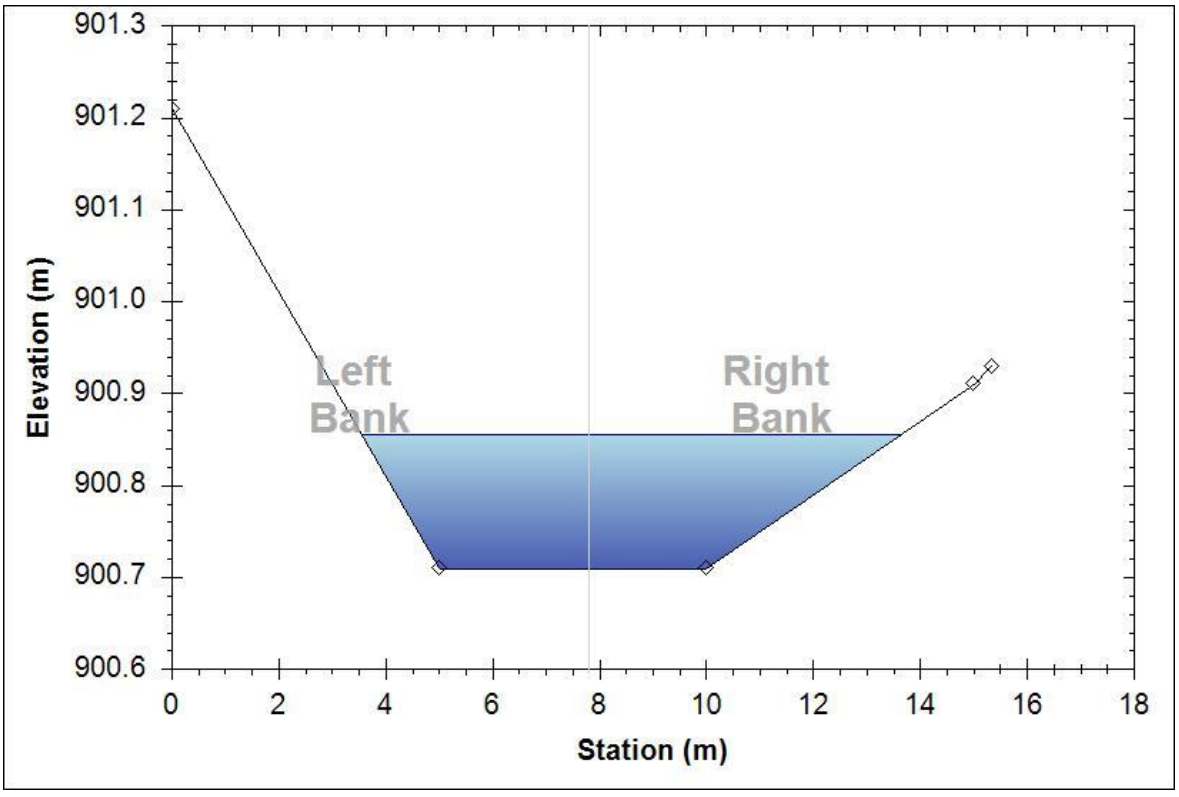
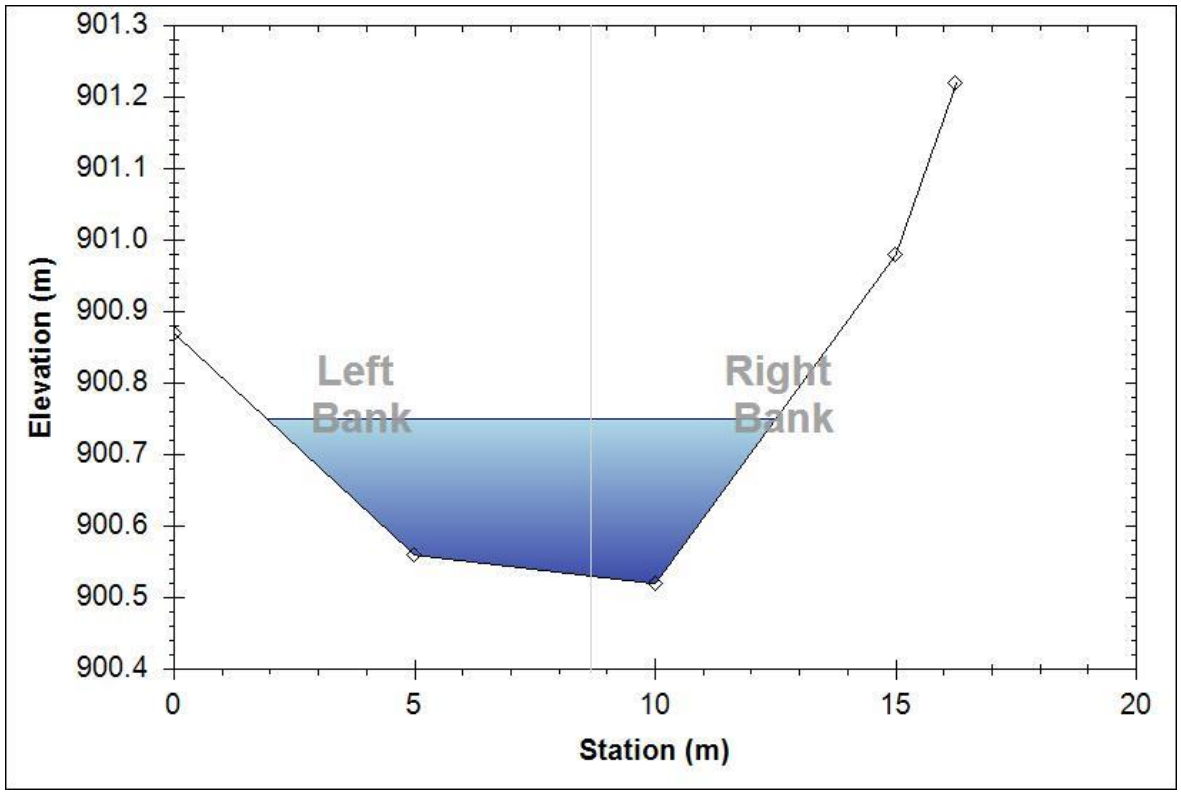
BRIDGE SITE SURVEY GRAPHS

DOWNSTREAM



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Bank
Right
Bank
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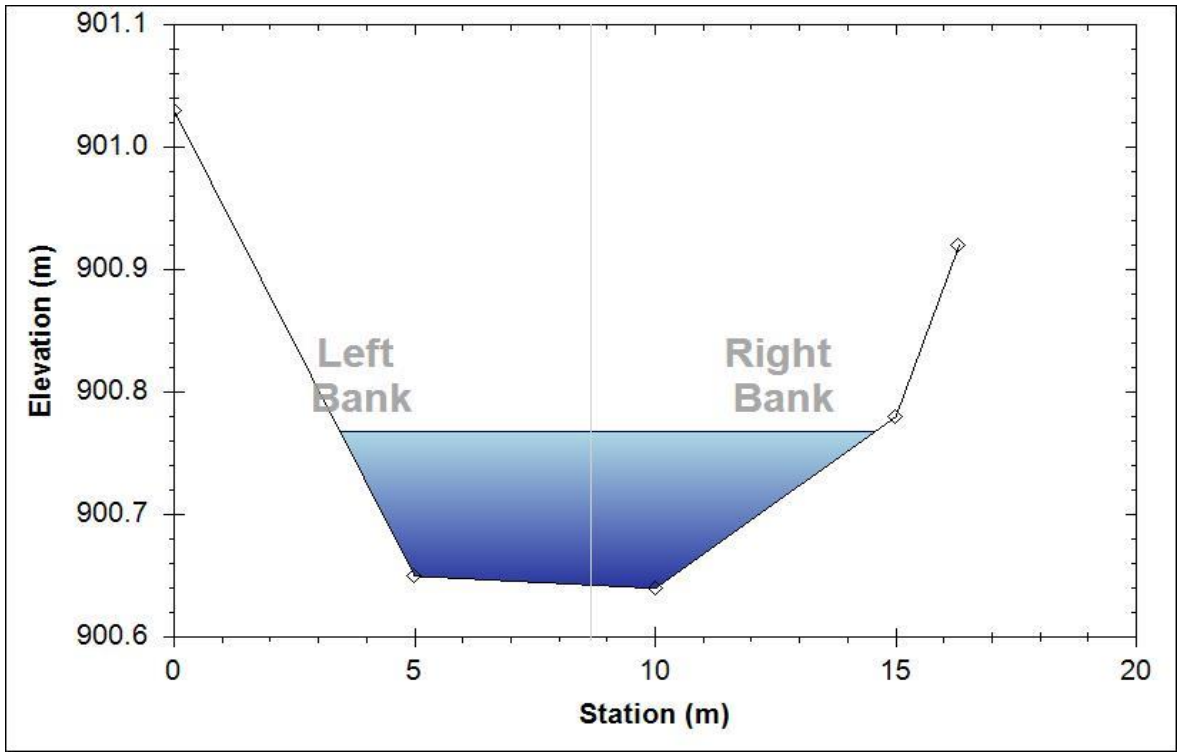
15
20
Station (m)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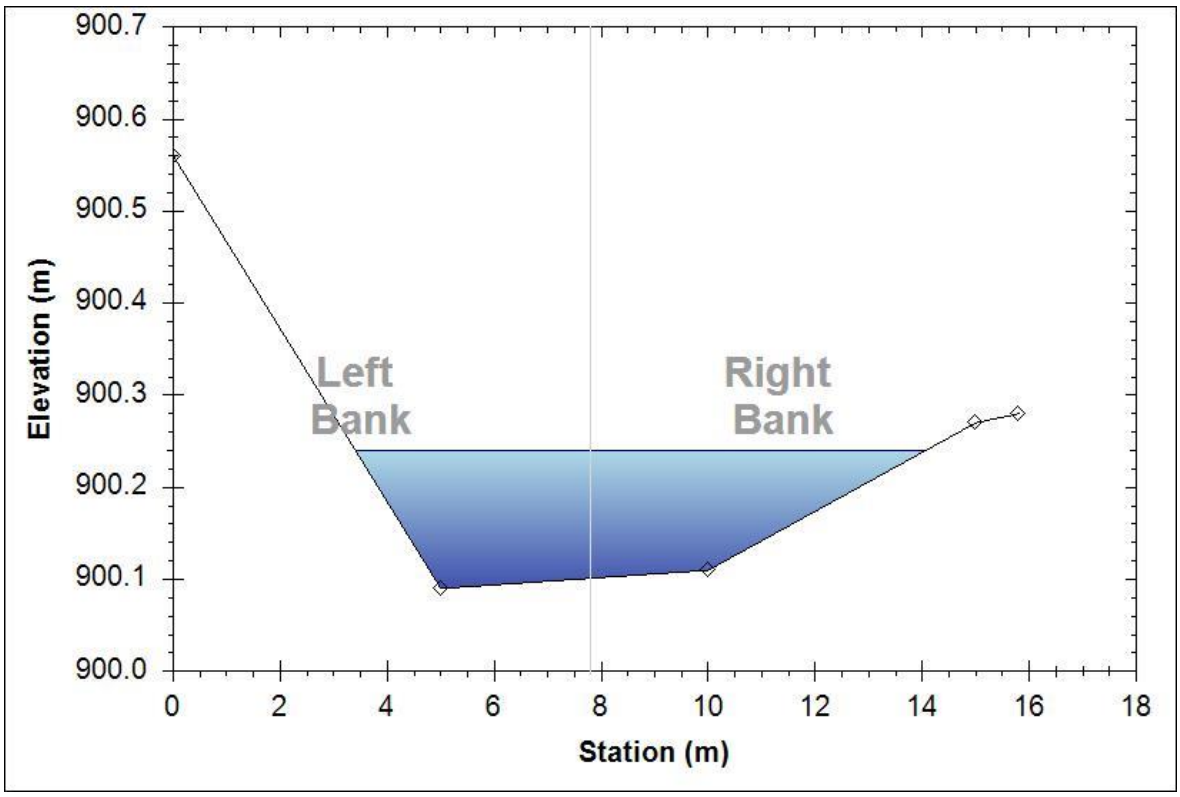
Station (m)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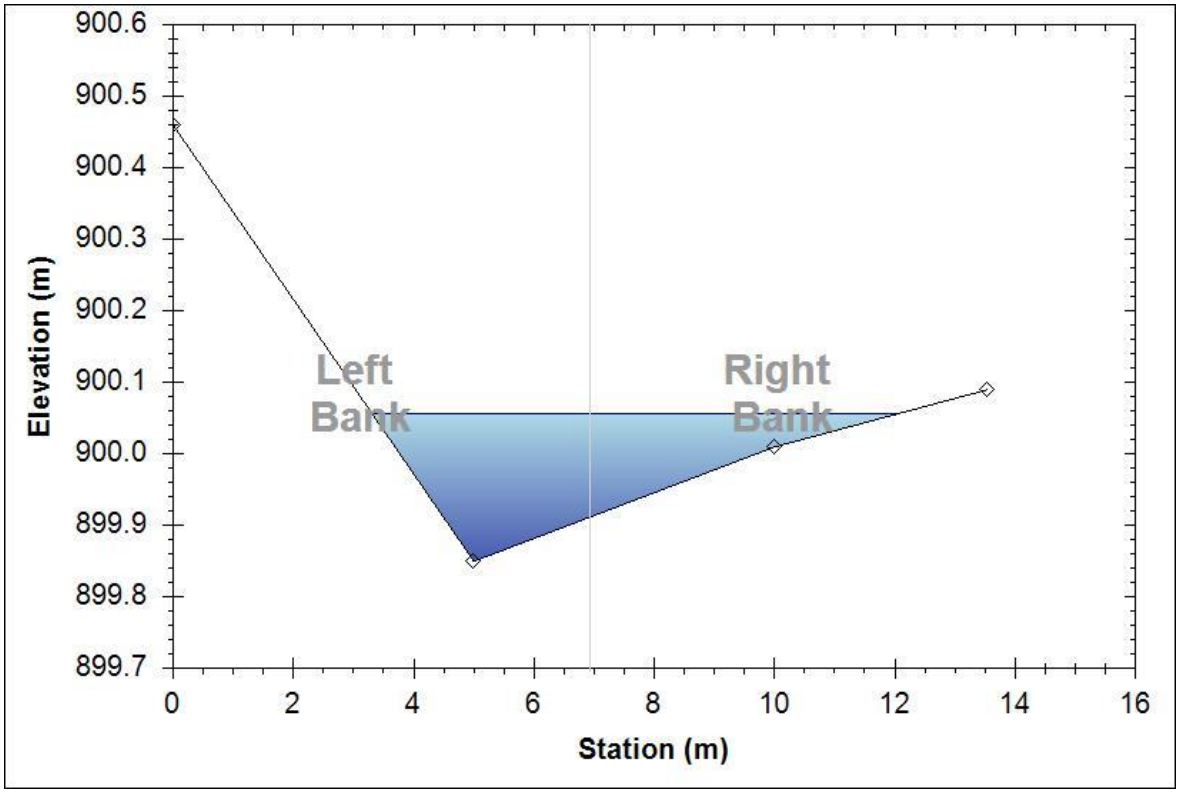
Station (m)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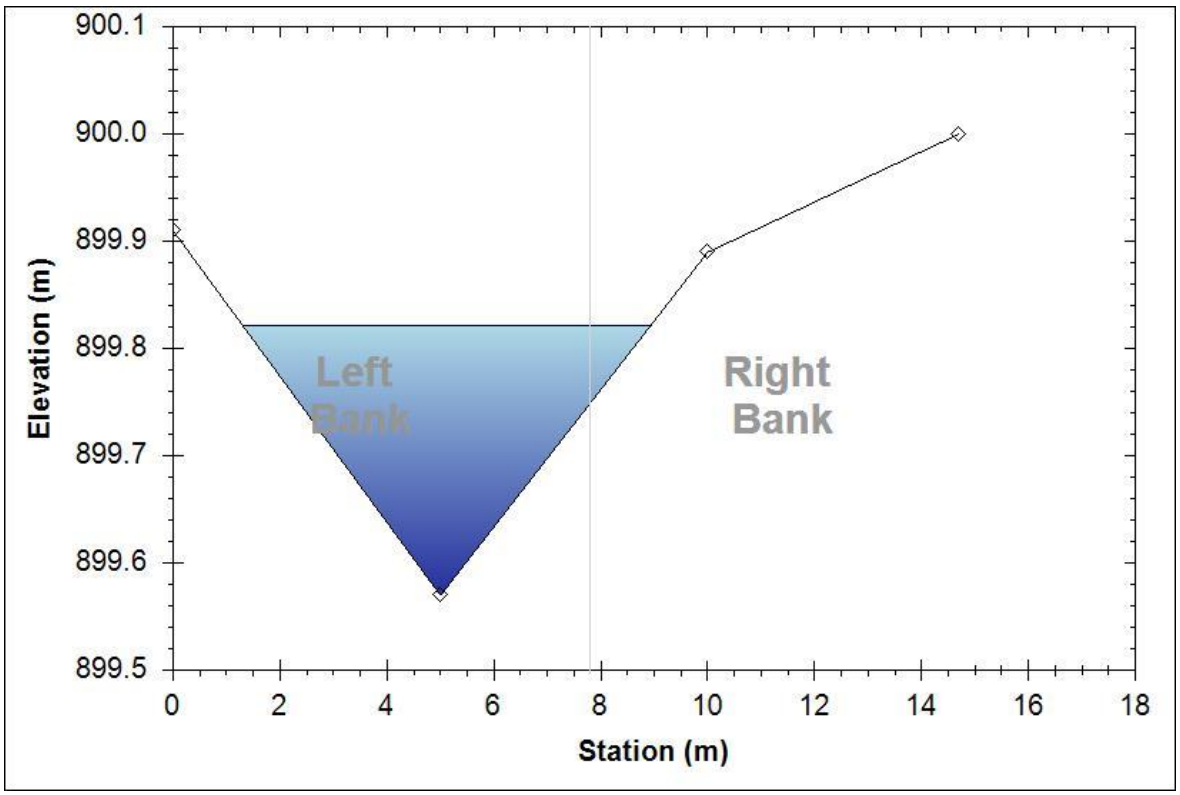
Station (m)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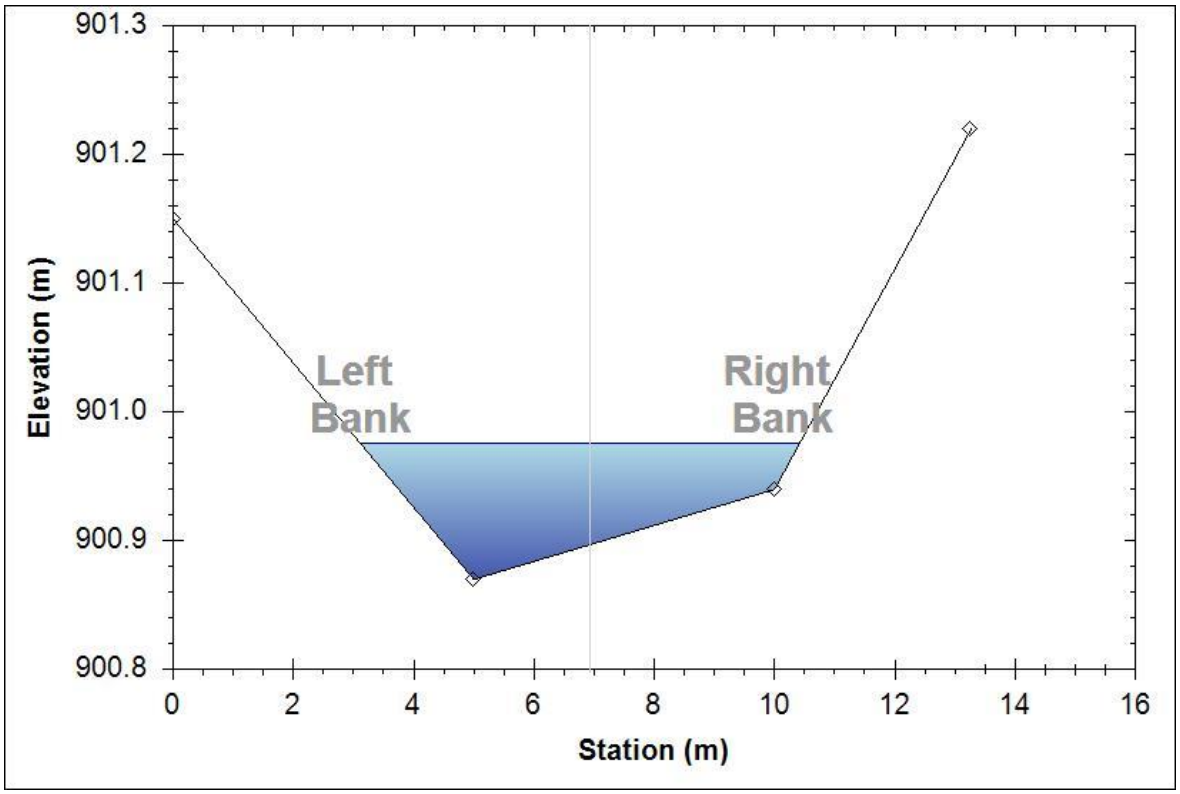
Station (m)

UPSTREAM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Bank
Right
Bank
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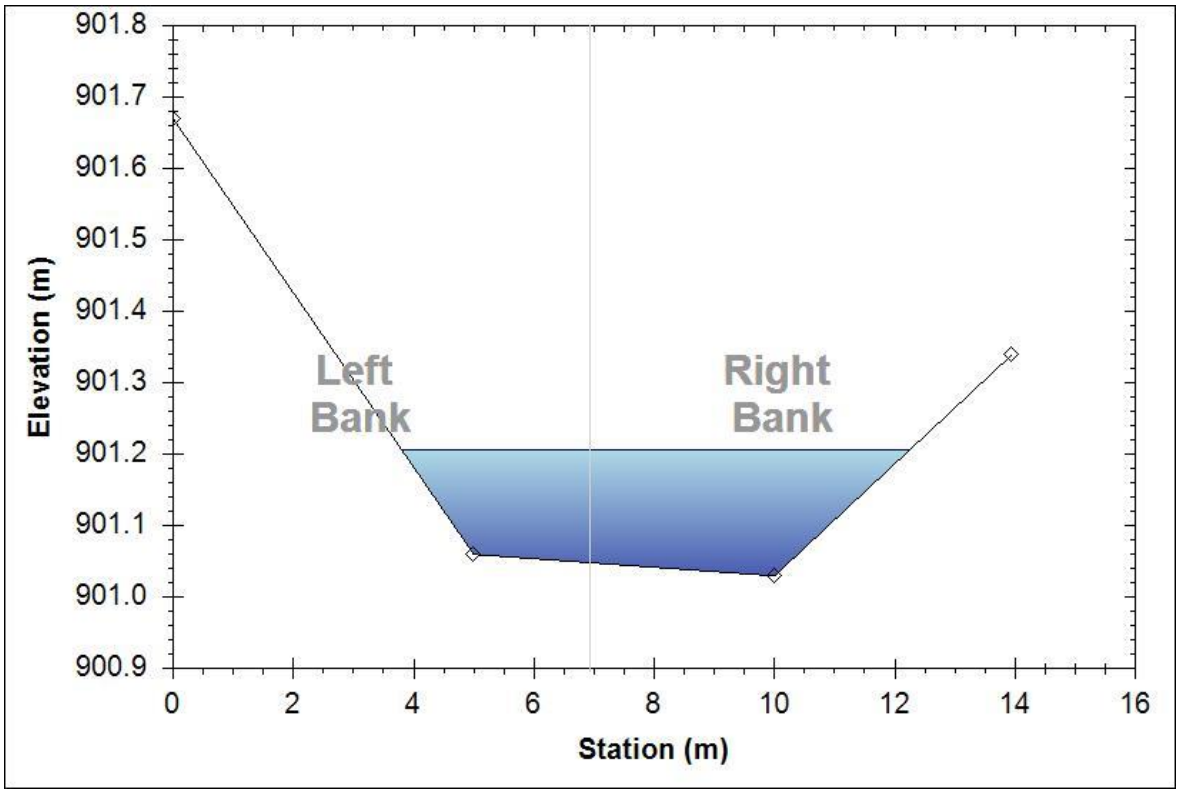
16
Station (m)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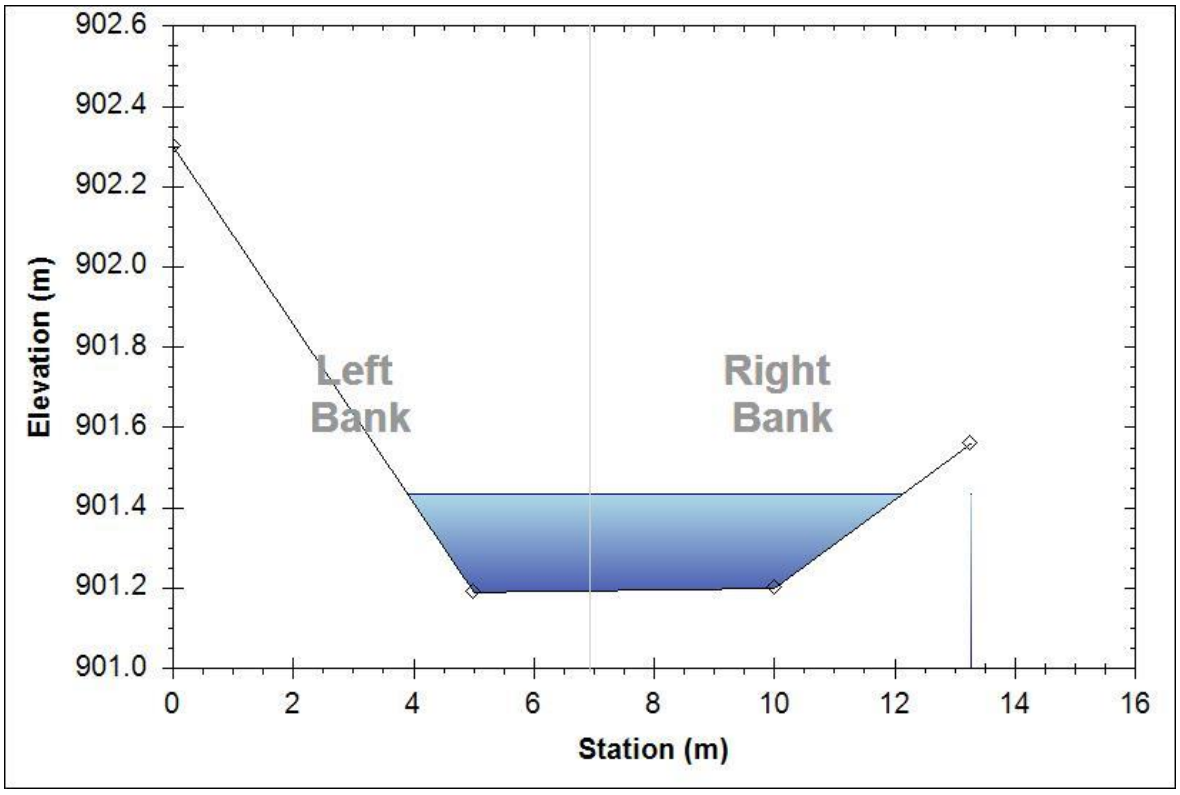
Station (m)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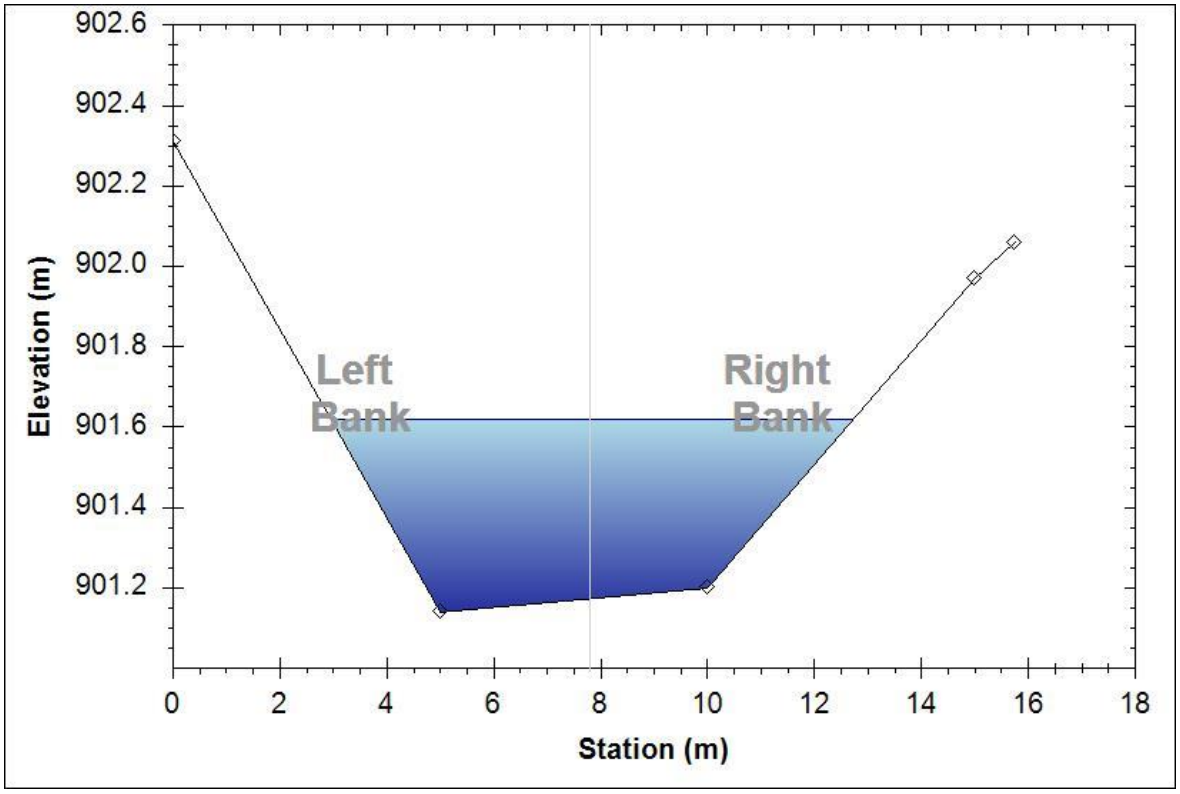
Station (m)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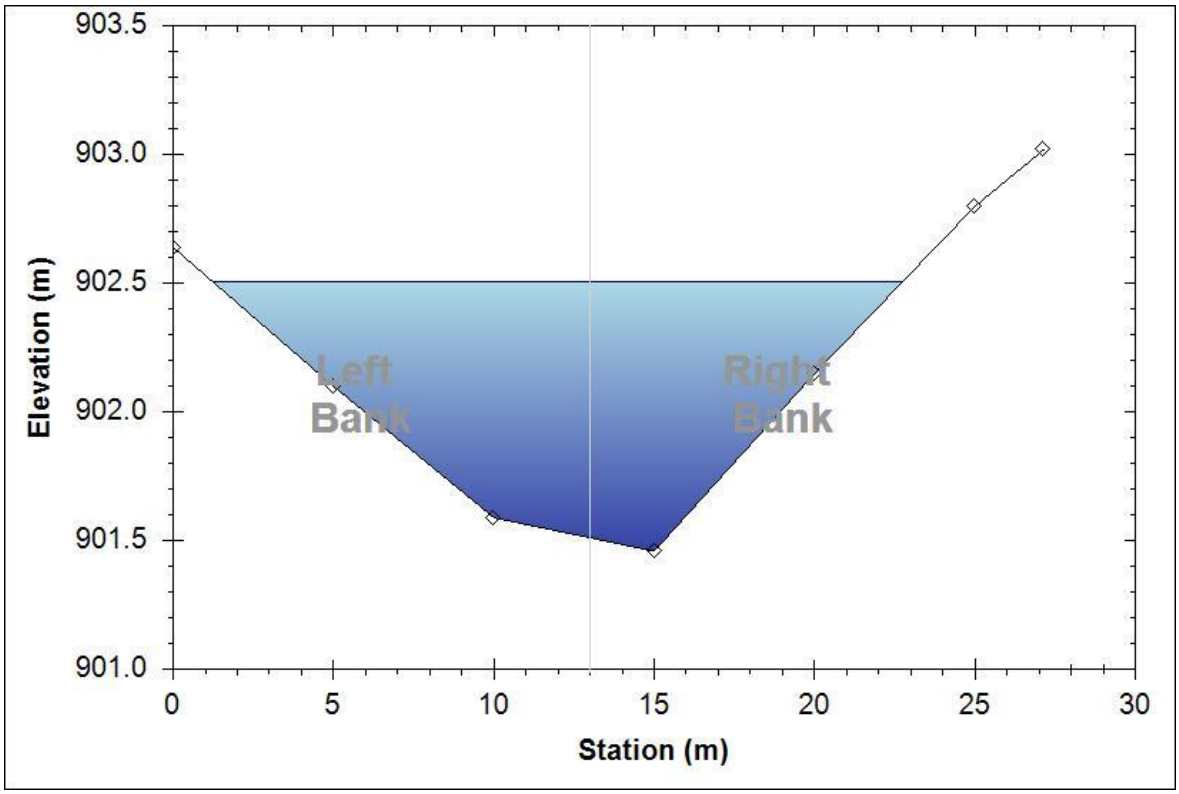
Station (m)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Elevation (m)
Left
Bank
Right
Bank
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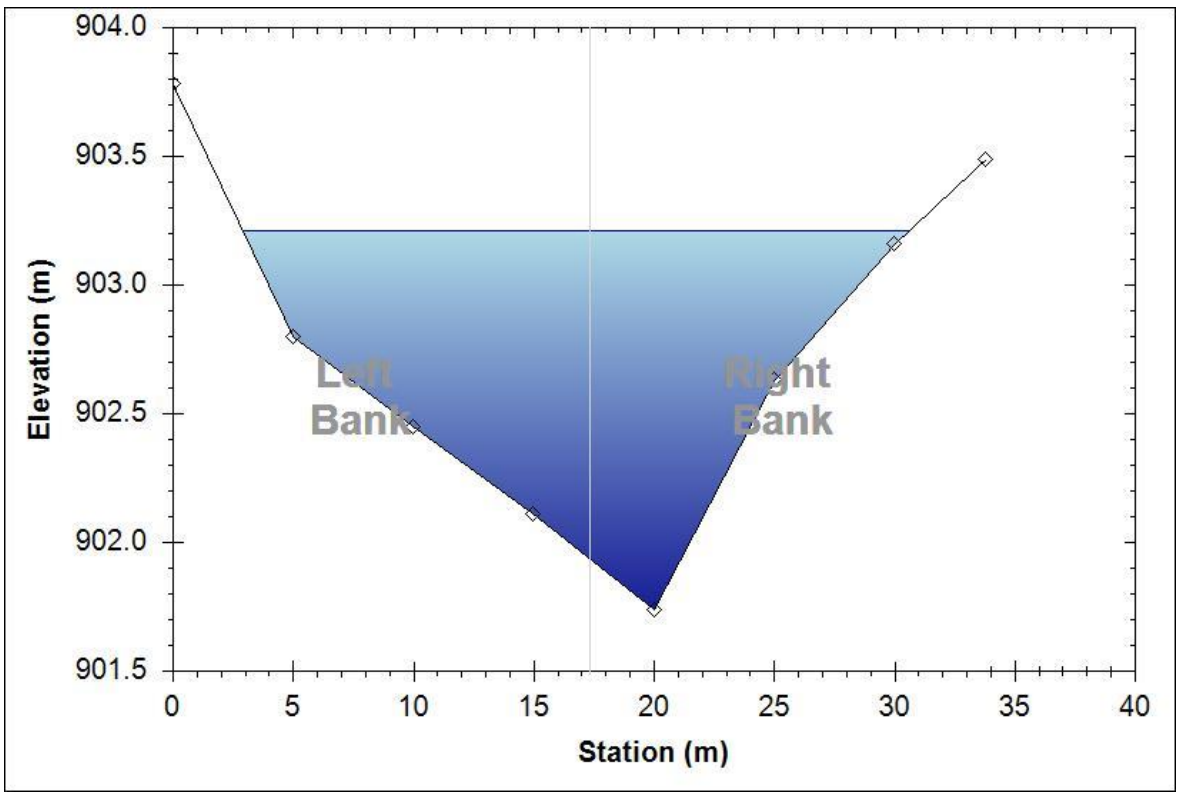
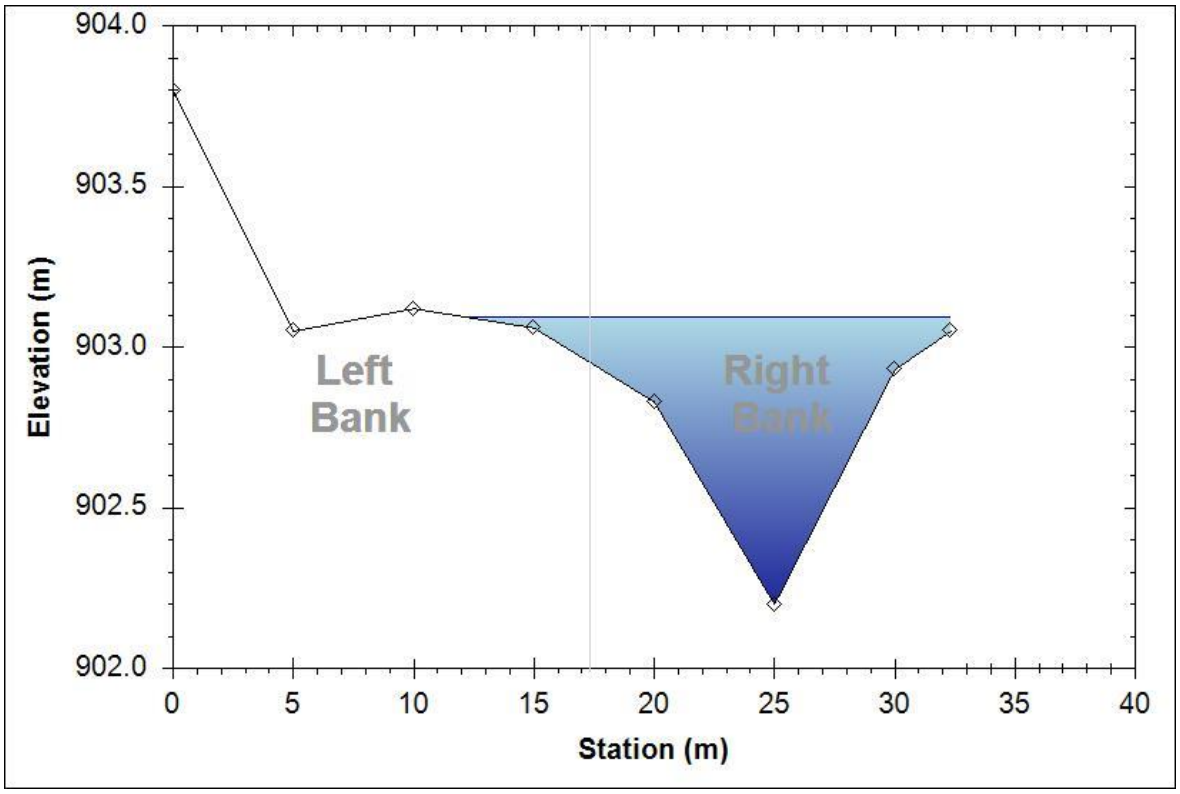
15
20
25
30
Station (m)


904.0
903.5
903.0
902.5
902.0
901.5
Elevation (m)
Left
Bank
Right
Bank
0
5
10
15
20
25
30
35
40
Station (m)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903.0
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Elevation (m)
Left
Bank
Right
Bank
0
5
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15
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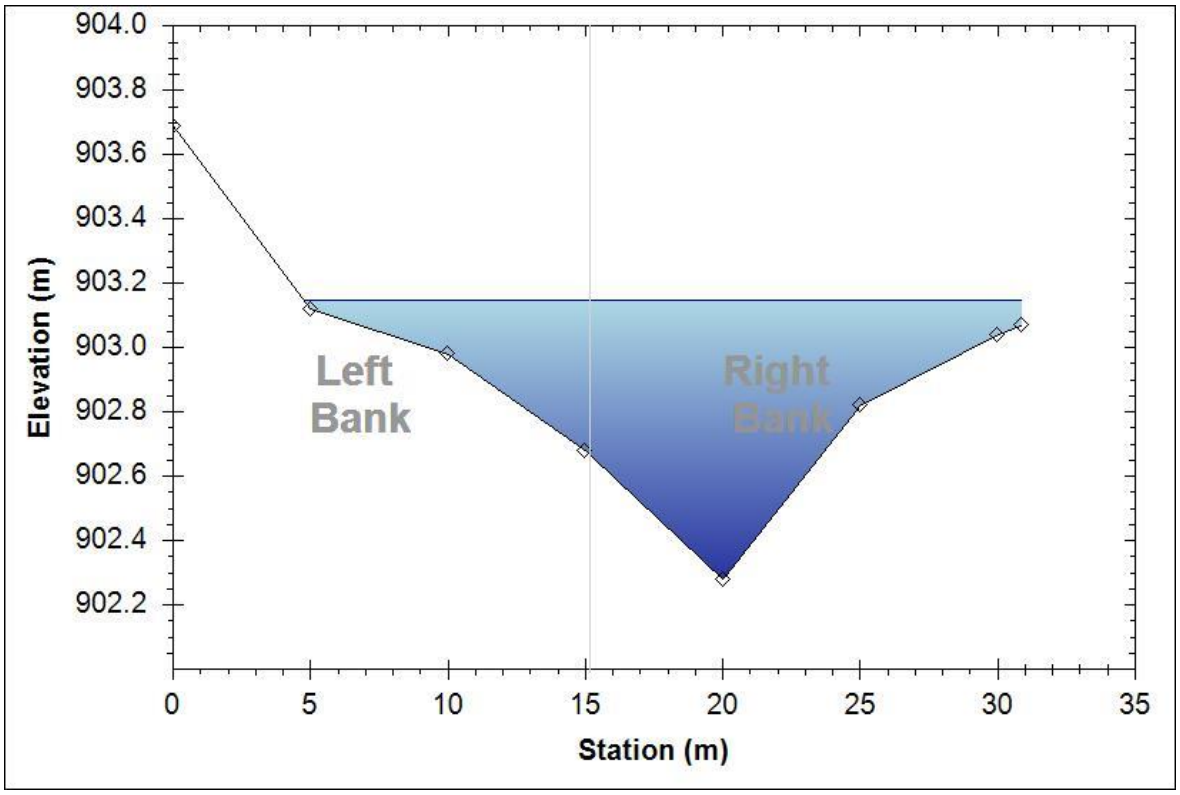
25
30
35
40
Station (m)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903.6
903.4
903.2
903.0
902.8
902.6
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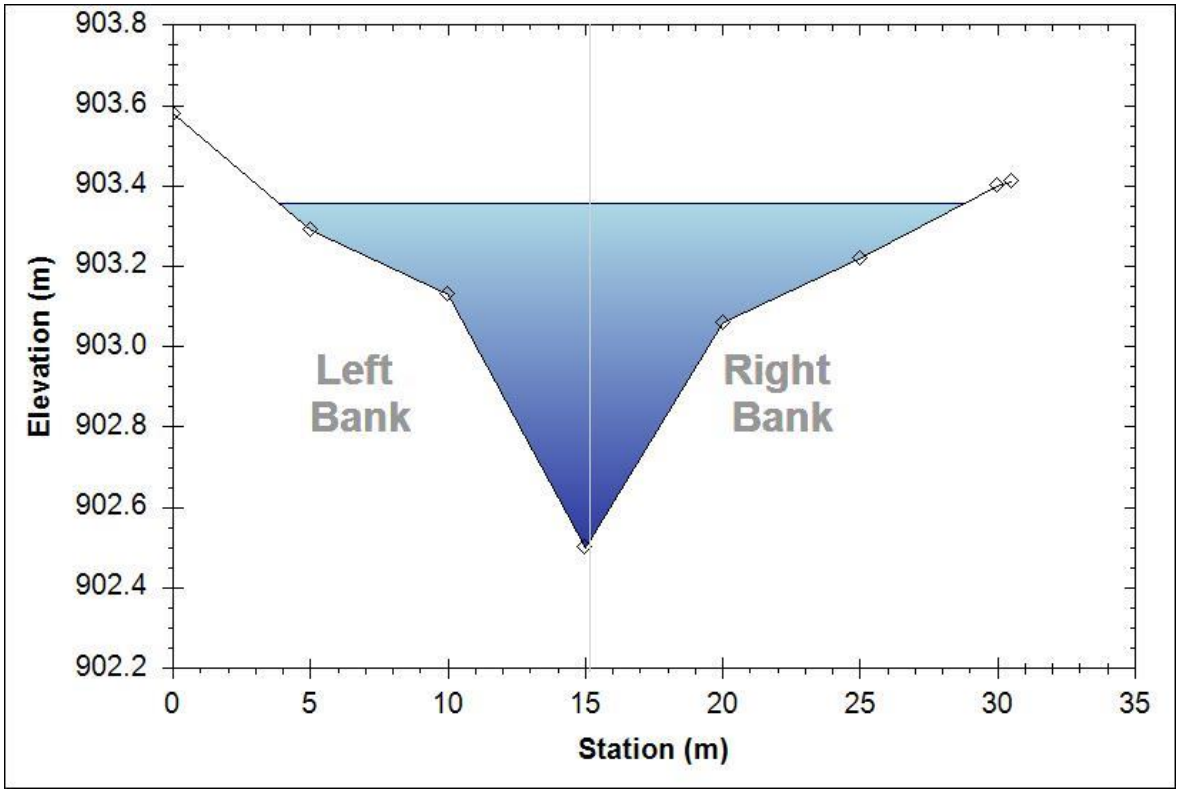
902.2
Elevation (m)
Left
Bank
Right
Bank
0
5
10
15
20
25
30
35
Station (m)


903.8
903.6
903.4
903.2
903.0
902.8
902.6
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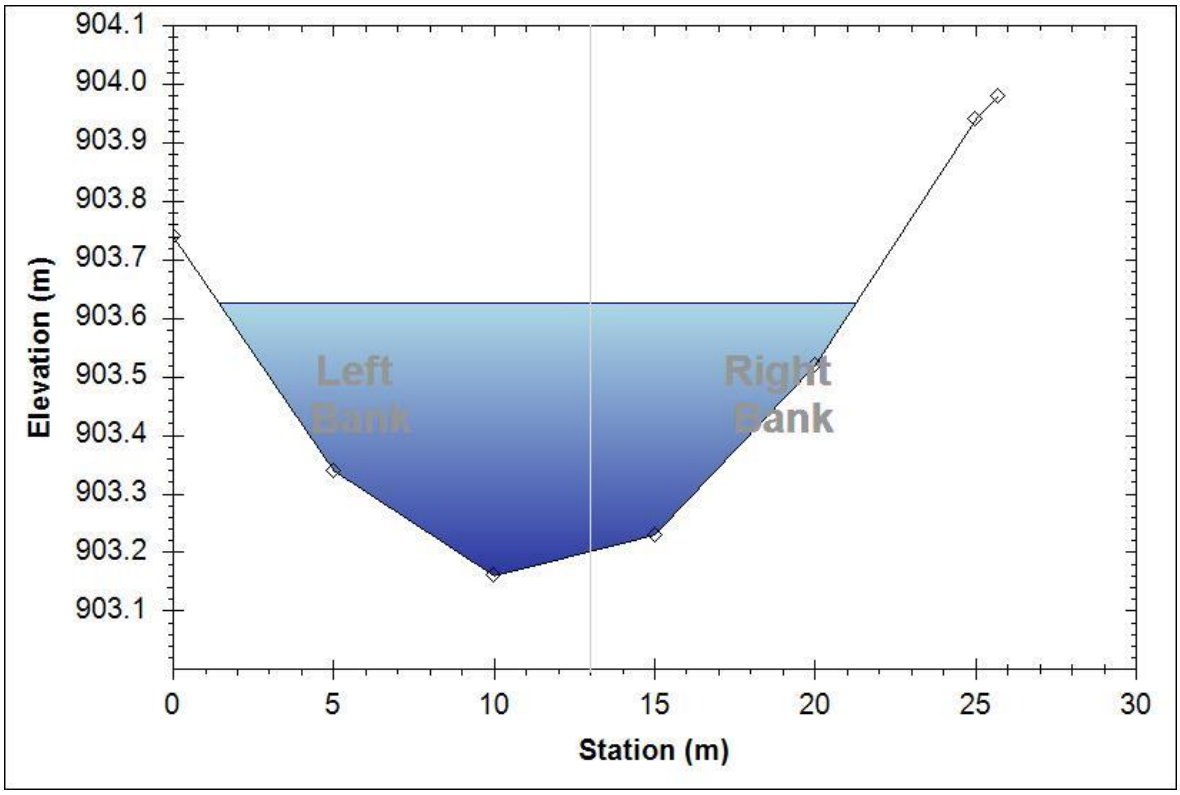
Elevation (m)
Left
Bank
Right
Bank
0
5
10
15
20
25
30
35
Station (m)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904.0
903.9
903.8
903.7
903.6
903.5
903.4
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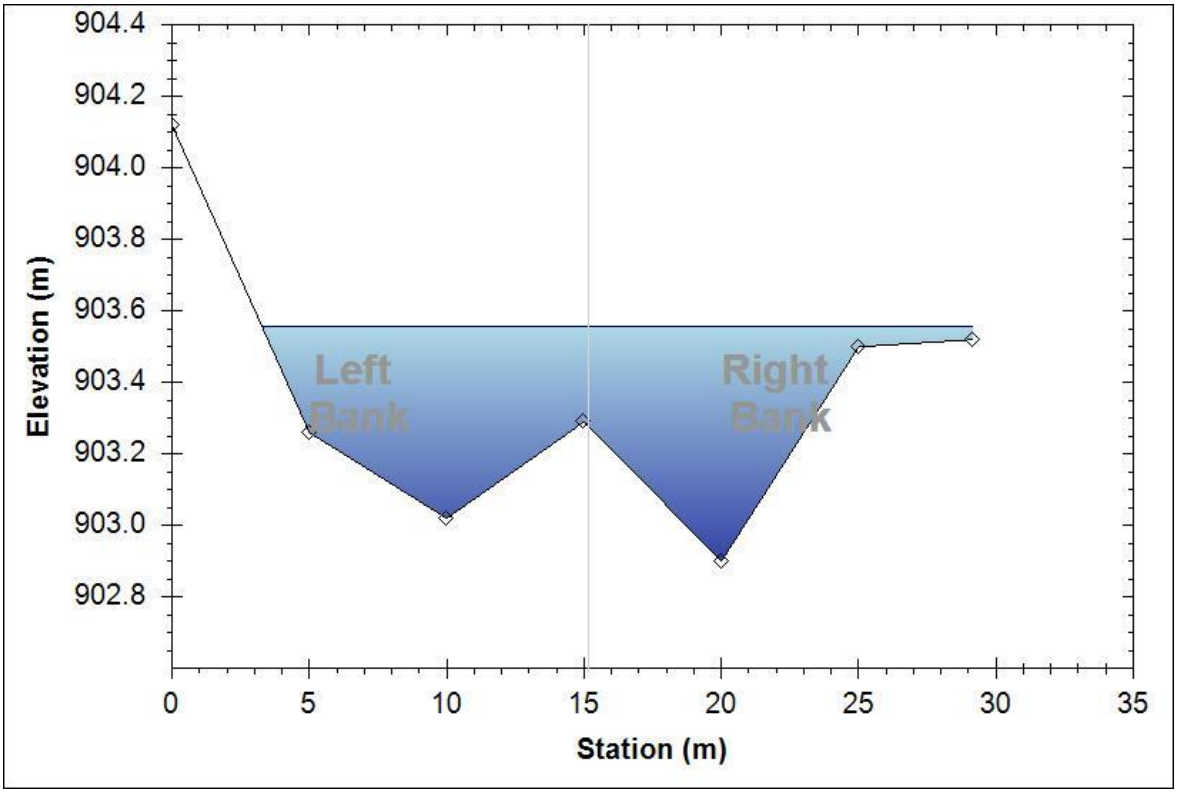
Elevation (m)
Left
Bank
Right
Bank
0
5
10
15
20
25
30
Station (m)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904.2
904.0
903.8
903.6
903.4
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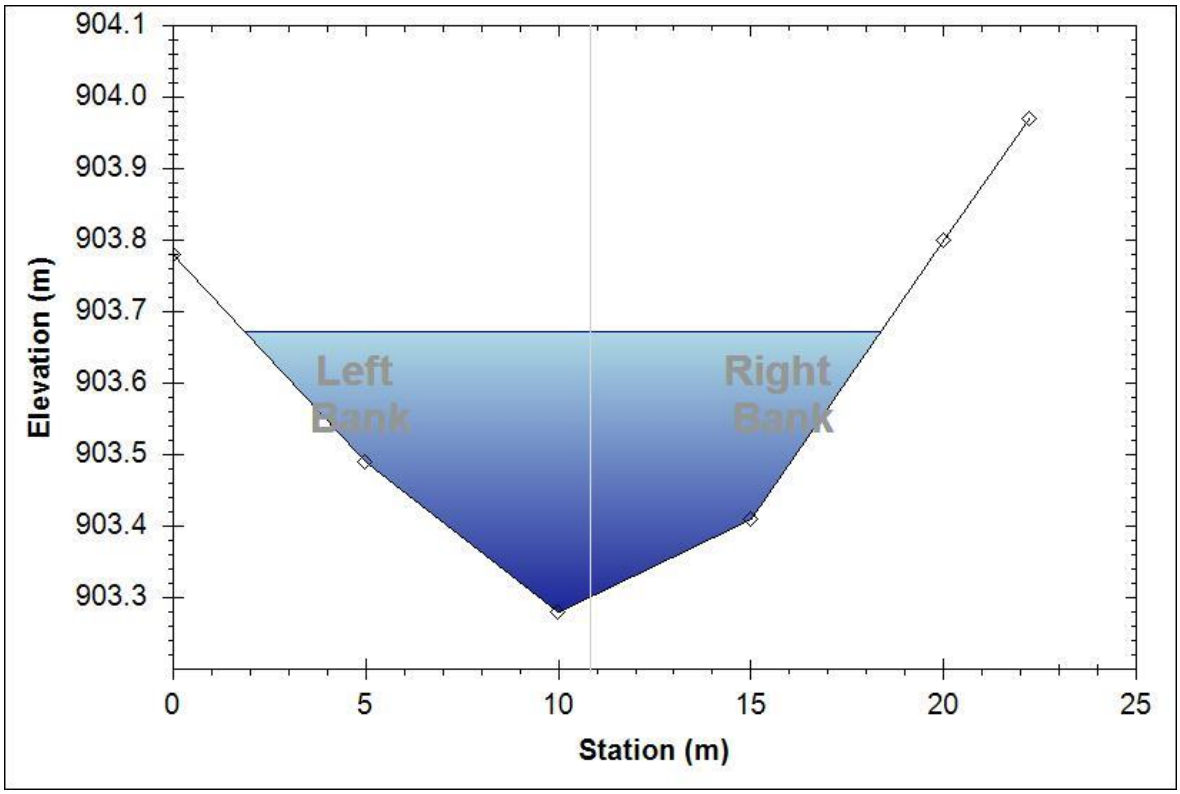
902.8
Elevation (m)
Left Bank
Right Bank
0
5
10
15
20
25
30
35
Station (m)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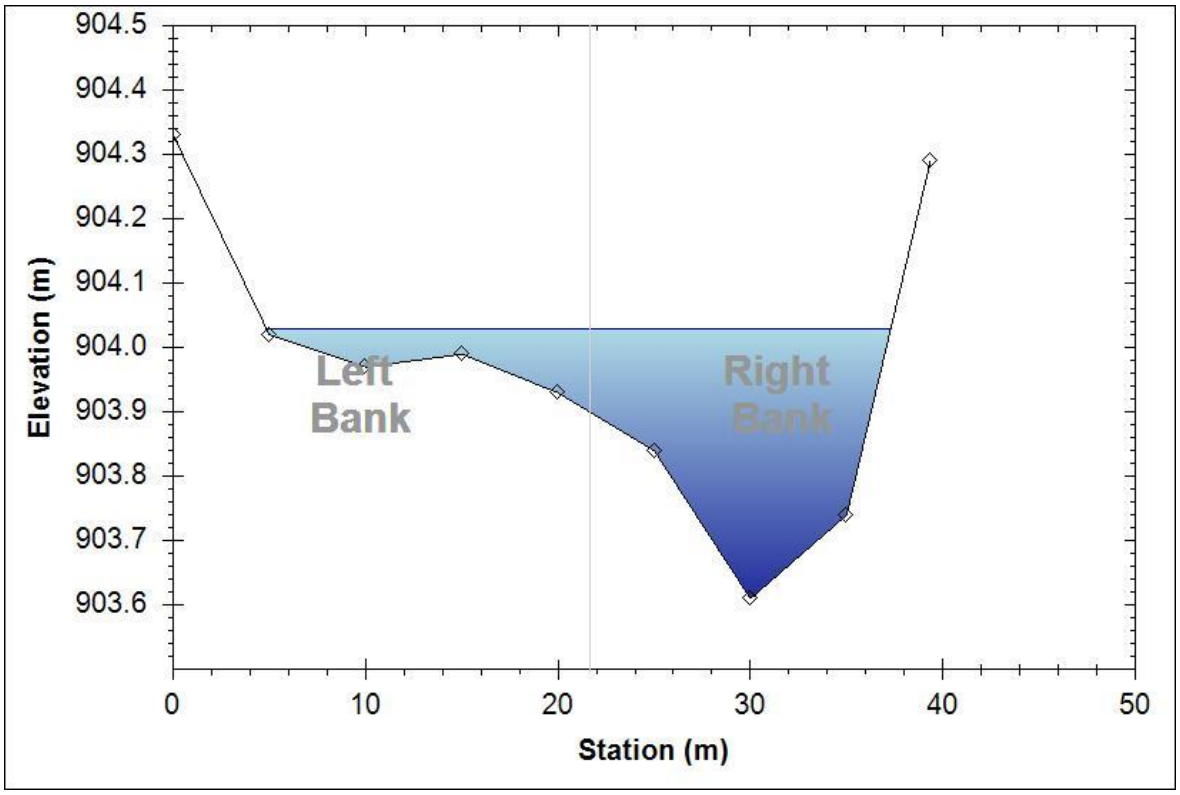
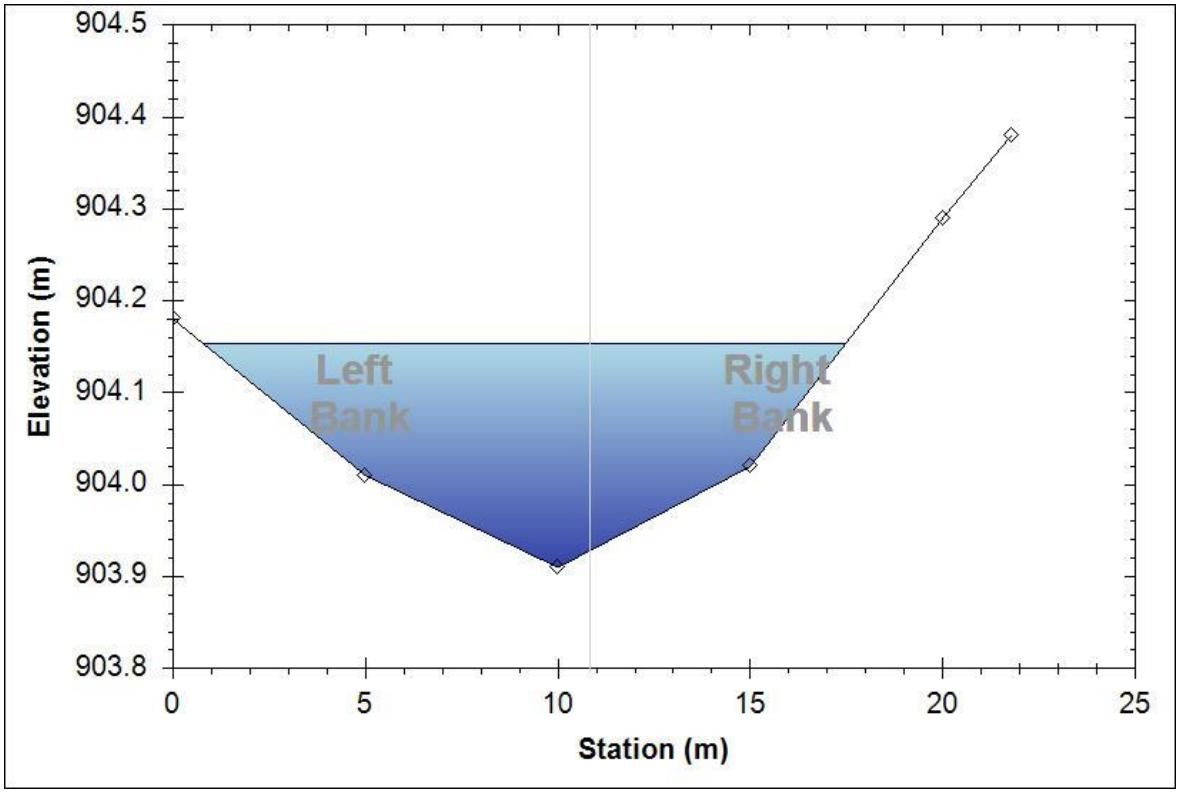
904.0
903.9
903.8
903.7
903.6
903.5
903.4
903.3
Elevation (m)
Left Bank
Right Bank
0
5
10
15
20
25
Station (m)


904.5
904.4
904.3
904.2
904.1
904.0
903.9
903.8
903.7
903.6
Elevation (m)
Left
Bank
Right
Bank
0
10
20
30
40
50
Station (m)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904.4
904.3
904.2
904.1
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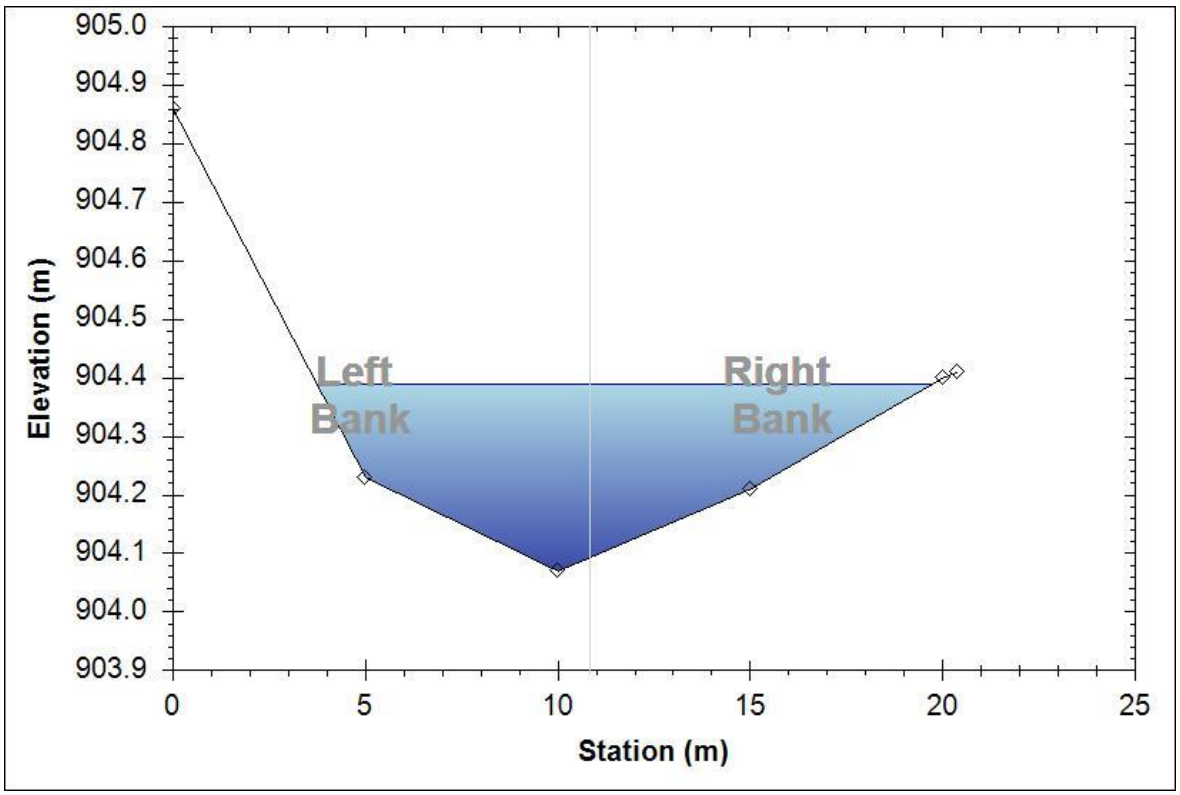
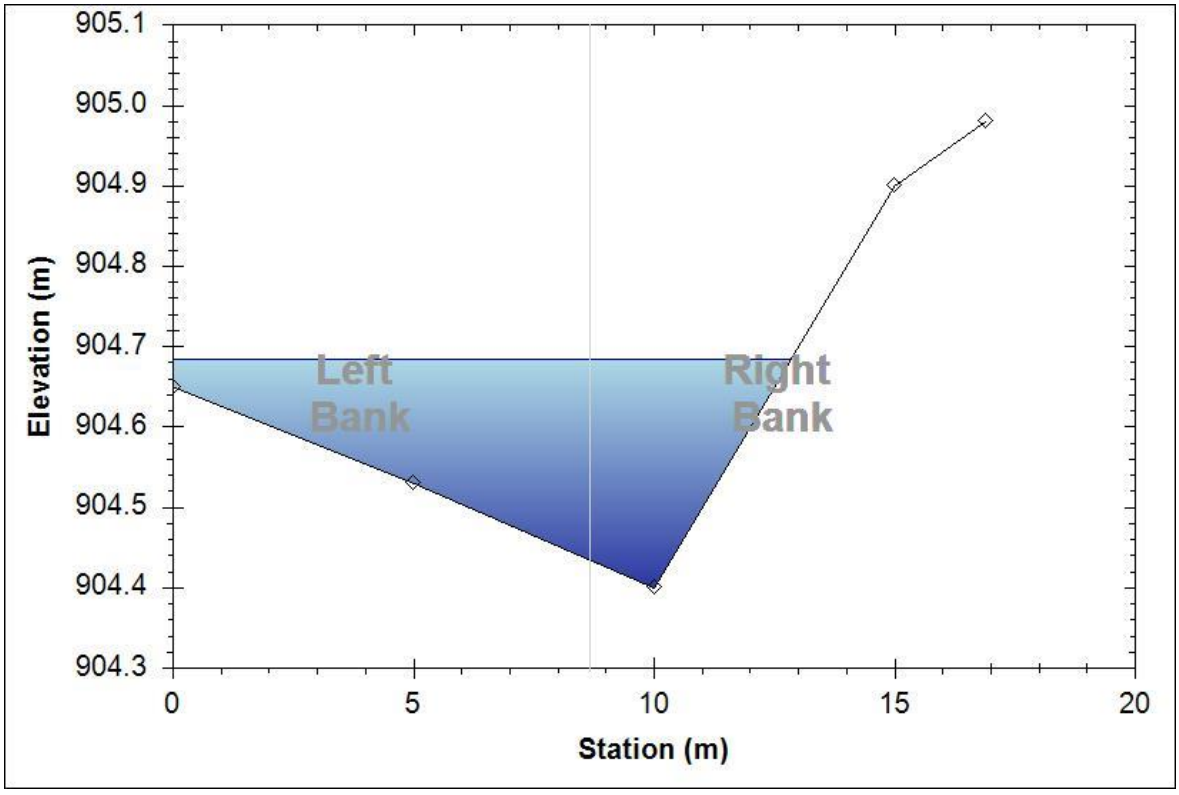
903.9
903.8
Elevation (m)
Left
Bank
Right
Bank
0
5
10
15
20
25
Station (m)


905.0
904.9
904.8
904.7
904.6
904.5
904.4
904.3
904.2
904.1
904.0
903.9
Elevation (m)
Left
Bank
Right
Bank
0
5
10
15
20
25
Station (m)


905.1
905.0
904.9
904.8
904.7
904.6
904.5
904.4
904.3
Elevation (m)
Left
Bank
Right
Bank
0
5
10
15
20
Station (m)