SSIGL 21

NATIONAL GUIDELINES

For Small Scale Irrigation Development in Ethiopia

Selected Application Software's

November 2018

Addis Ababa

MINISTRY OF AGRICULTURE

National Guidelines for Small Scale Irrigation Development in Ethiopia

SSIGL 21: Selected Application Software's

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First Edition 2018

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DISCLAIMER

Ministry of Agriculture through the Consultant and core reviewers from all relevant stakeholders included the information to provide the contemporary approach about the subject matter. The information contained in the guidelines is obtained from sources believed tested and reliable and are augmented based on practical experiences. While it is believed that the guideline is enriched with professional advice, for it to be successful, needs services of competent professionals from all respective disciplines. It is believed, the guidelines presented herein are sound and to the expected standard. However, we hereby disclaim any liability, loss or risk taken by individuals, groups, or organization who does not act on the information contained herein as appropriate to the specific SSI site condition.

FORWARD

Ministry of Agriculture, based on the national strategic directions is striving to meet its commitments in which modernizing agriculture is on top of its highest priorities to sustain the rapid, broad-based and fair economic growth and development of the country. To date, major efforts have been made to remodel several important strategies and national guidelines by its major programs and projects.

While efforts have been made to create access to irrigation water and promoting sustainable irrigation development, several barriers are still hindering the implementation process and the performance of the schemes. The major technical constrains starts from poor planning and identification, study, design, construction, operation, and maintenance. One of the main reasons behind this outstanding challenge, in addition to the capacity limitations, is that SSIPs have been studied and designed using many ad-hoc procedures and technical guidelines developed by various local and international institutions.

Despite having several guidelines and manuals developed by different entities such as MoA (IDD)-1986, ESRDF-1997, MoWIE-2002 and JICA/OIDA-2014, still the irrigation professionals follow their own public sources and expertise to fill some important gaps. A number of disparities, constraints and outstanding issues in the study and design procedures, criteria and assumptions have been causing huge variations in all vital aspects of SSI study, design and implementation from region to region and among professionals within the same region and institutions due mainly to the lack of agreed standard technical guidelines. Hence, the SSI Directorate with AGP financial support, led by Generation consultant (GIRDC) and with active involvement of national and regional stakeholders and international development partners, these new and comprehensive national guidelines have been developed.

The SSID guidelines have been developed by addressing all key features in a comprehensive and participatory manner at all levels. The guidelines are believed to be responsive to the prevalent study and design contentious issues; and efforts have been made to make the guidelines simple, flexible and adaptable to almost all regional contexts including concerned partner institution interests. The outlines of the guidelines cover all aspects of irrigation development including project initiation, planning, organizations, site identification and prioritization, feasibility studies and detail designs, contract administration and management, scheme operation, maintenance and management.

Enforceability, standardization, social and environmental safeguard mechanisms are well mainstreamed in the guidelines, hence they shall be used as a guiding framework for engineers and other experts engaged in all SSI development phases. The views and actual procedures of all relevant diverse government bodies, research and higher learning institutions, private companies and development partners has been immensely and thoroughly considered to ensure that all stakeholders are aligned and can work together towards a common goal. Appropriately, the guidelines will be familiarized to the entire stakeholders working in the irrigation development. Besides, significant number of experts in the corresponding subject matter will be effectively trained nationwide; and the guidelines will be tested practically on actual new and developing projects for due consideration of possible improvement. Hence, hereinafter, all involved stakeholders including government & non-governmental organizations, development partners, enterprises, institutions, consultants and individuals in Ethiopia have to adhere to these comprehensive national guidelines in all cases and at all level whilst if any overlooked components are found, it should be documented and communicated to MOA to bring them up-to-date.

Therefore, I congratulate all parties involved in the success of this effort, and urge partners and stakeholders to show a similar level of engagement in the implementation and stick to the guidelines over the coming years.

H.E. Dr. Kaba Urgessa
State Minister, Ministry of Agriculture

SMALL SCALE IRRIGATION DEVELOPMENT VISION

Transforming agricultural production from its dependence on rain-fed practices by creating reliable irrigation system in which smallholder farmers have access to at least one option of water source to increase production and productivity as well as enhance resilience to climate change and thereby ensure food security, maintain increasing income and sustain economic growth.

ACKNOWLEDGEMENTS

The preparation of SSIGLs required extensive inputs from all stakeholders and development partners. Accordingly many professionals from government and development partners have contributed to the realization of the guidelines. To this end MOA would like to extend sincere acknowledgement to all institutions and individuals who have been involved in the review of these SSIGLs for their comprehensive participation, invaluable inputs and encouragement to the completion of the guidelines. There are just too many collaborators involved to name exhaustively and congratulate individually, as many experts from Federal, regional states and development partners have been involved in one way or another in the preparation of the guidelines. The contribution of all of them who actively involved in the development of these SSIGLs is gratefully acknowledged. The Ministry believes that their contributions will be truly appreciated by the users for many years to come.

The Ministry would like to extend its appreciation and gratitude to the following contributors:

- Agriculture Growth Program (AGP) of the MoA for financing the development and publication of the guidelines.
- The National Agriculture Water Management Platform (NAWMP) for overseeing, guidance and playing key supervisory and quality control roles in the overall preparation process and for the devotion of its members in reviewing and providing invaluable technical inputs to enrich the guidelines.
- Federal Government and Regional States organizations and their staff for their untiring effort in reviewing the guidelines and providing constructive suggestions, recommendations and comments.
- National and international development partners for their unreserved efforts in reviewing the guidelines and providing constructive comments which invaluably improved the quality of the guidelines.
- Small-scale and Micro Irrigation Support Project (SMIS) and its team for making all efforts to have quality GLs developed as envisioned by the Ministry.

The MOA would also like to extend its high gratitude and sincere thanks to AGP's multi development partners including the International Development Association (IDA)/World Bank, the Canada Department of Foreign Affairs, Trade and Development (DFATD), the United States Agency for International Development (USAID), the Netherlands, the European Commission (EC), the Spanish Agency for International Development (AECID), the Global Agriculture and Food Security Program (GAFSP), the Italy International Development Cooperation, the Food and Agriculture Organization (FAO) and the United Nations Development Program (UNDP).

Moreover, the Ministry would like to express its gratitude to Generation Integrated Rural Development Consultant (GIRDC) and its staff whose determined efforts to the development of these SSIGLs have been invaluable. GIRDC and its team drafted and finalized all the contents of the SSIGLs as per stakeholder suggestions, recommendations and concerns. The MoA recognizes the patience, diligence, tireless, extensive and selfless dedication of the GIRDC and its staff who made this assignment possible.

Finally, we owe courtesy to all national and International source materials cited and referred but unintentionally not cited.

Ministry of Agriculture

DEDICATIONS

The National Guidelines for Small Scale Irrigation Development are dedicated to Ethiopian smallholder farmers, agro-pastoralists, pastoralists, to equip them with appropriate irrigation technology as we envision them empowered and transformed.

LIST OF GUIDELINES

Part I. SSIGL 1: Project Initiation, Planning and Organization

Part II: SSIGL 2: Site Identification and Prioritization

Part III: Feasibility Study and Detail Design

SSIGL 3: Hydrology and Water Resources Planning
SSIGL 4: Topographic and Irrigation Infrastructures Surveying
SSIGL 5: Soil Survey and Land Suitability Evaluation
SSIGL 6: Geology and Engineering Geology Study
SSIGL 7: Groundwater Study and Design
SSIGL 8: Irrigation Agronomy and Agricultural Development Plan
SSIGL 9: Socio-economy and Community Participation
SSIGL 10: Diversion Weir Study and Design
SSIGL 11: Free River Side Intake Study and Design
SSIGL 12: Small Embankment Dam Study and Design
SSIGL 13: Irrigation Pump Facilities Study and Design
SSIGL 14: Spring Development Study and Design
SSIGL 15: Surface Irrigation System Planning and Design
SSIGL 16: Canals Related Structures Design
SSIGL 17: Sprinkler Irrigation System Study and Design
SSIGL 18: Drip Irrigation System Study and Design
SSIGL 19: Spate Irrigation System Study and Design
SSIGL 20: Quantity Surveying
SSIGL 21: Selected Application Software's
SSIGL 22: Technical Drawings
SSIGL 23: Tender Document Preparation
SSIGL 24: Technical Specifications Preparation
SSIGL 25: Environmental & Social Impact Assessment
SSIGL 26: Financial and Economic Analysis

Part IV: Contract Administration & Construction Management

SSIGL 27: Contract Administration

SSIGL 28: Construction Supervision

SSIGL 29: Construction of Irrigation Infrastructures

Part V: SSI Scheme Operation, Maintenance and Management

SSIGL 30: Scheme Operation, Maintenance and Management

SSIGL 31: A Procedural Guideline for Small Scale Irrigation Schemes Revitalization

SSIGL 32: Monitoring and Evaluation

Ancillary Tools for National Guidelines of Small Scale Irrigation Development

SSIGL 33: Participatory Irrigation Development and Management (PIDM)

SSIGL 34: Quality Assurance and Control for Engineering Sector Study and Design

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ACRONYMS

AGP	Agricultural Growth Program
CAD	Computer Aided Design
GIRDC	Generation Integrated Rural Development Consultant
GIS	Geographic Information System
MOANR	Ministry of Agriculture and Natural Resource
MOWIE	Ministry of Water, Irrigation and Electricity
SSID	Small Scale Irrigation Development
SSIGL	Small Scale Irrigation Guideline
SSIP	Small Scale Irrigation Project
SSIS	Small Scale Irrigation Scheme

PREFACE

While irrigation development is at the top of the government's priority agendas as it is key to boost production and improve food security as well as to provide inputs for industrial development. Accordingly, irrigated land in different scales has been aggressively expanding from time to time. To this end, to enhance quality delivery of small-scale irrigation development planning, implementation and management, it has been decided to develop standard SSI guidelines that must be nationally applied. In September 2017 the Ministry of Agriculture (MoA) had entrusted Generation Integrated Rural Development Consultant (GIRDC) to prepare the National Small-scale Irrigation Development Guidelines (SSIGLs).

Preparation of the SSIGLs for enhancing development of irrigated agriculture is recognized as one of the many core initiatives of the MoA to improve its delivery system and achieve the targets in irrigated agriculture and fulfill its mission for improving agricultural productivity and production. The core objective of developing SSIGLs is to summarize present thinking, knowledge and practices to enable irrigation practitioners to properly plan, implement and manage community managed SSI schemes to develop the full irrigation potential in a sustainable manner.

As the SSIGLs are prepared based on national and international knowledge, experiences and practices, and describe current and recommended practice and set out the national standard guides and procedures for SSI development, they serve as a source of information and provide guidance. Hence, it is believed that the SSIGLs will contribute to ensuring the quality and timely delivery, operation and maintenance of SSI schemes in the country. The SSIGLs attempt to explain and illustrate the important concepts, considerations and procedures in SSI planning, implementation and management; and shall be used as a guiding framework for professionals engaged in SSI development. Illustrative examples from within the country have been added to enable the users understand the contents, methodologies presented in the SSIGLs.

The intended audiences of the SSIGLs are government organizations, NGOs, CSOs and the private sector involved in SSI development. Professionally, the SSIGLs will be beneficial for experienced and junior planners, experts, contractors, consultants, suppliers, investors, operators and managers of SSI schemes. The SSIGLs will also serve as a useful reference for academia and researchers involved and interested in SSI development. The SSIGLs will guide to ensure that; planning, implementation and management of SSI projects is formalized and set procedures and processes to be followed. As the SSIGLs provide information and guides they must be always fully considered and applied by adapting them to the local specific requirements.

In cognizance with the need for quality SSIGLs, the MoA has duly considered quality assurance and control during preparation of the guidelines. Accordingly, the outlines, contents and scope of the SSIGLs were thoroughly discussed, reviewed and modified by NAWMP members (senior professionals from public, national and international stakeholder) with key stakeholders in many consultative meetings and workshops. Moreover, at each milestone of SSIGL preparation, resource persons from all stakeholders reviewed and confirmed that SSIGLs have met the demands and expectations of users.

Moreover, the Ministry has mobilized resource persons from key Federal, National Regional States level stakeholders and international development partners for review, validation and endorsement of the SSIGLs.

Several hundreds of experienced professionals (who are very qualified experts in their respective fields) from government institutions, relevant private sector and international development partners have significantly contributed to the preparation of the SSIGLs. They have been involved in all aspects of the development of SSIGLs throughout the preparation process. The preparation process included a number of consultation meetings and workshops: (i) workshop to review inception report, (ii) workshop on findings of review of existing guidelines/manuals and proposed contents of the SSIGLs, (iii) meetings to review zero draft SSI GLs, (iv) review workshop on draft SSI GLs, (v) small group review meetings on thematic areas, (vi) small group consultation meetings on its final presentation of contents and layout, (vii) consultation mini-workshops in the National States on semi-final versions of the SSIGLs, and (viii) final write-shop for the appraisal and approval of the final versions of SSIGLs.

The deliberations, concerns, suggestions and comments received from professionals have been duly considered and incorporated by the GIRD Consultant in the final SSIGLs.

There are 34 separate guidelines which are categorized into the following five parts concurrent to SSI development phases:

Part-I. Project Initiation, Planning and Organization Guideline which deals with key considerations and procedures on planning and organization of SSI development projects.

Part-II. Site Identification and Prioritization Guideline which treats physical potential identification and prioritization of investment projects. It presents SSI site selection process and prioritization criteria.

Part-III. Feasibility Study and Detail Design Guidelines for SSID dealing with feasibility study and design concepts, approaches, considerations, requirements and procedures in the study and design of SSI systems.

Part-IV. Contract Administration and Construction Management Guidelines for SSI development presents the considerations, requirements, and procedures involved in construction of works, construction supervision and contract administration.

Part-V. SSI Scheme Management, Operation and Maintenance Guidelines which covers SSI Scheme management and operation.

Moreover, Tools for Small Scale Irrigation development are also prepared as part of SSIGLs.

It is strongly believed and expected that; the SSIGLs will be quickly applied by all stakeholders involved in SSI development and others as appropriate following the dissemination and familiarization process of the guidelines in order to ensure efficient, productive and sustainable irrigation development.

The SSIGLs are envisioned to be updated by incorporating new technologies and experiences including research findings. Therefore, any suggestions, concerns, recommendations and comments on the SSIGLs are highly appreciated and welcome for future updates as per the attached format below. Furthermore, despite efforts in making all types of editorial works, there may still errors, which similarly shall be handled in future undated versions.

UPDATING AND REVISIONS OF GUIDELINES

The GLs are intended as an up-to-date or a live document enabling revisions, to be updated periodically to incorporate improvements, when and where necessary; may be due to evolving demands, technological changes and changing policies, and regulatory frameworks. Planning, study and design of SSI development interventions is a dynamic process. Advancements in these aspects are necessary to cope up with the changing environment and advancing techniques. Also, based on observation feedbacks and experiences gained during application and implementation of the guidelines, there might be a need to update the requirements, provisions and procedures, as appropriate. Besides, day-by-day, water is becoming more and more valuable. Hence, for efficient water development, utilization and management will have to be designed, planned and constructed with a new set up of mind to keep pace with the changing needs of the time. It may, therefore, be necessary to take up the work of further revision of these GLs.

This current version of the GLs has particular reference to the prevailing conditions in Ethiopia and reflects the experience gained through activities within the sub-sector during subsequent years. This is the first version of the SSI development GLs. This version shall be used as a starting point for future update, revision and improvement. Future updating and revisions to the GLs are anticipated as part of the process of strengthening the standards for planning, study, design, construction, operation and management SSI development in the country.

Completion of the review and updating of the GLs shall be undertaken in close consultation with the federal and regional irrigation institutions and other stakeholders in the irrigation sub-sector including the contracting and consulting industry.

In summary, significant changes to criteria, procedures or any other relevant issues related to technological changes, new policies or revised laws should be incorporated into the GLs from their date of effectiveness. Other minor changes that will not significantly affect the whole nature of the GLs may be accumulated and made periodically. When changes are made and approved, new page(s) incorporating the revision, together with the revision date, will be issued and inserted into the relevant GL section.

All suggestions to improve the GLs should be made in accordance with the following procedures:

I. Users of the GLs must register on the MOA website: Website: www.moa.gov.et
II. Proposed changes should be outlined on the GLs Change Form and forwarded with a covering letter or email of its need and purpose to the Ministry.
III. Agreed changes will be approved by the Ministry on recommendation from the Small-scale Irrigation Directorate and/or other responsible government body.
IV. The release date of the new version will be notified to all registered users and authorities.

Users are kindly requested to present their concerns, suggestions, recommendations and comments for future updates including any omissions and/or obvious errors by completing the following revisions form and submitting it to the Ministry. The Ministry shall appraise such requests for revision and will determine if an update to the guide is justified and necessary; and when such updates will be published. Revisions may take the form of replacement or additional pages. Upon receipt, revision pages are to be incorporated in the GLs and all superseded pages removed.

Suggested Revisions Request Form (Official Letter or Email)

To: ----------
From: ----------
Date: ----------
Description of suggested updates/changes: Include GL code and title, section title and # (heading/subheading #), and page #.

GL Code and Title	Date	Sections/ Heading/Subheading/ Pages/Table/Figure	Explanation	Comments (proposed change)

Note that be specific and include suggested language if possible and include additional sheets for comments, reference materials, charts or graphics.

GLs Change Action

Suggested Change	Recommended Action	Authorized by	Date

Director for SSI Directorate**: _____Date: _____**

The following table helps to track initial issuance of the guidelines and subsequent Updates/Versions and Revisions (Registration of Amendments/Updates).

Revision Register

Version/Issue/Revision No	Reference/Revised Sections/Pages/topics	Description of revision (Comments)	Authorized by	Date

1 BACKGROUND

Basic software's like Global Mapper, Google earth, different GIS software's, DEM are useful in planning and site assessment. Global Mapper is the easiest user interface software used for data management including organizing, generating contours, layout design, generating & exporting profiles, etc.

Engineering and water management software's incudes

- Arc GIS and Arc Hydro: This is a very powerful software used for analyzing vector and raster images, studying and delineating the catchment area, generating contours and profiles, mapping the layout, etc.
- AutoCAD: This software is used for designing layout, plan and cross sections of irrigation infrastructures, generating profiles, etc.
- Z-profile: this software used for generating profiles for which design was done initially on excels.
- Eagle Point: This software is a powerful tool for generating contours, designing layout of irrigation infrastructures, design plan and cross sections of irrigation canals and structures, etc.
- Geoslope/Geo studio is mainly used for stability analysis
- CLIMWAT 2, LocClim 1.0, CROPWAT 8, are used in analysis of climate input data and water requirement of irrigated crops
- MS Project and Primavera are used for scheduling and controlling study and design as well as construction activities of SSIP
- Other software's like SWAT, Water Cad, SAP, SMADA, Hydrochan are also in SSID

Software's used in geology, Engineering geology & hydrogeology are: Geo studio (including all integrated tools like Slope//w, SEEP/W, SIGMA/W, Quake/W) and other geotechnical software's like Starter, Stero plot. Auto cad is also equally important for the geologists to prepare the sections.

Software's used in Topo surveying are: are AutoCAD, Arc GIS; Global Mapper, Auto Cad, Golden Software (Surfer), Stereo net, Strata for data compilation and topo mapping.

Software's used in Socioeconomics are; SPSS16 and SPSS 20, STATA

We will discuss here in this specific Guideline selected software's. The other application software's will be discussed in respective subjects of the Guidelines.

2 MANUAL FOR EAGLE POINT

2.1 BASIC KNOWLEDGE OF EAGLE POINT

2.1.1 The eagle point software suite

Eagle Point software is the most powerful, yet easy-to-use, civil engineering, surveying and landscape design software's available. By combining the power of AutoCAD the software employs methods identical to conventional methods used in hand calculations.

The software it is not intended to replace the presence of qualified surveyor, designer or drafting personnel. Instead, the software enlarges the capabilities of qualified professionals. Therefore; a solid working knowledge on the principles of Surveying, Hydrology, Road, Civil and Water Engineering expected by the user.

2.1.2 Purpose

Eagle Point is application software that is used to aid most of Land Development problem including:

- Watershed Modeling
- Road Design
- Storm and Sanitary Sewer Analysis
- Landscape Design
- Pressurized Irrigation Design
- Site Planning, Design and Analysis
- Intersection Design
- Quantity takeoff and so on…

2.1.3 Scope

This guideline covers the basic procedures for Surface Modeling, Roadcalc for irrigation design and Drafting (Case study of Petu SSI Project).

2.1.4 Computer requirements

Pentium III with Microsoft, Windows 2000 and above, (recommended: Intel processor with 1GB of RAM), 1024x768 display. AUTOCAD software Version 2000-2007

2.2 CASE STUDY FOR PETU SURFACE MODELING

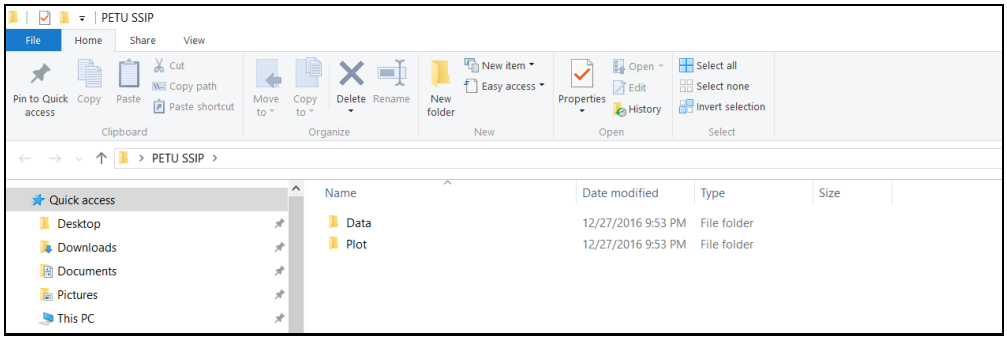
2.2.1 Preparation of working environment

This practical exercise will help how to prepare topographical map using Eagle point surface model package for Petu SSIP.

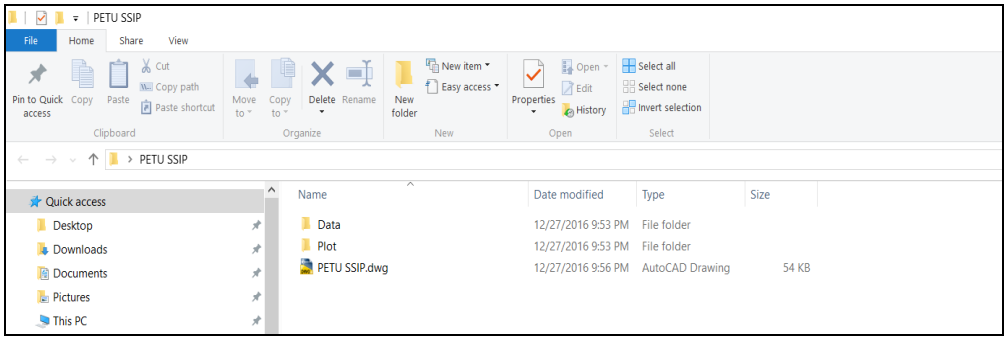
2.2.2 Getting started

Defining a project

- Create project folder anywhere and Name it PETU SSIP
- Create two folders within it and name them as Data, Plot

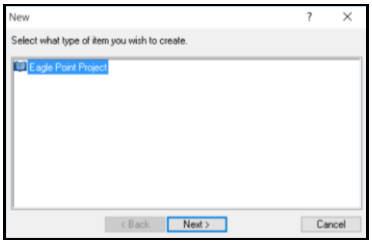


- Open new AutoCAD file and save it in your project folder as PETU SSIP

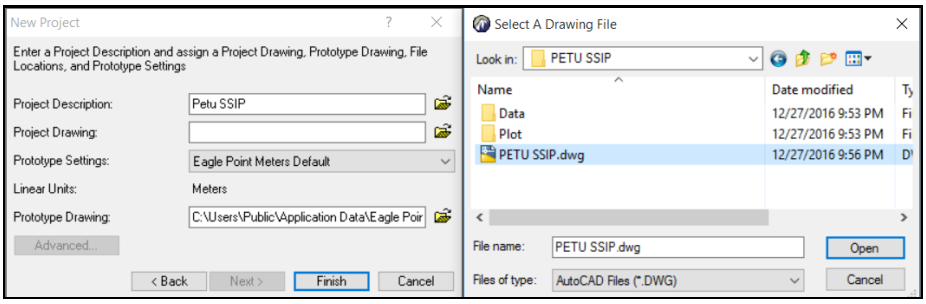


- Run the program from start menu and the following dialogue will box popup

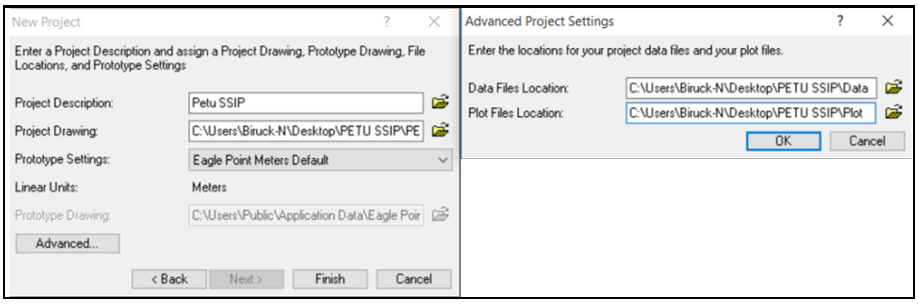
- Click on the Create New Project
- Click next by selecting eagle point project



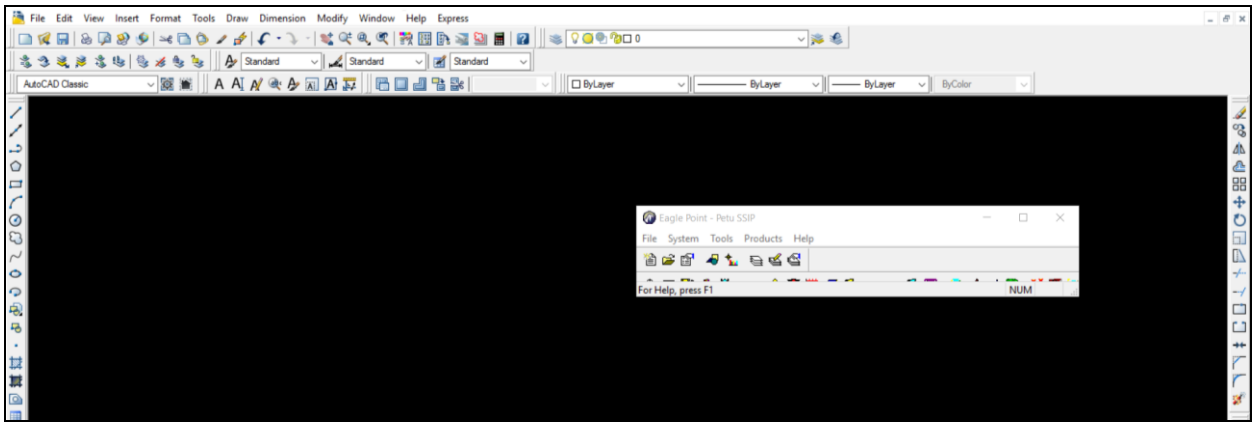
- In the project description edit box fill it as Petu SSIP
- In project drawing edit box and click open the previously saved AUTO CAD file



- Select Eagle point Meters default from the prototype setting drop list
- Click on the Advanced tab and select Data and Plot folders for the respective dialogue



- Click finish button and Click ok
- Eagle point software then launches AutoCAD
- The Eagle point software menu bar displays as follows



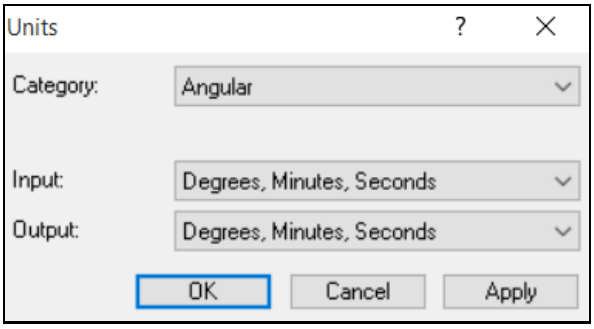
2.2.3 *Project setting*

I. Units

Select **units** from the system pull down menu to display the unit's dialog box. Units are going to be set for the project are adjusted as follows

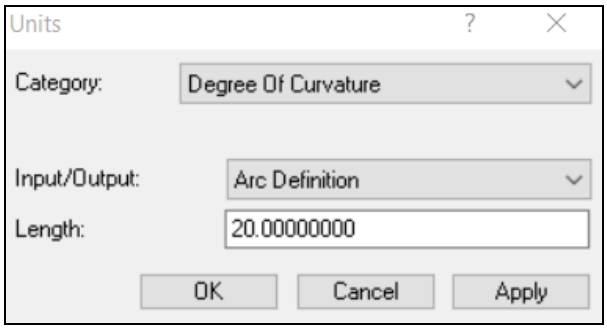
a) Angular

- Select angular from the category drop list
- For both input and output make sure that degree, minutes, seconds are selected
- Clicks Apply and OK



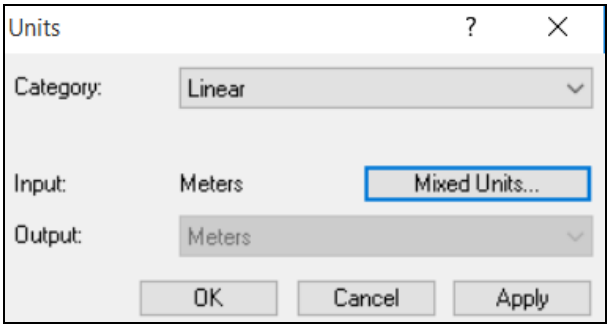
b) Degree of curvature

- Select degree of curvature from the category dropdown list
- Select Arc definition from the input/output drop list
- Type 20 in the arc definition from the input /output list
- Clicks Apply and OK



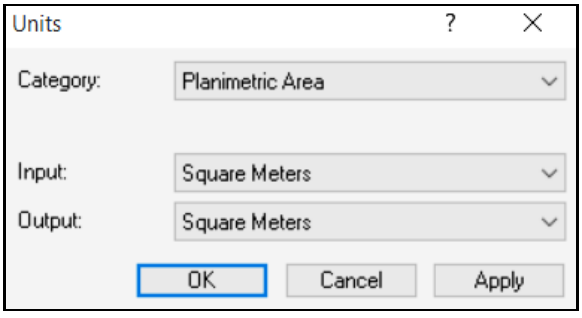
c) Linear

- Select linear from the category drop list in the unit's dialog box



d) Plan metric area

- Select plan metric Area from the category drop list.
- Select both input/output and make sure square meters are selected
- Click Ok to save the changed

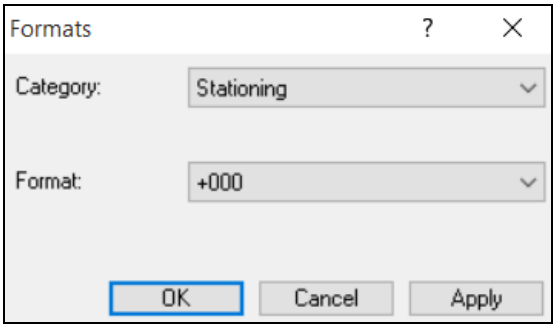


II. Formats

Select Formats from the system menu to display the formats dialog box

a) Stationing

- Select stationing from the category drop list in the format dialog box
- Select +000 from the format drop list
- Clicks Apply and OK

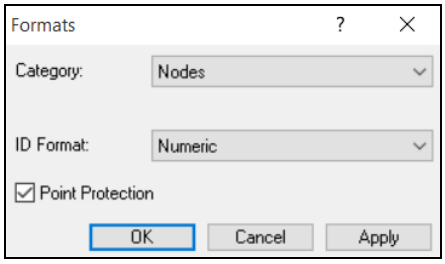


b) Horizontal Direction

- Select horizontal direction from the category drop list in the format dialog box.
- Select North Azimuth from the format drop list
- Clicks Apply and OK

c) Nodes

- Select nodes from the category drop list in the formatted dialog box.
- Select Alpha Numeric from the ID format drop list.
- Make sure point protection * is toggled on.
- Clicks Apply and OK

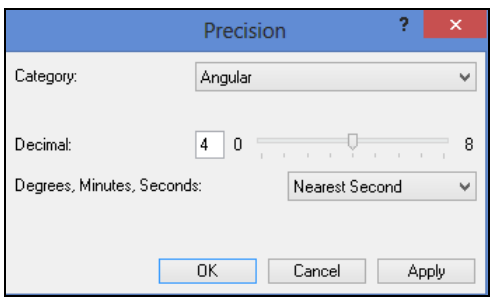


III. Precision

Select precision from the system menu and keep default values

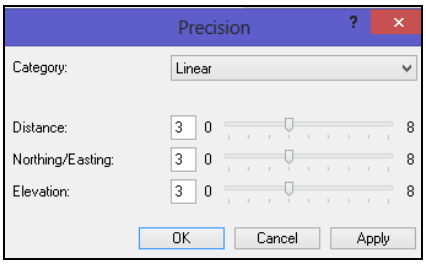
a) Angular

- Select angular from the category drop list
- Slide decimal slider to 4.
- Select nearest second form Degree, Minutes, Second drop list
- Click apply



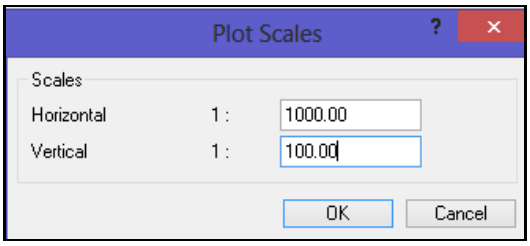
b) Linear

- Select linear from the category drop list
- Click apply to accept the default value of 3 decimal places.
- Select also plan metric area, dry volume, wet volume, station offset consequently and apply the default value of 3 decimal places precision respectively.



IV. Scales

- From the Eagle point menu bar, select tools-plot scales
- Type 1000 in the horizontal scale field
- Type 100 in the vertical scale field
- Click OK

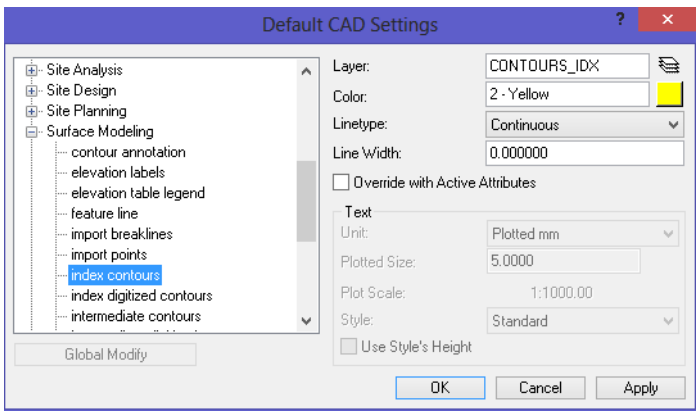


V. CAD settings

Eagle point provides a tool whereby you can set default CAD parameters for the majority of CAD objects that are constructed by eagle point.

a) Default CAD settings

- Select system –Default CAD settings.
- Highlight the Surface Modeling and then Index Contours entry
- Type the size and select the color of the line (index contours) you wish to display in CAD entry.
- Type the size and select the color of the line (intermediate contours) you wish to display in CAD entry
- Click on OK



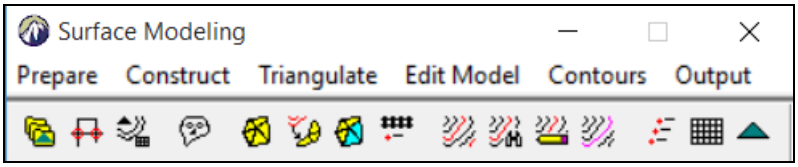
2.2.4 Surface Modeling

Surface modeling is a one of eagle point package that models the surface you are working on by performing different manipulation of the raw data from survey, DEM and DTM by creating three dimensional grid formations on the terrain.
Surface Modeling also allows users to create a model from topographical information such as points, break lines or contours. From this surface model, you can create contours, annotate contours, create rectangular grids and place spot elevations.

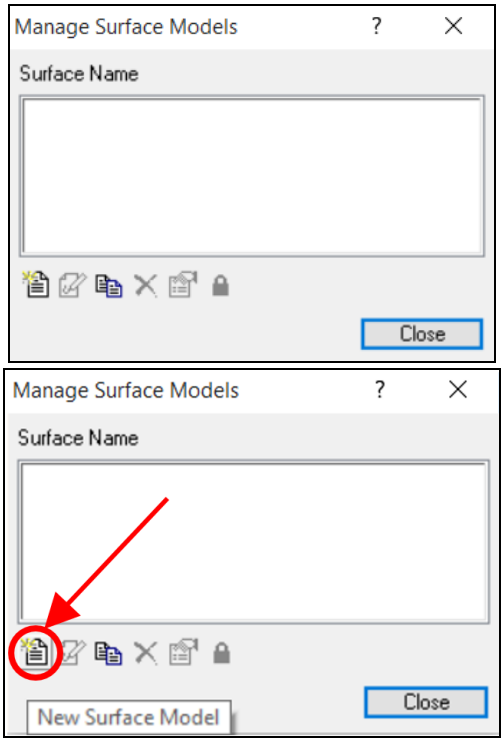
2.2.5 Setting up a surface model

Creating and defining a new surface model, requires the following procedures

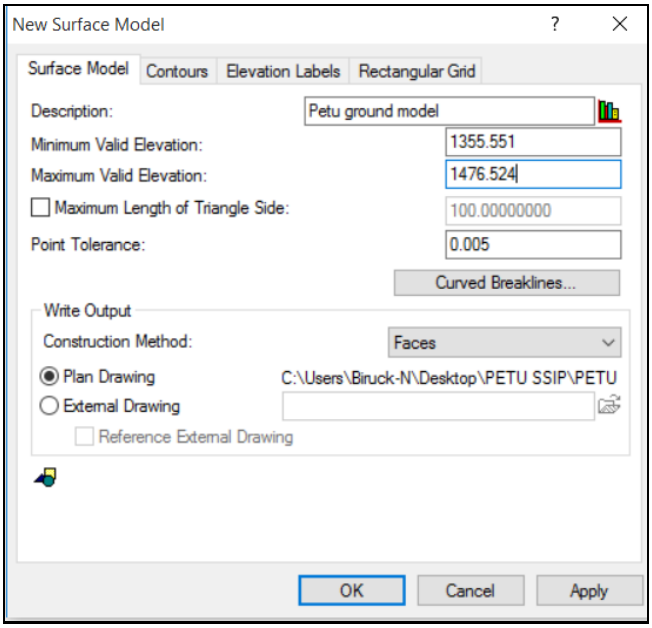
- In eagle point, select Products-Surface modeling



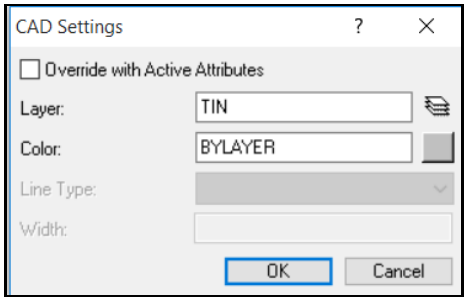
- In surface modeling, select prepare-manage surface models



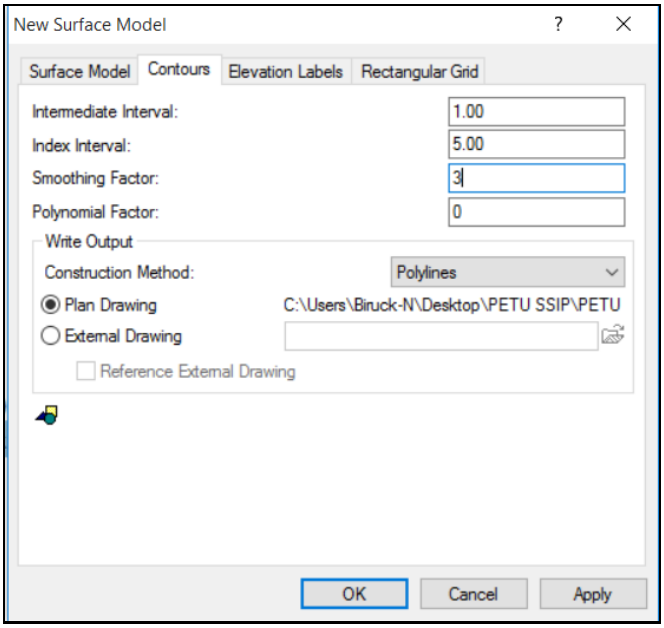
- Click on the new surface model icon then the new surface model dialog box displays



- Type Petu ground model in the description edit filed.
- Minimum elevation from Surveying data is 1355.551
- Maximum elevation from Surveying data is 1476.524



- Click on the CAD setting icon, the CAD setting dialog box displays.
  - Layer -TIN
  - Color - by layer
- Click Ok
- Click on apply in the new surface model dialog box and then OK
- Click Contour setting Tab icon.

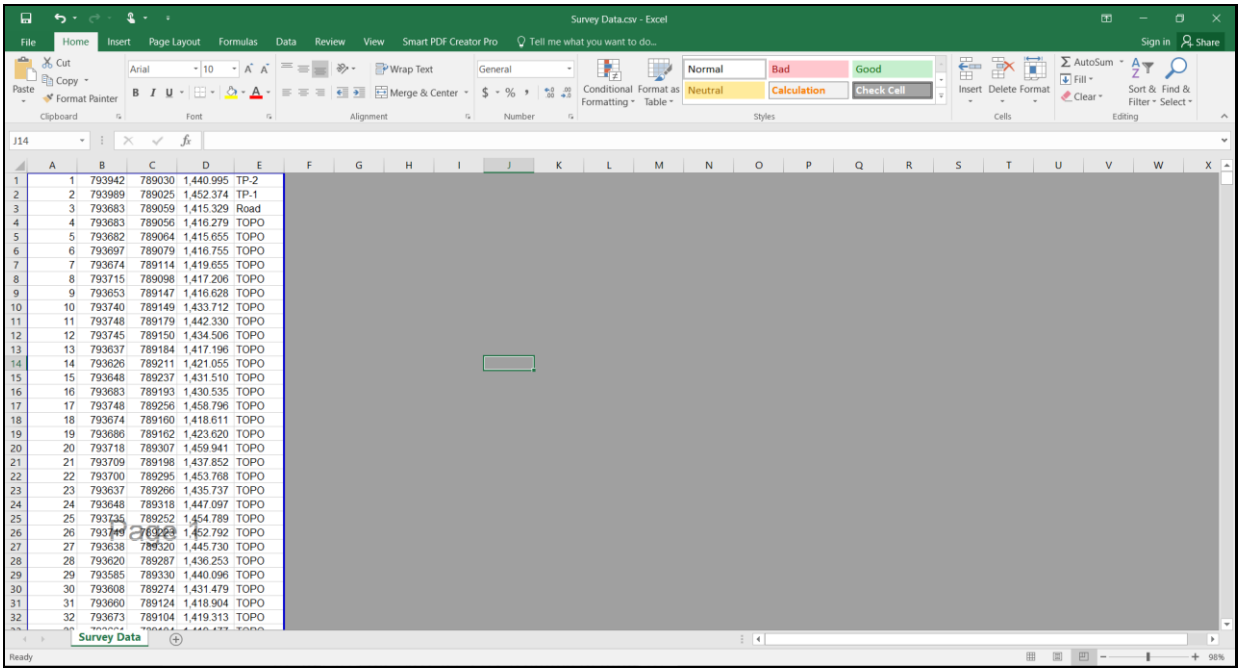


- Intermediate Interval = 1
- Index Interval = 5
- Smoothing Factor = 3
- Set the remaining values of the setting as:
  - Index contours
    - Layer IDX-contours
    - Color 9
    - Line type by layer
    - Width 0
  - Intermediate contours
    - Layer contours
    - Color 8
    - Line type by layer
    - Width 0
- Click on apply in the new surface model dialog box.
- Keep the rest as default.
- Click apply and OK
- Click close

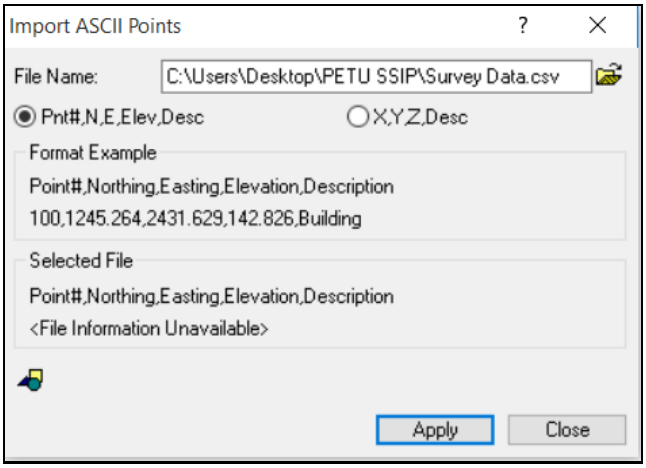
2.2.6 *Importing Survey Data*

- Survey data's can be imported from an excel file, an instrument, global mapper, GPS, etc as eagle point have different option to import the data. For this training purpose, you are going to import the survey data from an excel file which is saved in CSV file format.

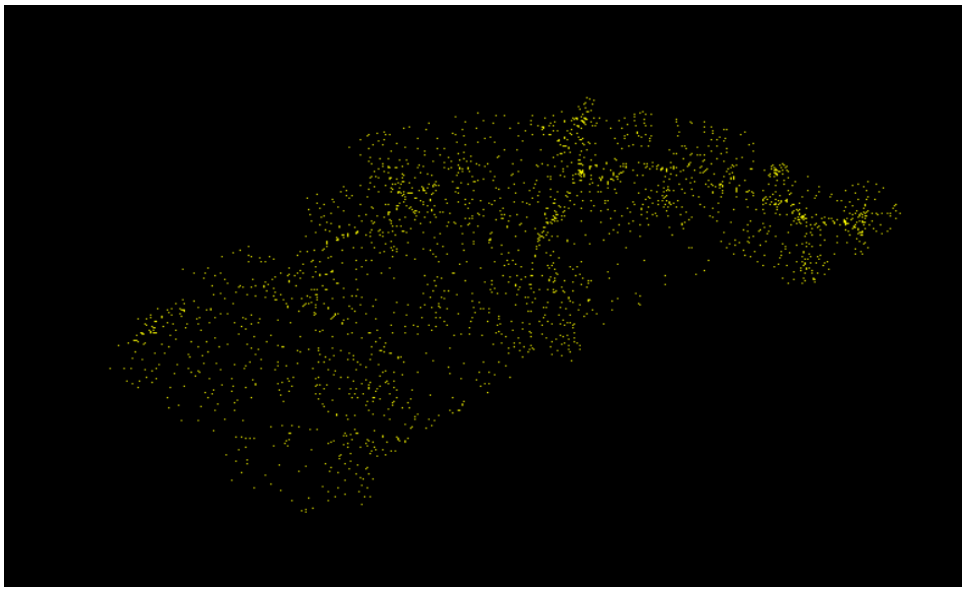
- Open excel (Survey Data.CSV) and view your data down loaded from a total station. The survey consists of information with point#, Easting, Northing, Elevation and description.



- In eagle point, surface modeling- select Prepare-Import ASII-points
- Browse the survey file to the location you have saved
- Click on the open bottom
- Check the button point#, N, E, description (point code)
- Click on apply in the import ASCII point dialog box
- Click on close



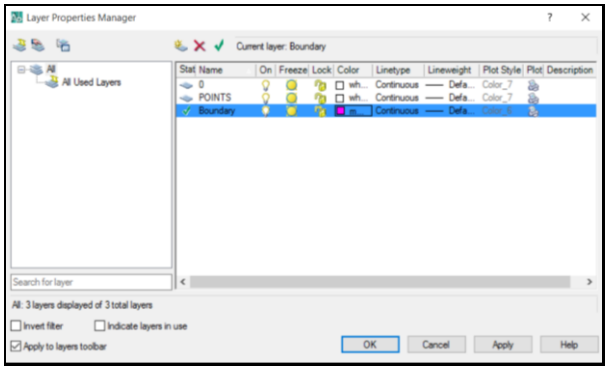
- Type Z in the command line then e to view the imported data



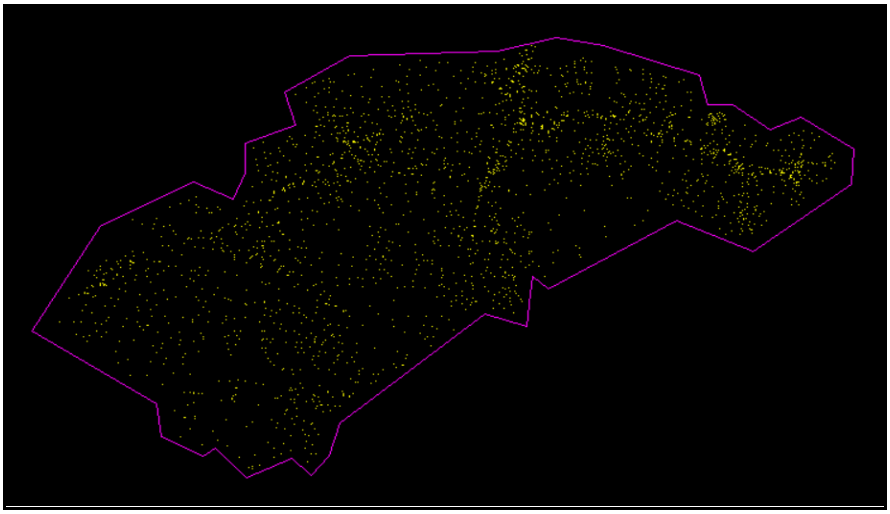
2.2.7 Creating model boundary

Draw a boundary around the data and then predefine it for use in the surface model. To create a predefined boundary for the surface model,

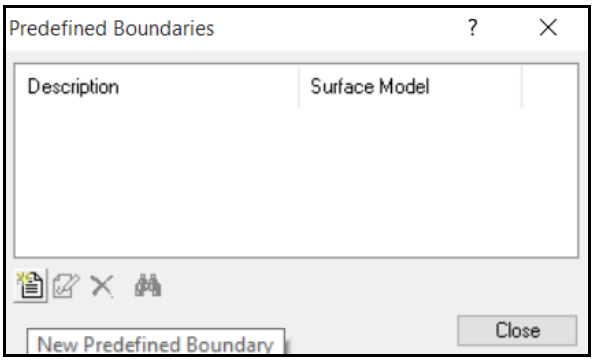
- In Auto CAD, create a layer called Boundary line and make it current



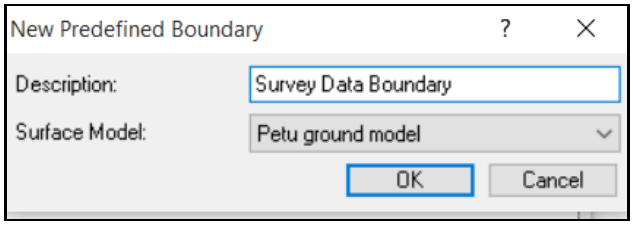
- Select the poly line command.
- Draw the boundary around your data



- In surface modeling, select Prepare-Predefined boundaries command

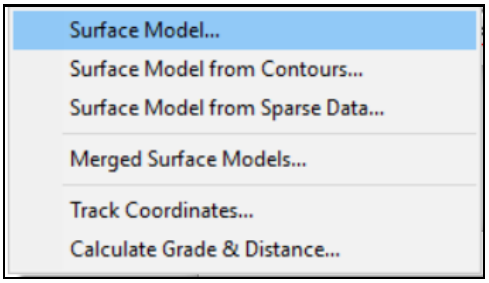


- Click on the new predefined boundary icon.
- Pick the boundary object you drew earlier
- Type Survey Data boundary in the description edit field
- Select Petu ground model from the surface model drop list
- Click ok and close

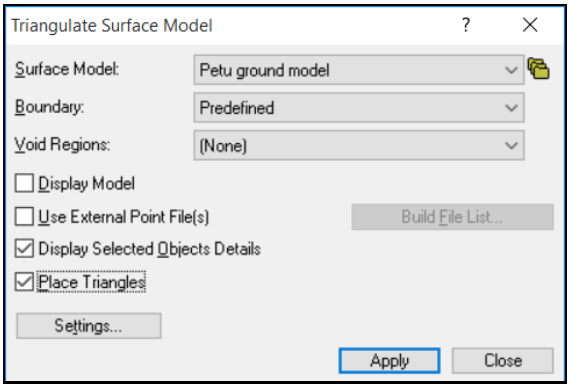


2.2.8 *Triangulate a surface model*

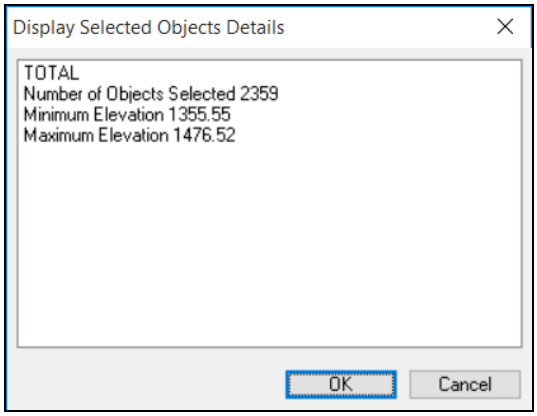
- In surface modeling, select triangulate-surface model
- Select ground model from the surface model drop list



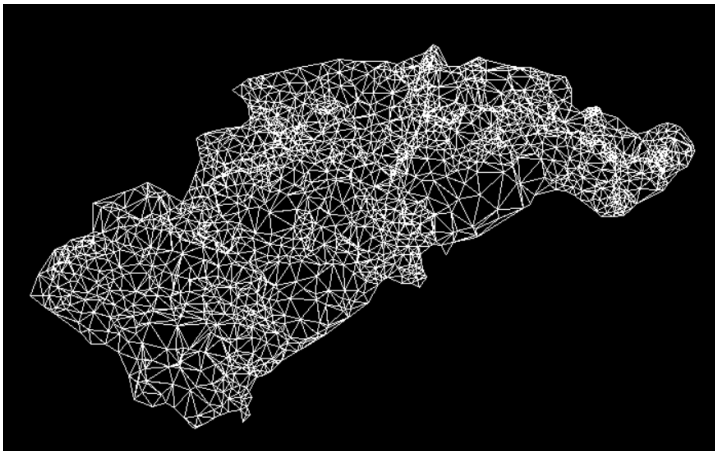
- Select predefined from the boundary drop list



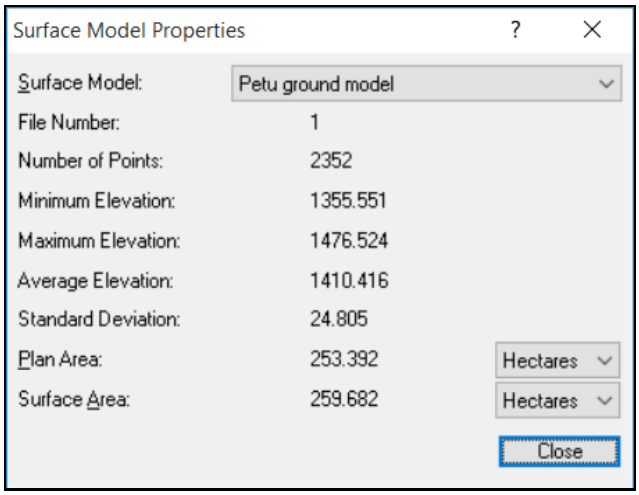
- Make sure the display selected objects details and Place Triangles are toggled on
- Click on apply in the triangulate surface model then close
- Select the area to be triangulated by selecting the bounded data in the CAD graphic



- Click Ok display selected objects details to proceed triangulation
- The result of Triangulation should look like this

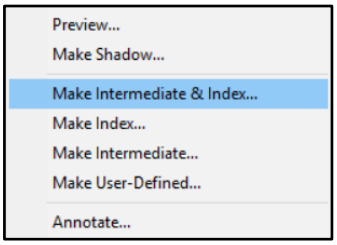


- In surface modeling, select Prepare-Manage surface model.
- Click on the properties for surface model icon. The surface model properties dialog displays a variety of information for the model as follows.
- Click on close

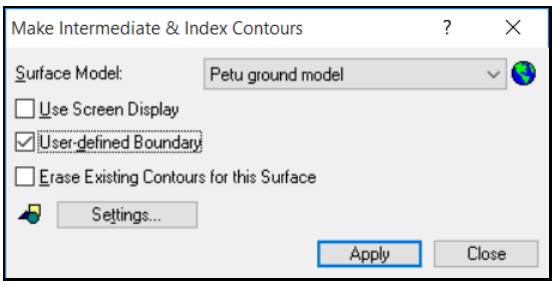


2.2.9 Creating contours

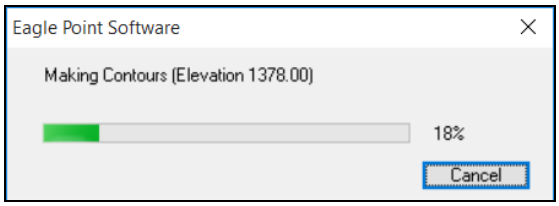
- In Surface modeling, on contours tab select Make intermediate and index



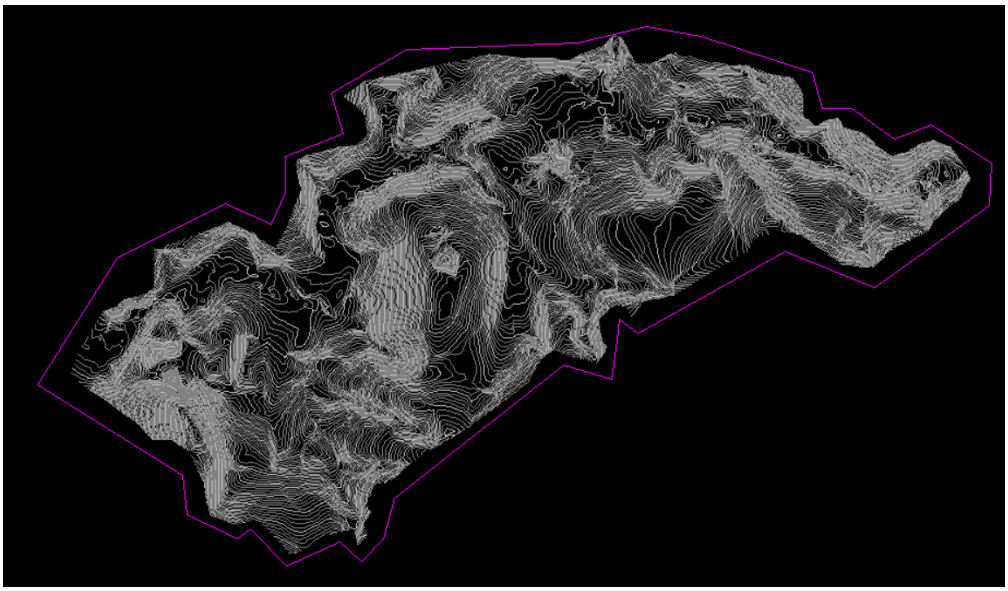
- Make sure the Petu ground model is selected from the surface model drop list.
- Toggle on only User defined boundary



- Click on apply on the make intermediate and index contours in the CAD graphic
- Select the boundary you have prepared earlier
- Eagle point will execute the process



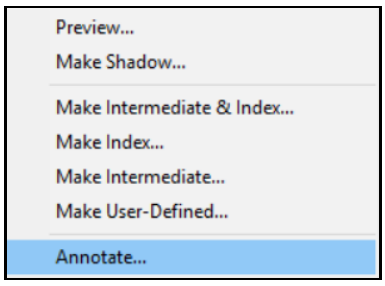
- The processed contour should look like this



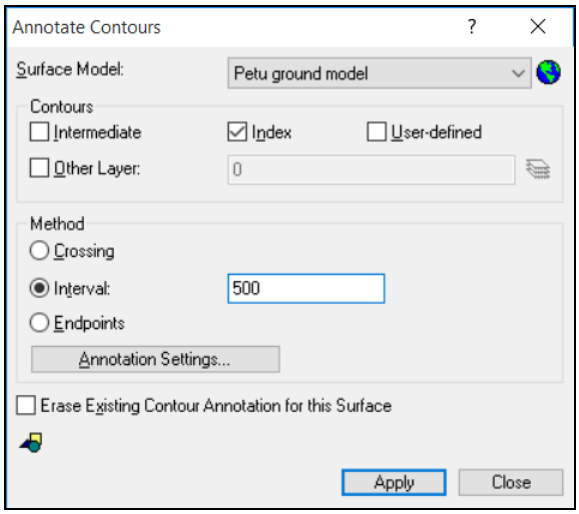
2.2.10 Annotating contours

Contour annotation is a process that is used label each contour and makes the user to easily recognize the terrain types in CAD graphic.

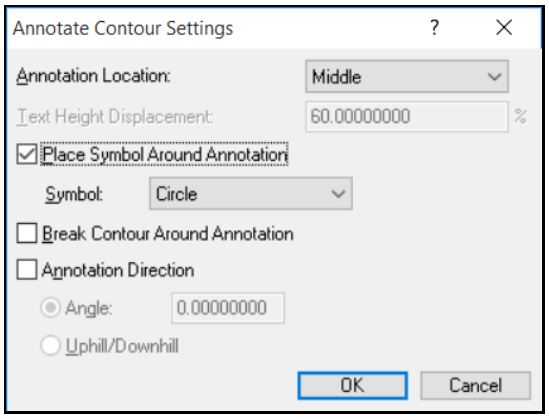
- In surface modeling select Contours- Annotate



- Make sure the Petu Ground Model is selected

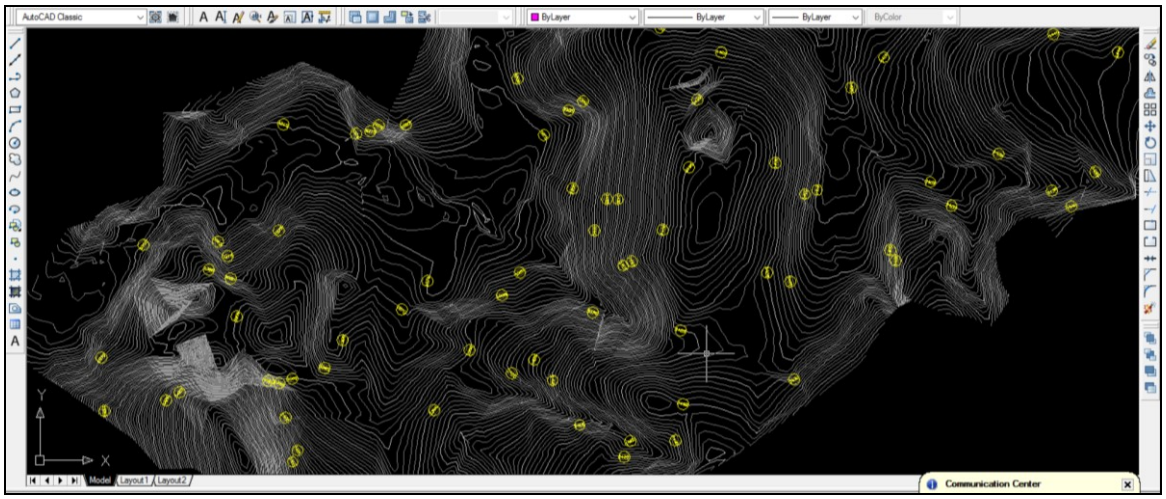


- Make the index toggle on
- Select the Interval option in the method sections
- Interval = 500
- Click on the Annotation setting button.



- Make sure middle is selected from the annotation drop list.
- Toggle on Place Symbol Around Annotation
- Toggle off the other option.
- Click on OK
- Click on apply in the annotate contours dialog box.
- Select the contour to annotate in CAD graphics

- Click on close.
- The result should look like this



- Zoom into the area that was annotated to view the contour elevation.

2.3 CANAL PROFILE EXTRACTION FROM IRRIGATION SYSTEM LAYOUT

In surface Modeling we have modeled the topographical features of the area of our interest (Topo of the Gross command area). Canal alignment and other important tasks are worked on the surface model as practical implementation of our canal design on the real ground. Precise representation of the ground is imperative prior to any design activity.

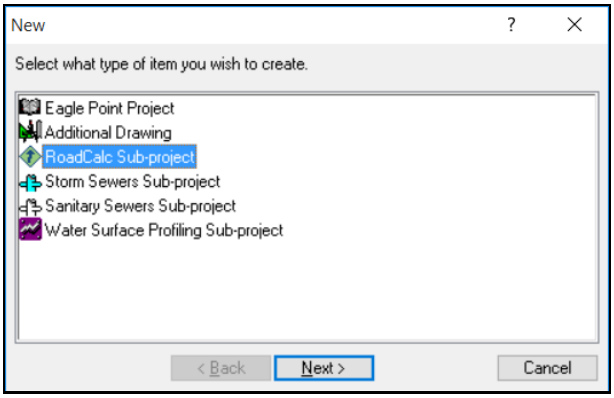
Designing an irrigation Canal is to be initiated by selecting the centreline of the alignment using the surface model created. The RoadCalc package found in Eagle point Product menu will be utilized to facilitate canal design.

2.3.1 Getting started

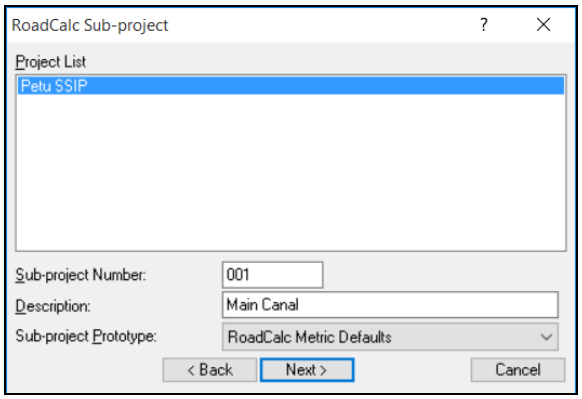
Roadcalc is the step to be started after you have successfully prepared the surface model and the step to be followed to initiate the launch RoadCalc is as follows.

2.3.2 Creating a roadcalc subproject

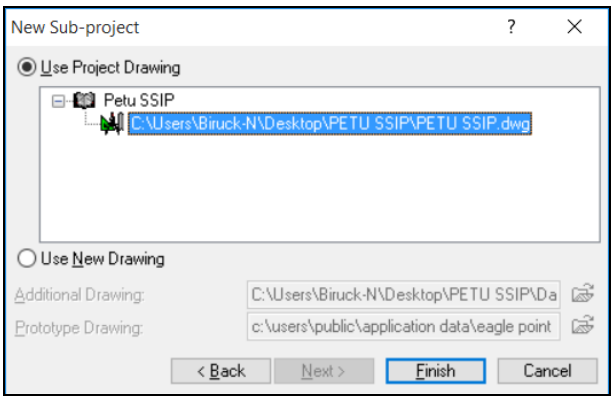
- In eagle point Select File-New
- Select Roadcalc subproject from the list box



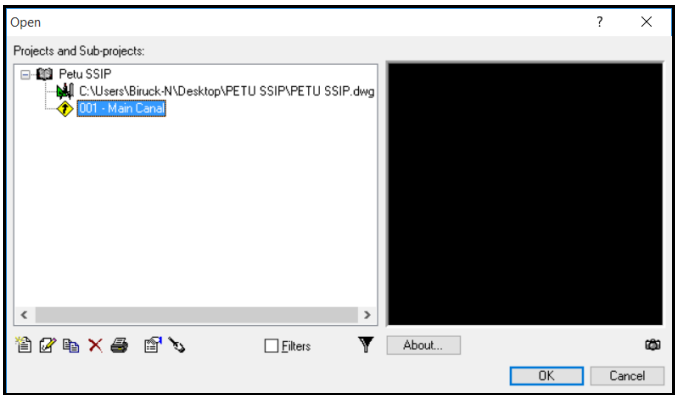
- Click on next
- Type MC in the project number edit field
- Type Main Canal Design in the description edit field
- Select RoadCalc metric defaults from the subproject prototype drop list
- Click on Next



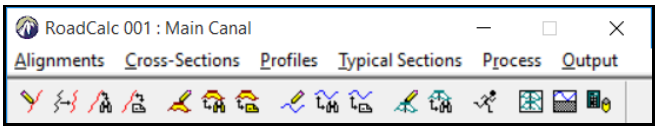
- Select Petu SSIP from the project list box
- Click on Finish



- To launch Roadcalc, select the Main Irrigation design project and click OK

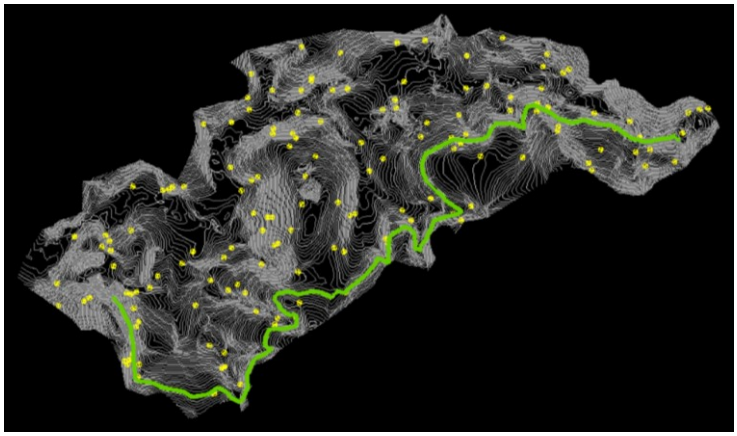


- The Roadcalc menu displays

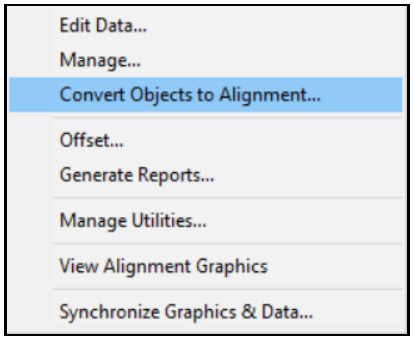


2.3.3 Canal alignment & profile

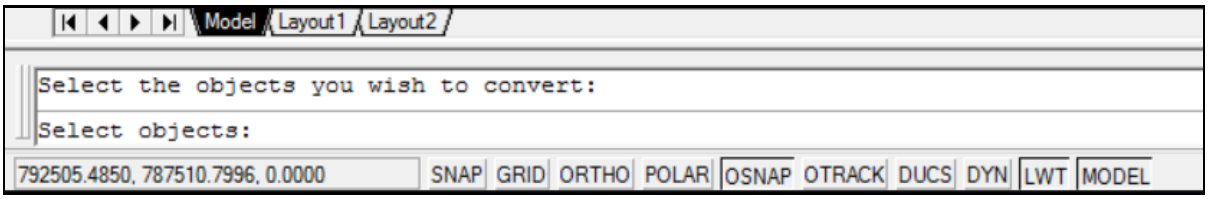
Eagle point software facilitates to view original ground profiles so that we can export it to excel to design Top bank, Full supply and Bed levels of a canal.
So the design profile of our canal alignment is to be created as allows



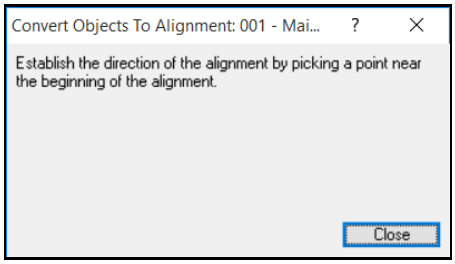
- The green line is the main canal route selected during irrigation system layout so we start by making alignment using it
- From Alignment tab select Convert Objects to Alignment



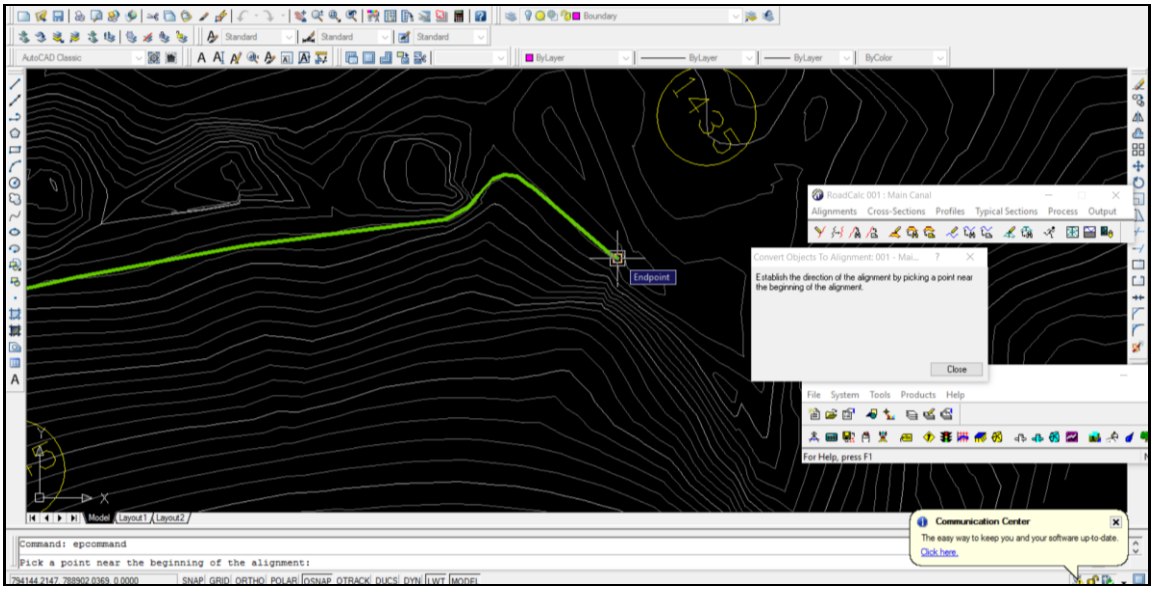
- From the CAD graphics you will be asked to select the object



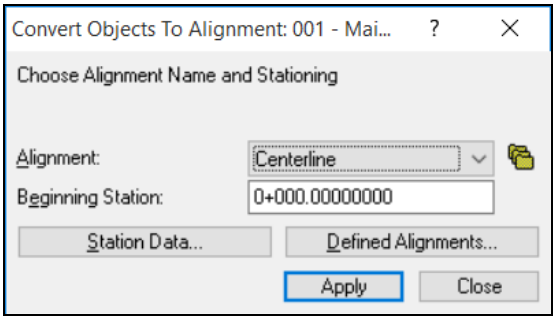
- Left Click on the main canal line and press enter
- Inquiry box will pop up to establish the direction of the alignment



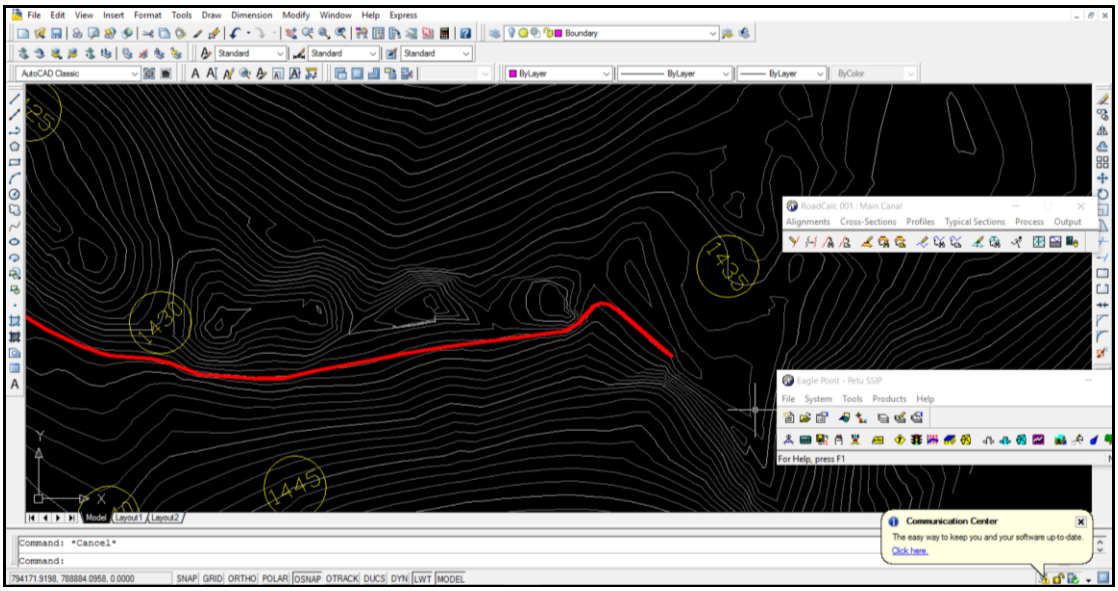
- Click on the station that is going to be the beginning 0+000



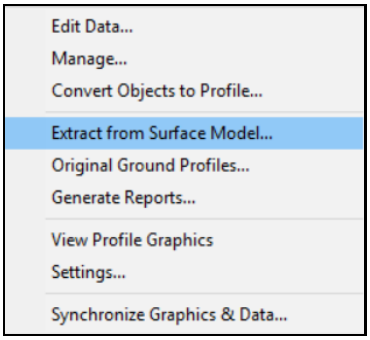
- Keep the default values if it suite you then click Apply



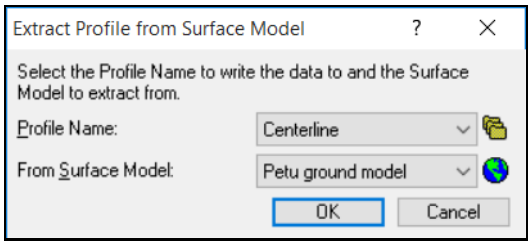
- The green line will change red color indicating the conversion is successful



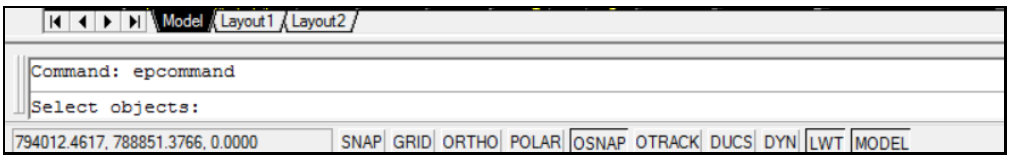
- Go to profile tab and select Extract from Surface Model



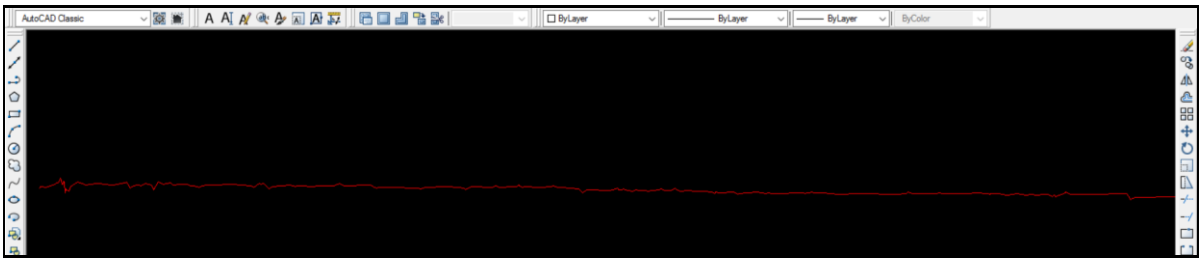
- Select centerline for Profile Name & Petu ground model from drop down list, then Ok



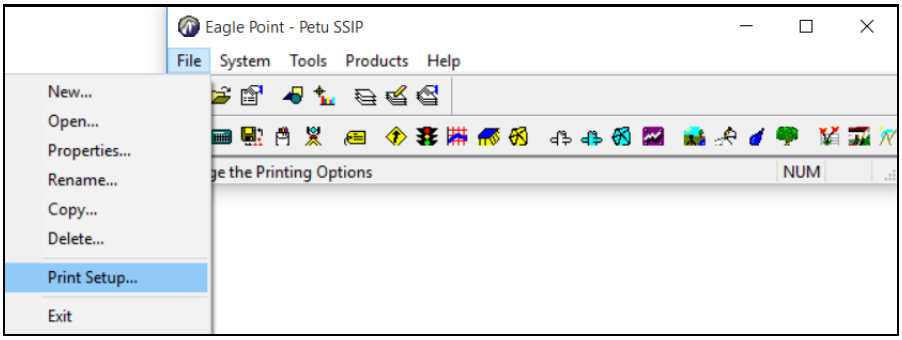
- Again you will be asked to select the object in command line of CAD



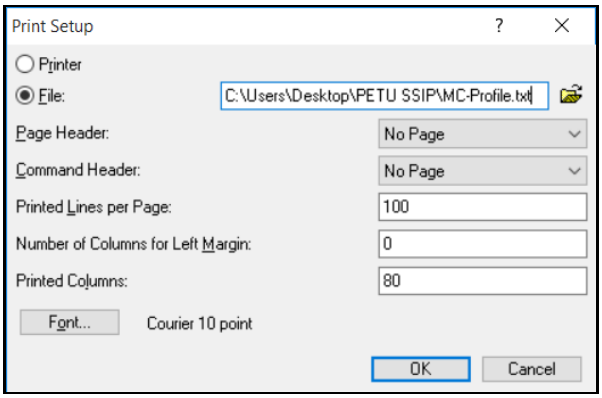
- Left click and RoadCalc will draw the canal Profile



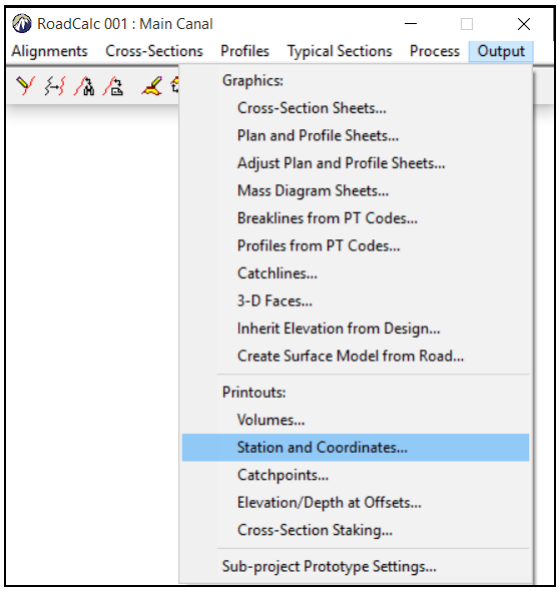
- In order to extract X, Y and Elevation values we have to prepare black notepad file so the results can be printed on it. To do so
- Create Notepad file, name it as MC-Profile, Save it in a place which suites you
- Go to file menu and select Print Setup



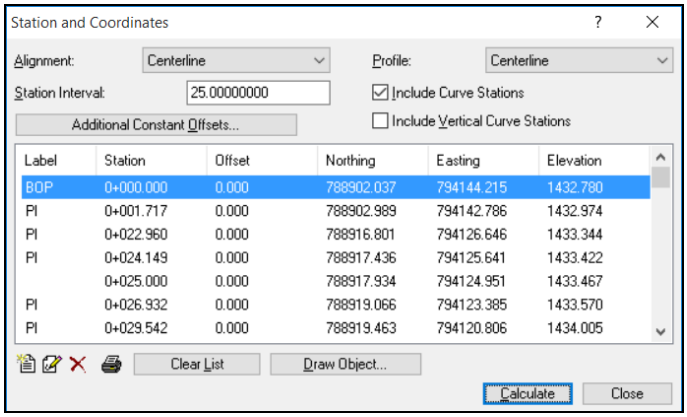
- Select the MC-profile.txt file by clicking the folder icon placed at top right hand side and leave the rest as default



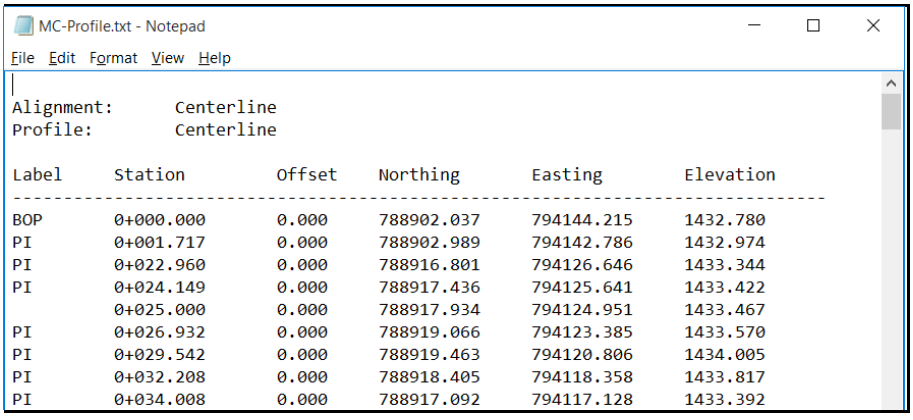
- Now go to output tab of RoadCalc and select Station and Coordinates



- Make sure for both Alignment and profile centerline is selected
- Enter 25.0 at Station interval
- Toggled on include Curve Stations only
- Click Clear List and After that click Calculate



- Finally, to export the data into the note pad file we have previously saved click the printer Station icon
- Open the note pad file and view the output file. Utilizing this file, you can design the canal using the canal design template.

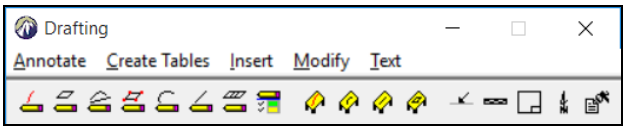


2.4 DRAFTING CAD GRAPHICS

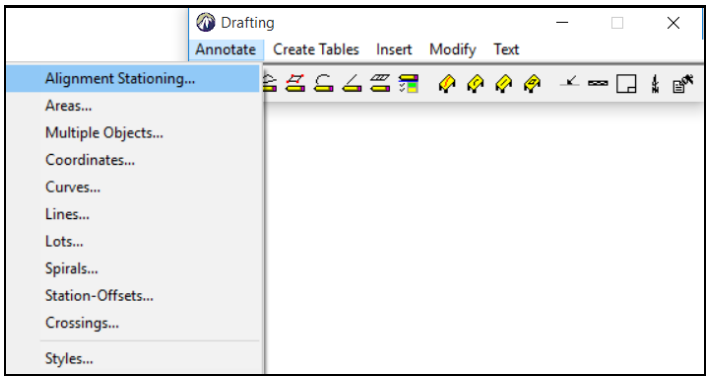
Drafting one of eagle point package that provides access to Eagle Point Dynamic Annotation and associates text with objects. With this attachment, objects may be modified and the associated text is automatically updated to match the modified object. In this section you will cover Annotate alignment stationing and Draw a coordinate grid.

2.4.1 Annotate alignment stationing

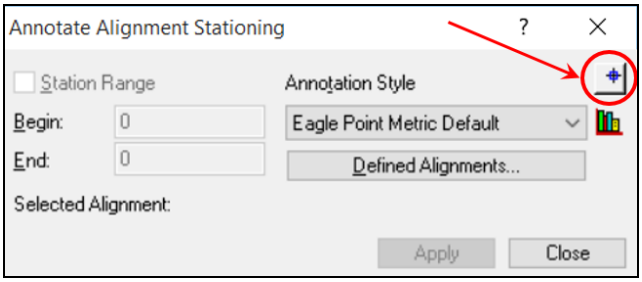
- In eagle point, select Drafting



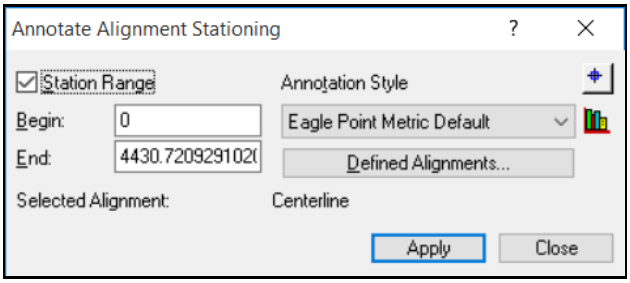
- Click Annotate and select Alignment Stationing



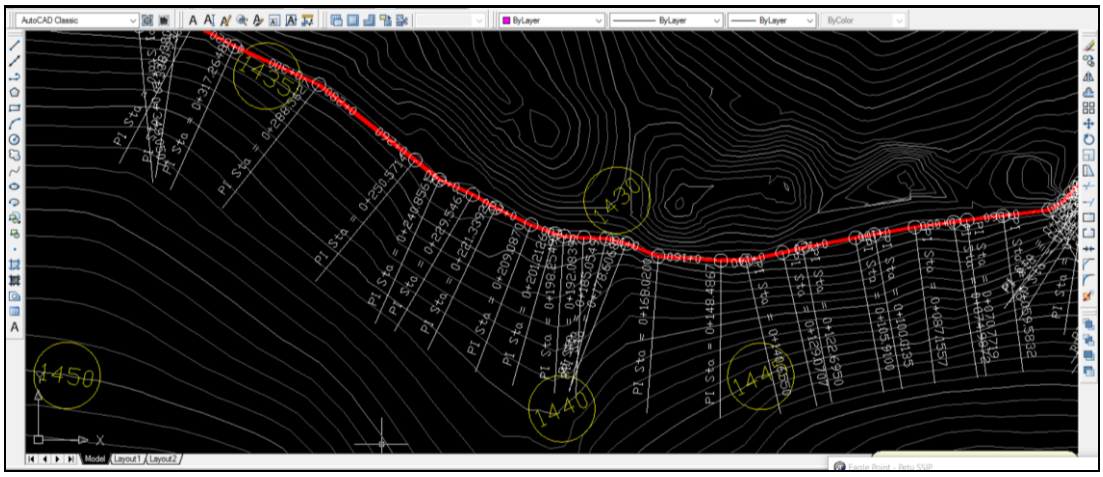
- Click on the Pick in CAD icon to select the Main Canal



- The Begin and End Station Range is filled in with the starting and ending stations automatically



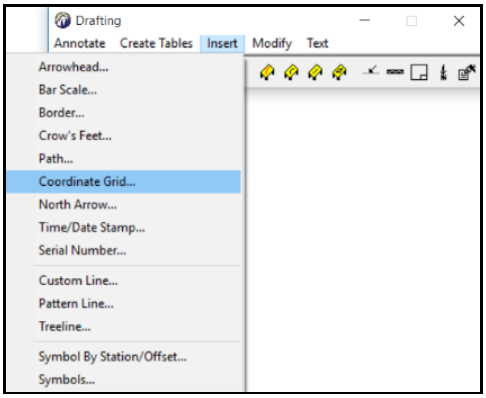
- Click on Apply to annotate the alignment stationing
- The result should look like this



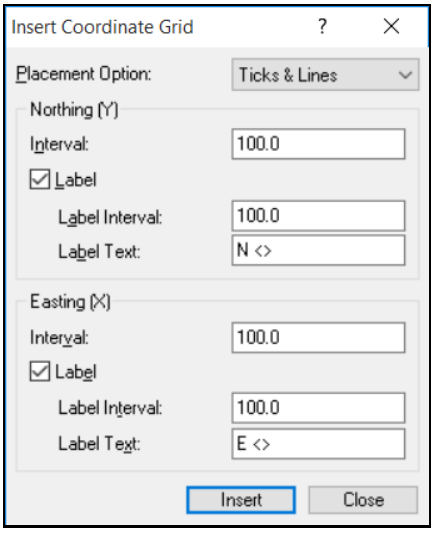
2.4.2 Draw a coordinate grid

The Insert Coordinate Grid command allows you to place ticks, lines or both ticks and lines into your CAD graphic at a specified interval.
To insert a coordinate grid into your CAD graphic, complete the following steps:

- Click Insert tab and select Coordinate Grid

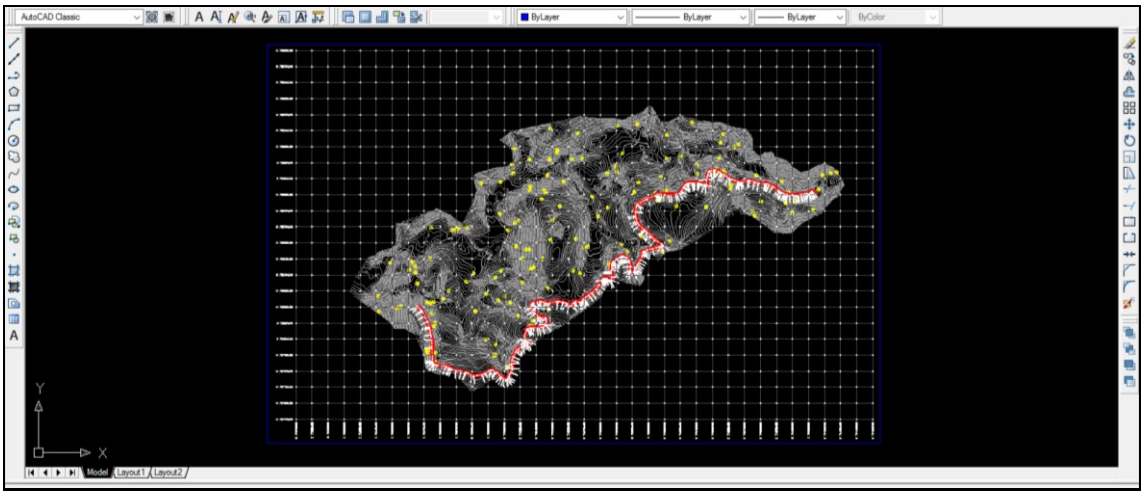


- Select Placement options as Ticks & Lines from drop list



- Northing (Y) interval =100
- Lable Interval =100
- Easting (X) interval =100

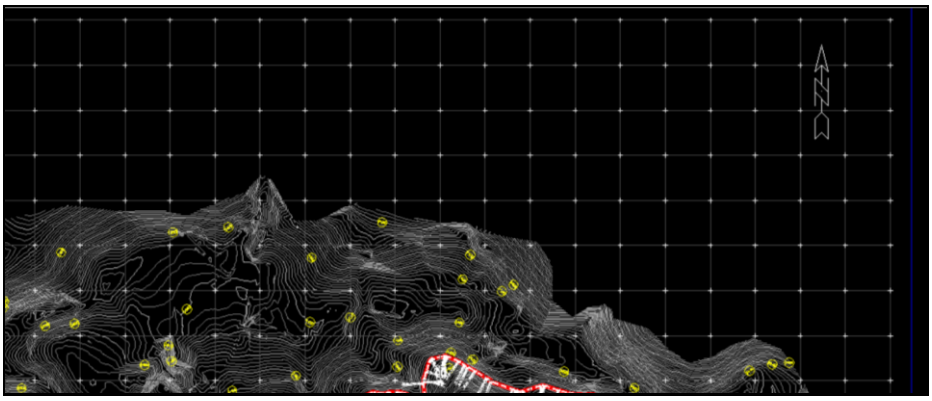
- Lable Interval =100
- Leave the rest as default
- Click on the Insert button to insert the coordinate grid
- Graphically select the location for the lower left corner of the coordinate grid
- Graphically select the location for the upper right corner of the coordinate grid
- The result should look like this



2.4.3 *Insert north arrow*

The Insert North Arrow command allows you to place a North arrow into your CAD graphic.

- Click Insert tab and North Arrow
- Enter the scale factor for the North arrow =5
- Click on the Insert button to insert the North arrow
- Drafting prompts you to select a location for the North arrow.
- Graphically select the location at which you want the North Arrow placed



You are done!!!

3 MANNUAL FOR HEC-RAS

3.1 BASIC KNOWLEDGE OF HEC-RAS

3.1.1 The Hec-Ras software suite

The Hydrologic Engineering Center River Analysis System (HEC-RAS) is intended for calculating water surface profiles for steady gradually varied flow in nature or man-made channels.
HEC-RAS is an integrated system of software, designed for interactive use in a multi-tasking, multi-user network environment. The system is comprised of a graphical user interface (GUI), separate hydraulic analysis components, data storage and management capabilities, graphics and reporting facilities.
The HEC-RAS system ultimately contain three one-dimensional hydraulic analysis components for: (1) steady flow water surface profile computations; (2) unsteady flow simulation; and (3) movable boundary sediment transport computations.

3.1.2 Purpose

HEC-RAS is application software that is used to model almost any Hydraulic model problem including:

- River Hydraulic Analysis and its inline structures
- Storage areas
- Irrigation Canals and its Structures
- Time series and elevation controlled gates
- Unsteady floodway analyses
- Dam break analyses and levee breaching
- Pump stations and navigation dams
- Sediment transport capacity

Other Advantage of HEC-RAS

- Useful tables, graphs, and cross-section and profile plots for viewing results
- Animation of simulations
- Detailed Investigations and alternative evaluations
- Design Studies
- Real-time forecasting

3.1.3 Scope

This guideline covers the basic procedures for Diversion weir, Irrigation canal and selected Irrigation canal structures Modeling (Case study of Petu SSI Project).

3.1.4 Computer requirements

Pentium III with Microsoft, Windows XP, Vista or Windows 7, (recommended: Intel dual-core processor with 1GB of RAM), 1024x768 display (recommended: 1280x1024 or higher).

3.2 CASE STUDY FOR PETU DIVERSION WEIR MODELING

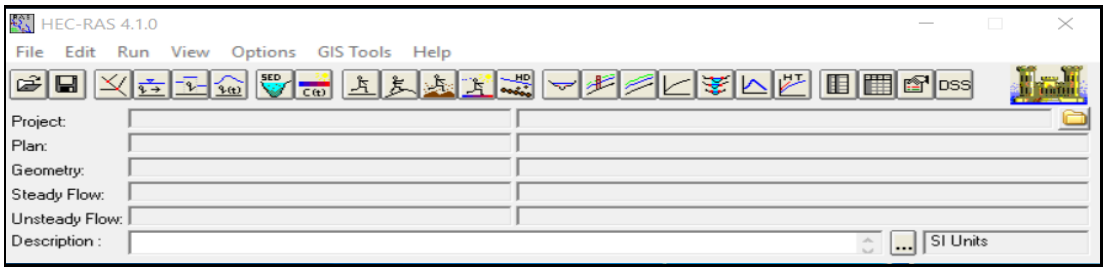
3.2.1 Preparation of working environment

This practical exercise will help how to model diversion weir using head work for Petu SSIP.

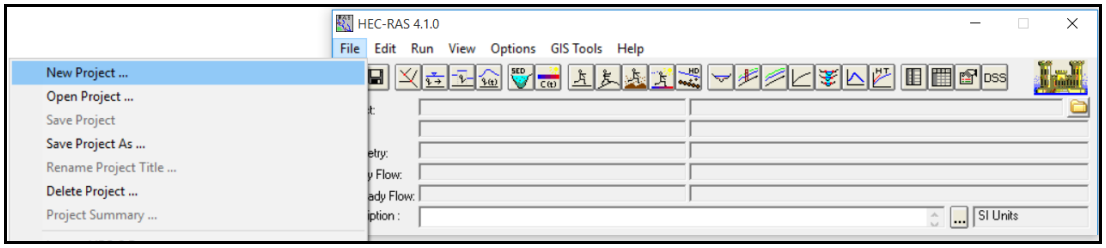
3.2.2 Getting started

Defining a project

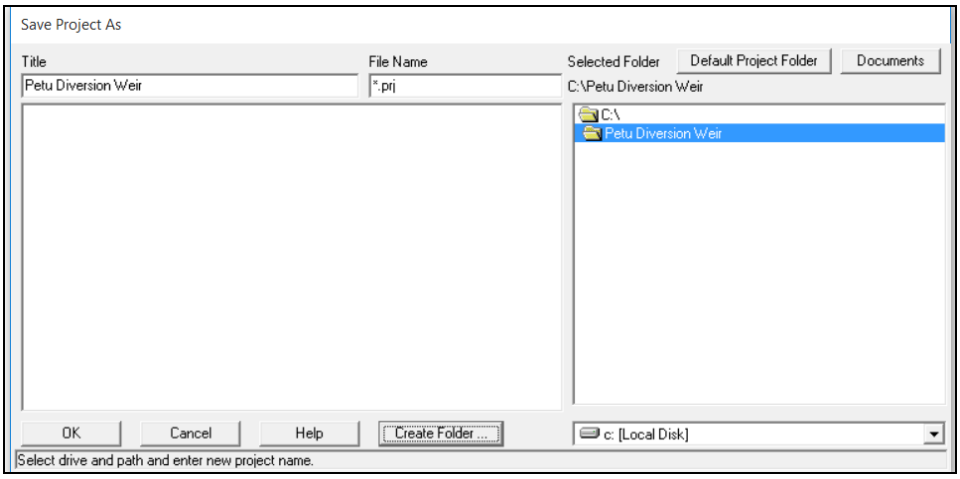
- Find the HEC-RAS folder in the Start Menu and click on HEC-RAS to start the program



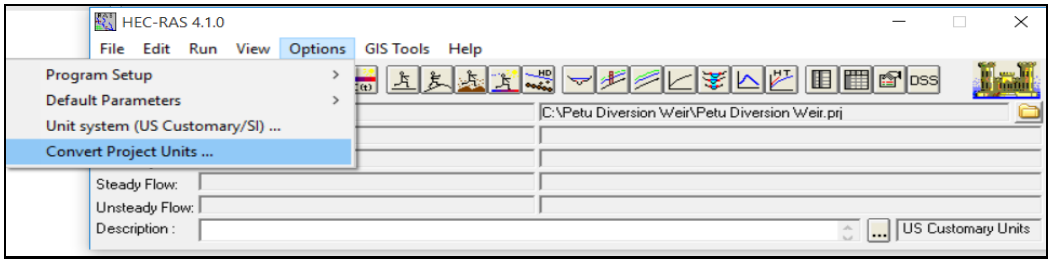
- Select New Project from the File pull down menu in the main HEC-RAS window



- Select a drive, and select a path by double clicking in the directory box of the New Project window. For this example, double click on the data subdirectory for c:\Petu Diversion Weir folder\ Enter a title Petu Diversion Weir and the filename is Petu Diversion Weir.prj Click OK

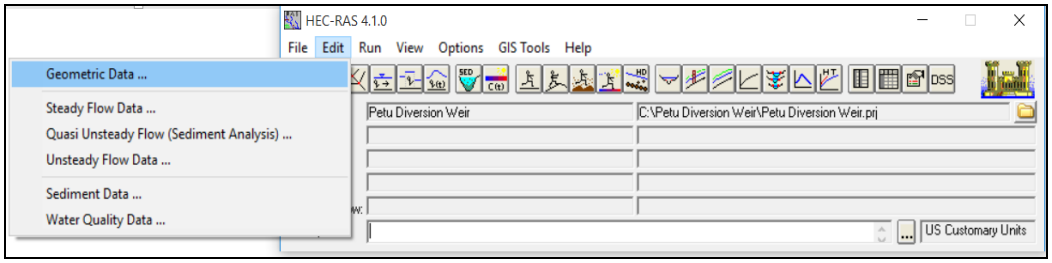


- The English System of units is the default. To use the Metric System, select Unit System from the Options pull down menu in the main HEC-RAS window to change from the English System to the Metric System.

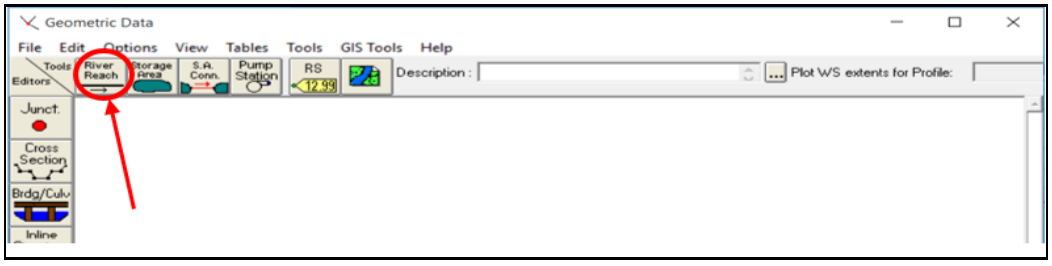


3.2.3 Incorporation cross sectional data

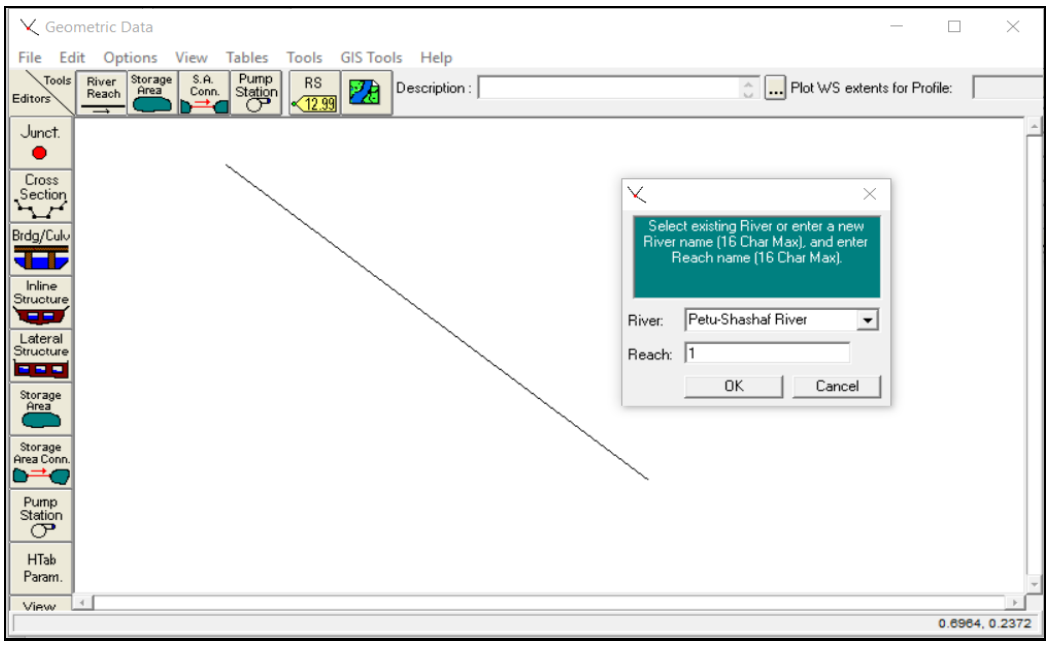
- Select Geometric data from the Edit pull down menu in the main HEC-RAS window



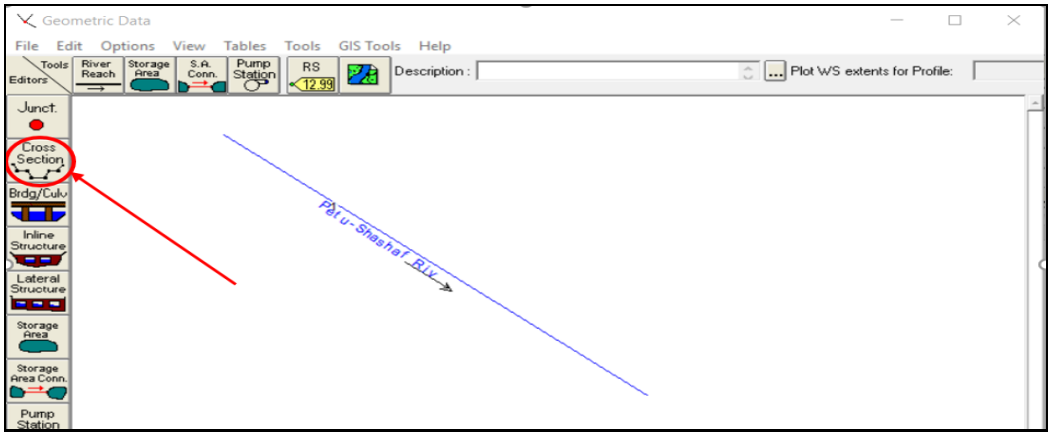
- In the Geometric Data window, click on the River Reach tool with the mouse and draw the following river schematic by clicking the left mouse button and dragging the reach in the direction of the flow.



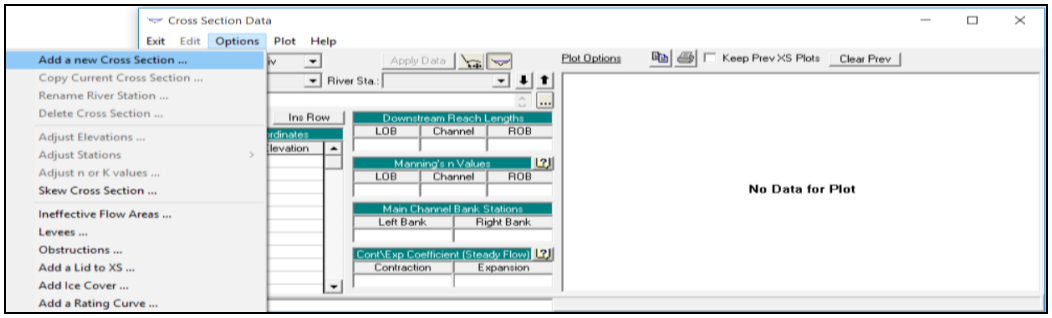
- Double-click the mouse to end the reach. Give each reach a name Petu-Shashaf River.



- Click on the Cross Section tool on the left side of the Geometric Data window

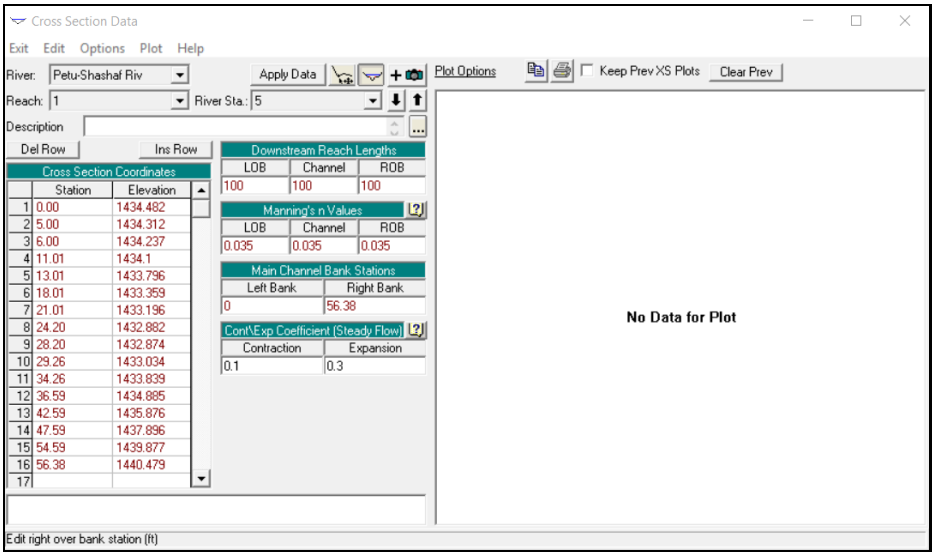


- Select Add a new Cross Section from the Options pull down menu in the Cross Section Data window and enter the river station label. HEC-RAS requires that river cross-sections be entered starting upstream using the highest number as a "river station" label and proceeding downstream in the direction of flow

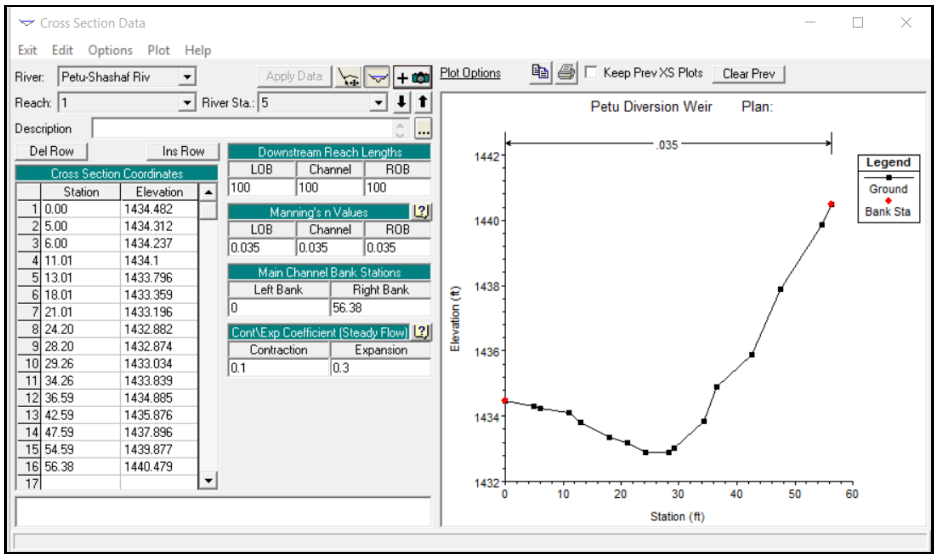


- Enter data provided below for the Upstream reach (Reach 5)
- Downstream reach length = 100
- Manning's Value = 0.035
- Main channel reach station, Left bank =0.00 and Right Bank = 56.38
- Contraction coefficients = 0.1 and Expansion coefficients =0.3

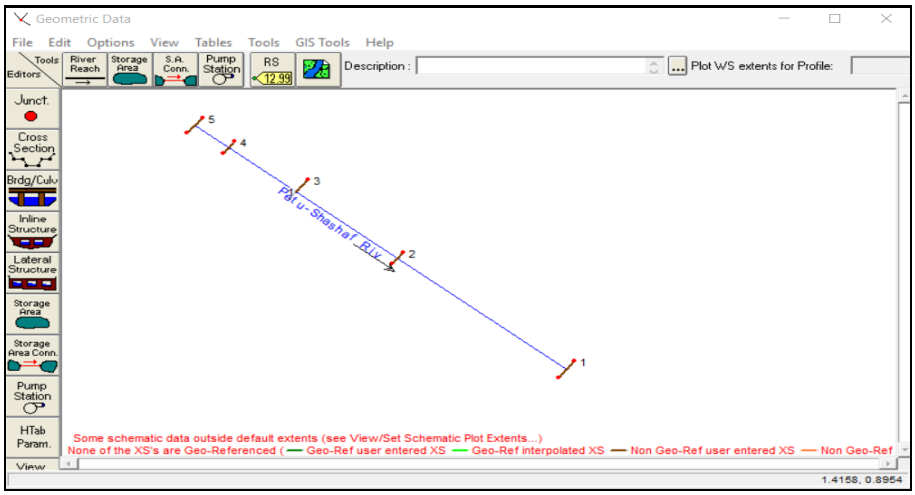
Reach = 5 D/S Reach length=100	
U/S Weir Axis	
Station	Elevation
0.00	1434.482
5.00	1434.312
6.00	1434.237
11.01	1434.100
13.01	1433.796
18.01	1433.359
21.01	1433.196
24.20	1432.882
28.20	1432.874
29.26	1433.034
34.26	1433.839
36.59	1434.885
42.59	1435.876
47.59	1437.896
54.59	1439.877
56.38	1440.479



- Subsequent station lengths are all measured from the first station. Enter the corresponding elevations for each station.
- The last station is on the right of the river valley, above the main channel and flow area.
- Click on Apply Data to accept entry for this cross-section.
- Select Plot Cross Section from the Plot pull down menu to visually check cross-section for errors.



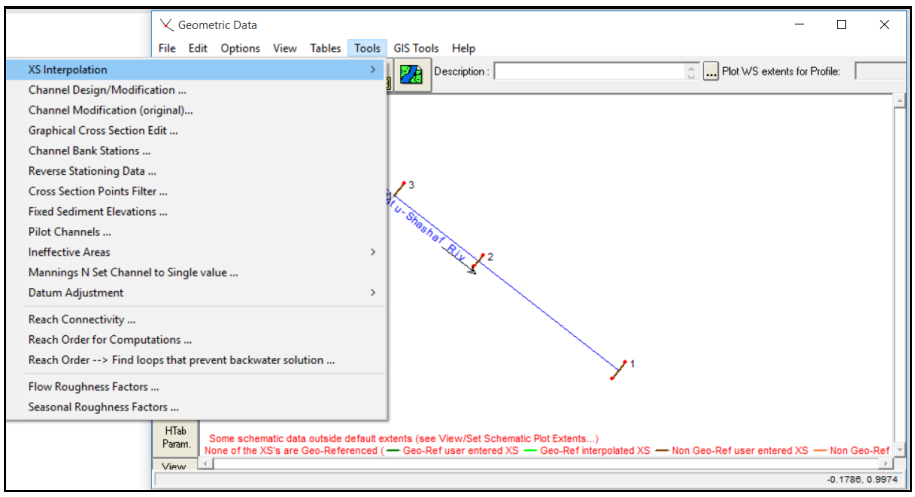
- Repeat the above Steps until all river stations for the reach (from reach-4 up to reach-1) are entered (Data provided in excel sheet provided). Then, change the Reach using the Reach pull-down menu and enter data for the rest of the reaches. Press the apply data button after each cross section is entered.
- After all the cross section data is entered, select Exit Cross Section Editor from the Exit pull down menu in the Cross Section Data window
- Your main geometry menu should now look like this



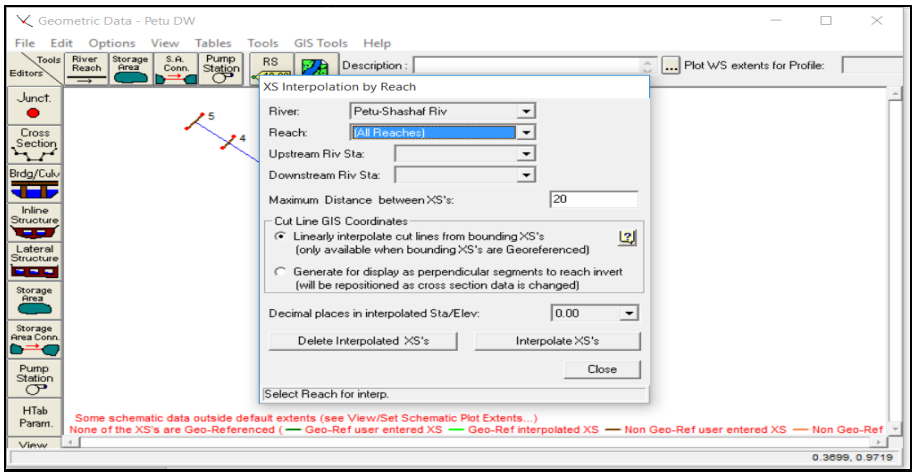
3.2.4 *Incorporating weir into a HEC-RAS analysis*

Hec-Ras requires two cross section u/s and d/s of weir structure located at reach-4, to do so

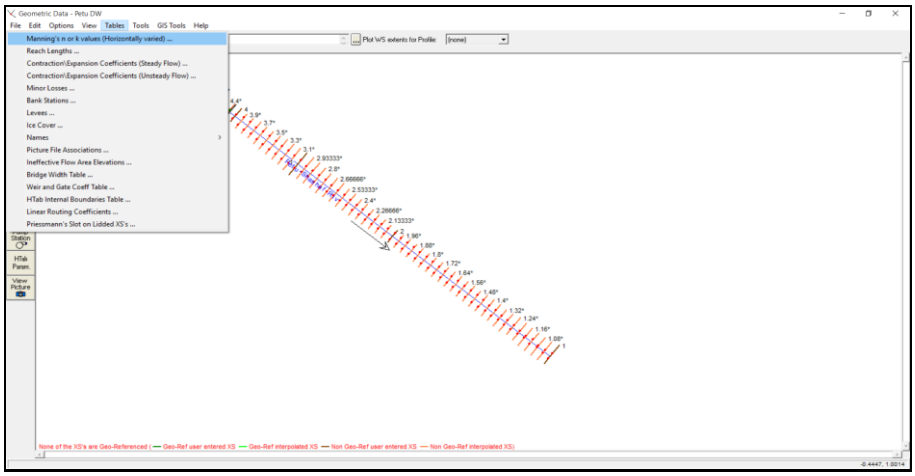
- Click tools in geometric data and select XS interpolation



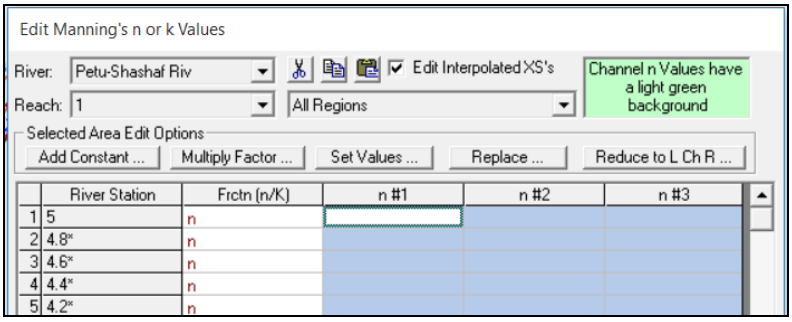
- Click in interpolation and for max distance between XS's insert 20
- In Reach drop down menu select All Reach
- Click interpolate Xs's



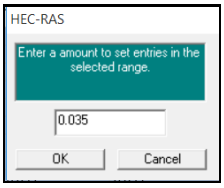
- Click Tables in geometric data and select Manning's n or K value



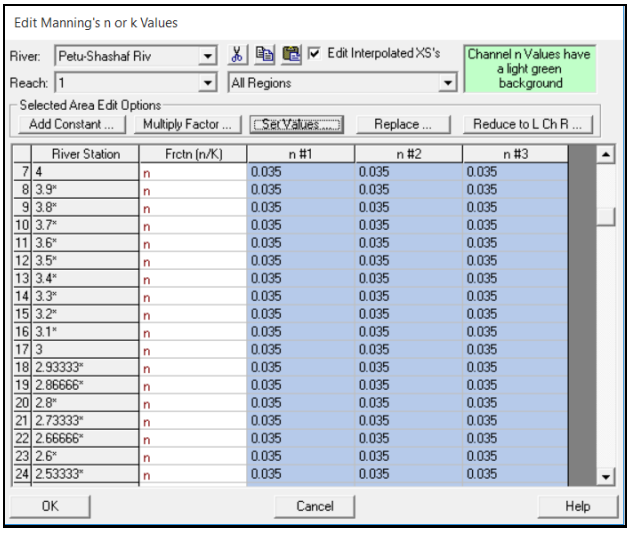
- Click and select tabs n#1, n#2 and n#3



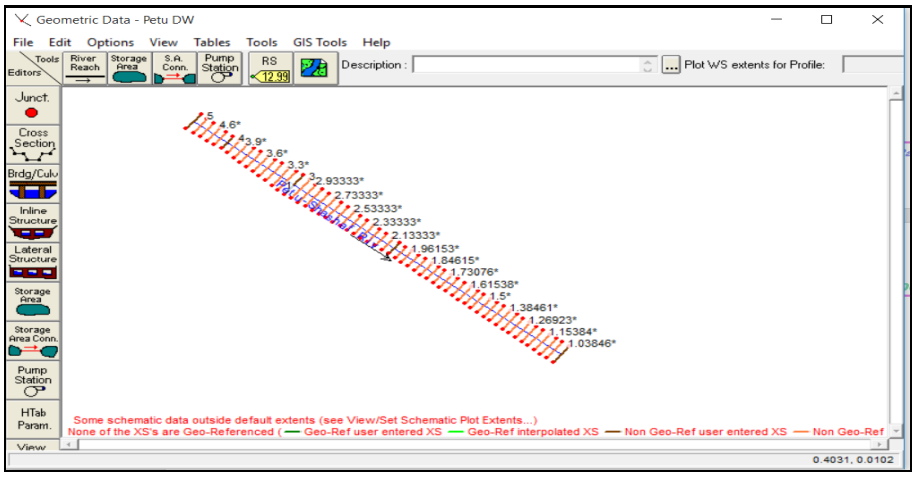
- Click Set Values and insert value = 0.035



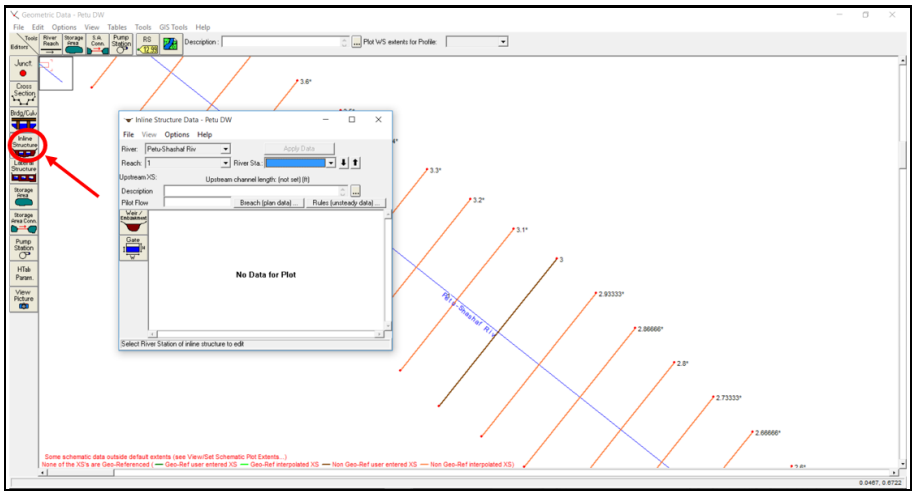
- Click Ok and make sure all cross sections have manning's value entered



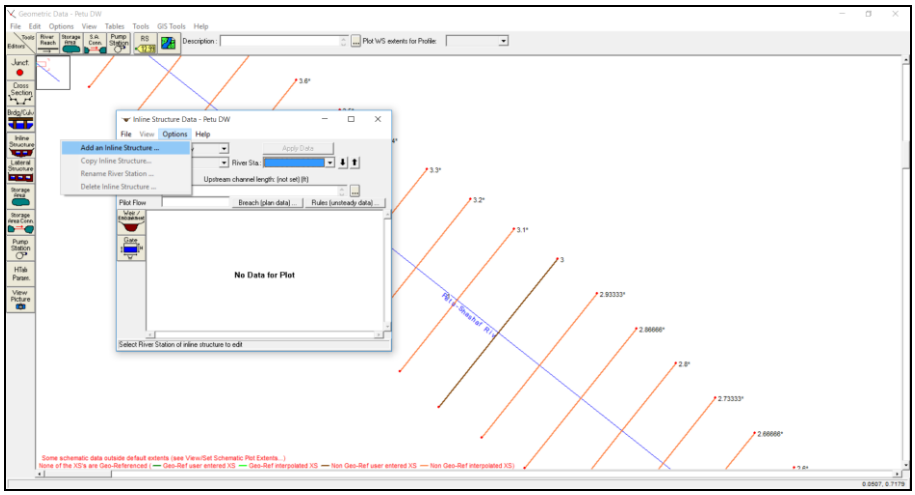
- Your main geometry menu should now look like this



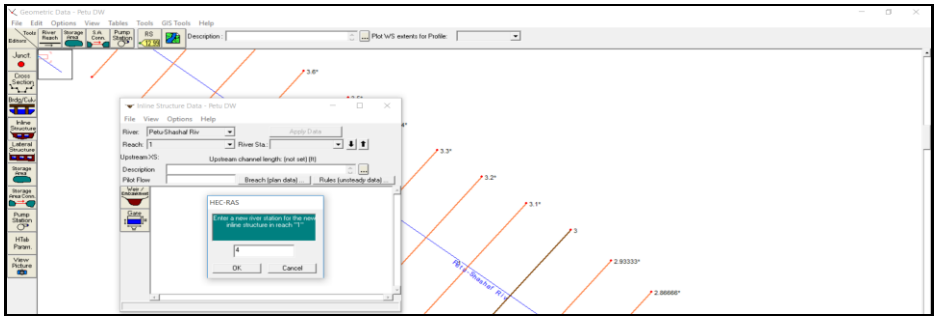
- Click inline structure located at the left side of toolbar
- File menu select save as and give it a name Petu Dw



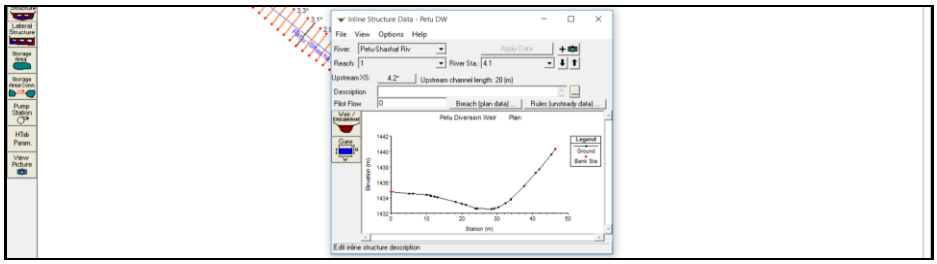
- Right click and select zoom to the area around reach 4
- Click option menu and select add inline structure



- Enter value of 4.1 (in which the Weir is located) for the dialogue “enter new river station for inline structure



- Click ok and its ready to enter the weir structure



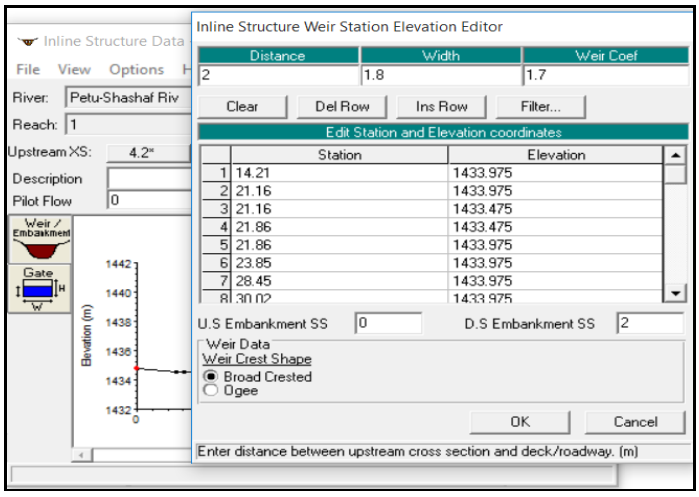
- Salient features of the weir to be incorporated in HEC-RAS

  - Weir Crest Level = 1433.975 m
  - Weir Height = 1.5m
  - Effective length of Weir = 6.6m
  - Two under sluices = 0.70m
  - Two piers = 0.5m
  - Top width of the weir = 1.0 to 1.8 m
  - Downstream apron length, L of 12m

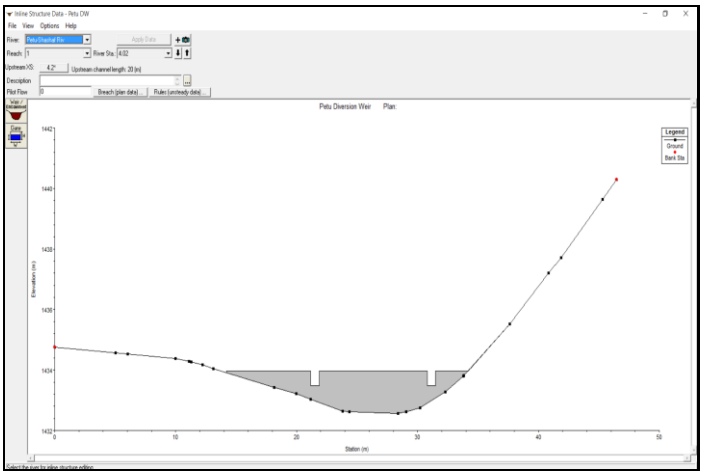
Click Weir/embankment tool bar and insert values for the respective fields

  - Distance = 2, Width =1.8, Weir coefficient =1.7
  - For weir & under sluice section insert the table provided below

Station	Elevation
14.21	1433.975
21.16	1433.975
21.16	1432.475
21.86	1432.475
21.86	1433.975
23.85	1433.975
28.45	1433.975
30.02	1433.975
30.80	1433.975
30.80	1432.475
31.50	1432.475
31.50	1433.975
34.20	1433.975

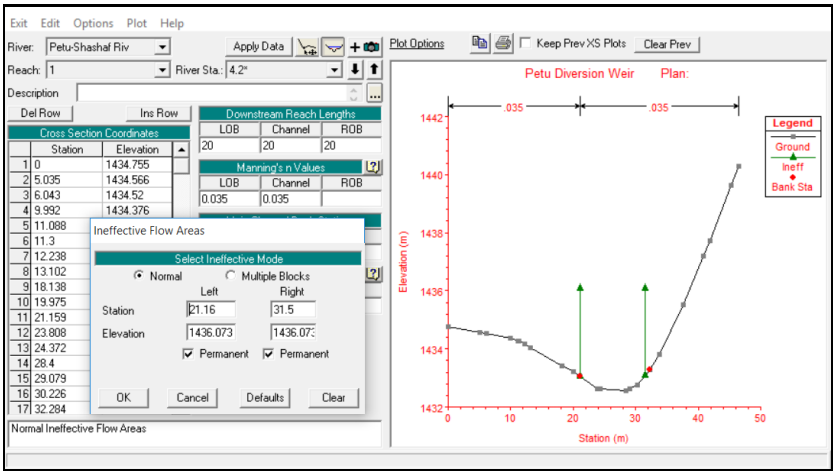


- Click Ok and Exit



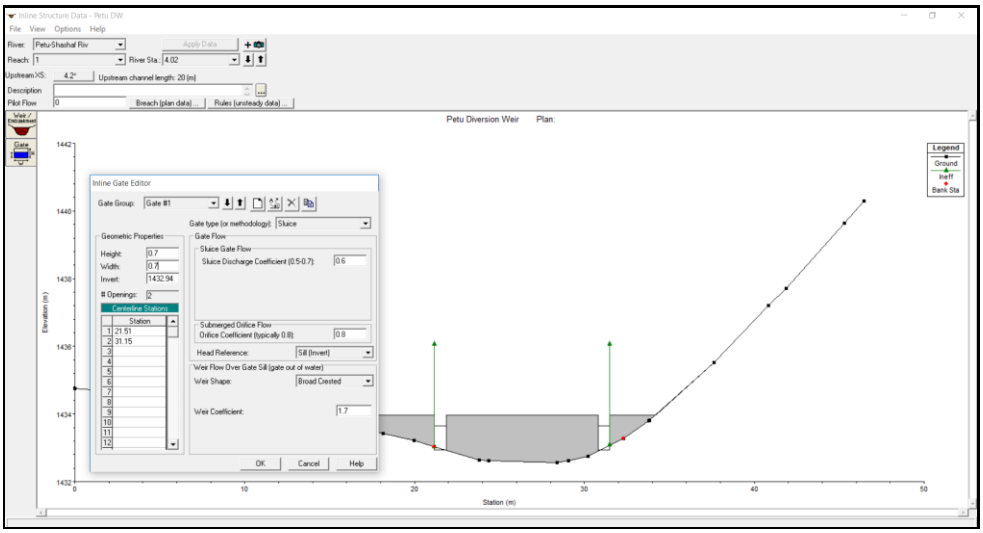
- Select cross-section 4.2 while in the Cross Section Data window. Choose Ineffective Flow Areas from the Options pull down menu.
- Enter the stations and elevations from Table below in the Ineffective Flow Areas window that represent the blockage in the river channel due to the Weir abutments. Press OK

Station	21.16	31.5
Elevation	1436.073	1436.073

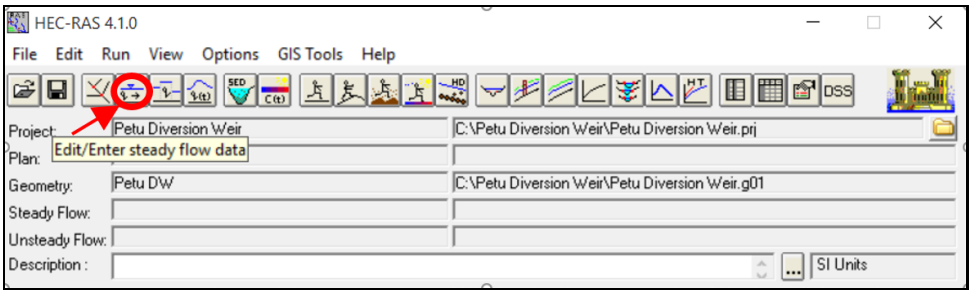


- Click on the Gate button in the inline structure data and insert the values provided below
  - Height = 0.7
  - Width = 0.7
  - Invert = 1432.94
  - Stations = 21.51

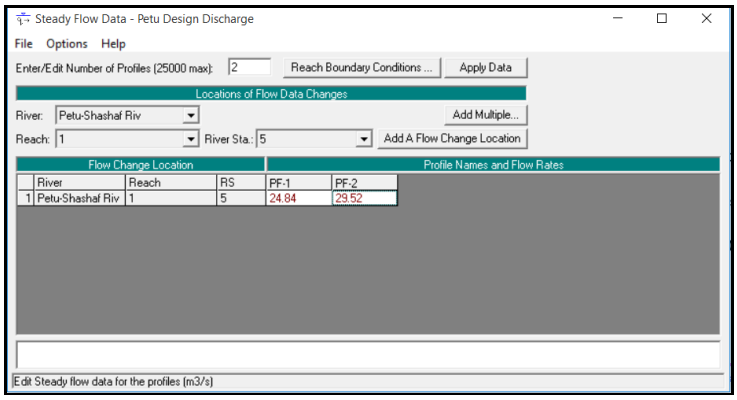
    = 31.15
  - Orifice Coefficient = 0.8
  - Sluice Coefficient = 0.6
  - Weir Coefficient = 1.7



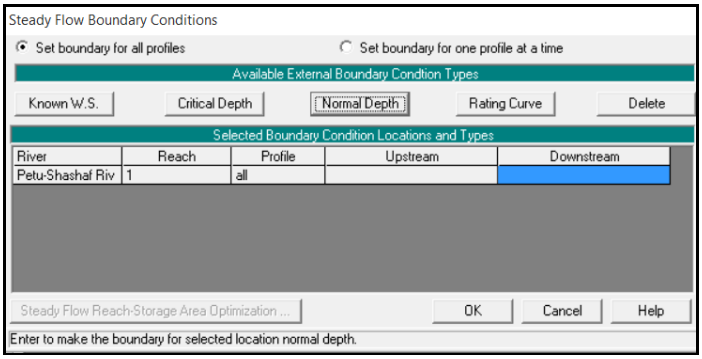
- Choose Exit from the File pull down menu of the inline structure data Editor window.
- Choose Exit Geometry Data Editor from the File pull down menu of the Geometric Data Window.
- Save the project.
- In the main HEC-RAS window, select Steady Flow Data from the Edit pull down menu to enter flow and boundary conditions.



- Enter a 2 in the "Number of profiles to be calculated" input for the two profiles modeled.
- Enter the flow at the farthest upstream station of each reach for each profile to be modeled. Once a flow value is entered at the upstream end of a reach, it is assumed that the flow remains constant until another flow value is encountered. For PF-1 insert flow = 24.84 and for PF-2 insert flow = 29.52 at station 5, which is 50 and 100 Year return period flood.

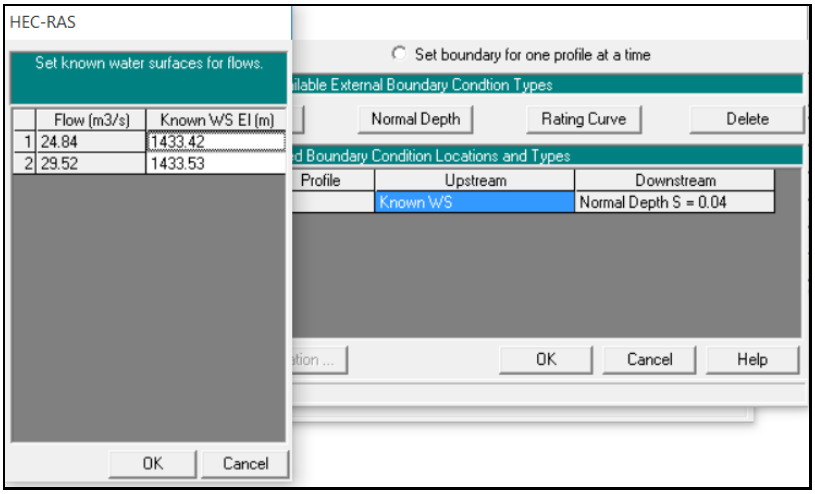


- Click on the Reach Boundary Conditions button to enter the steady flow boundary conditions window. Since we are computing multiple water surface profiles, click on Set Boundary for all profiles.

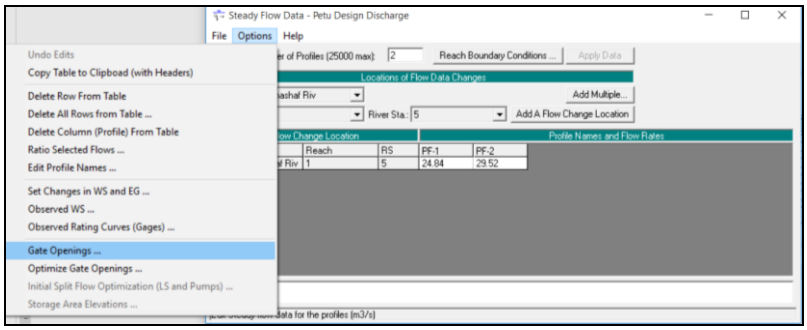


- For mixed flow, flow which has both super and subcritical sections, select both an upstream and downstream boundary condition. A mixed flow regime is anticipated, therefore, all upstream and downstream boundary conditions are required.
- For Down Stream select Normal Depth = 0.04, and choose Known W.S. UP Stream The known W.S. elevations are determined from a downstream weir.(Refer Petu Design Report)

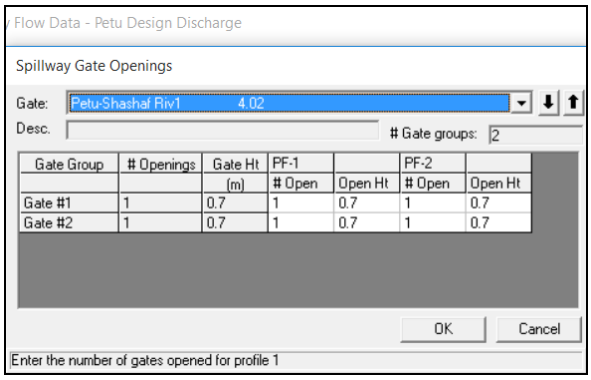
	Flow	Known Water Surface Elevation
Profile-1	24.84	1433.42
Profile-2	29.52	1433.53



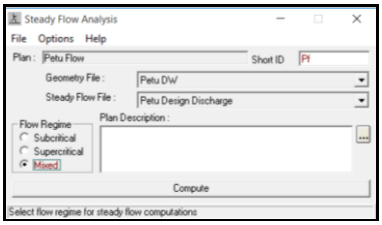
- Select Ok and Exit boundary condition to return to Steady Data Flow window
- Select Gate opening from option pull down menu



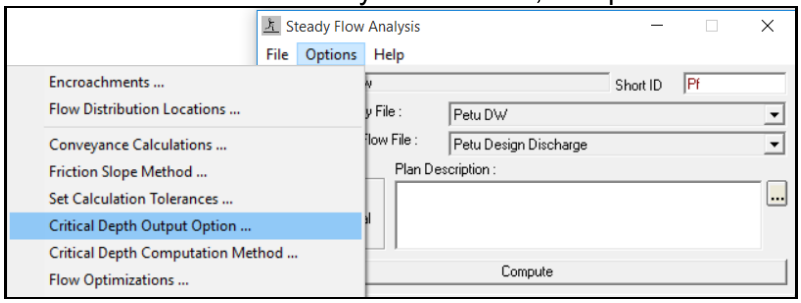
- Insert 0.7 for # open Ht and 1 for #open then click ok



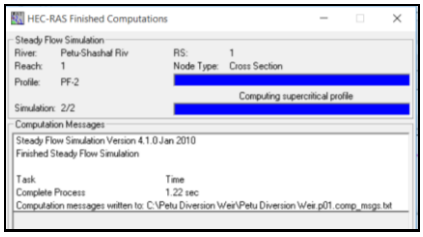
- Select Exit Flow Data editor from the File pull down menu of the Steady Data Flow window to return to main HEC-RAS window.
- Select Save Project from the File pull down menu in the main HEC-RAS window to save all geometric and flow data.
- Select Steady Flow Analysis from the Simulate pull down menu of the main HEC-RAS window. Choose Mixed Flow Regime.



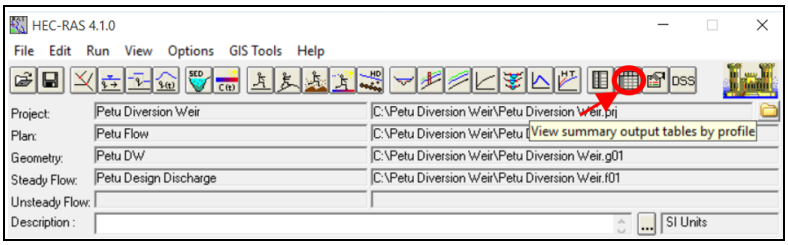
- Select Critical Depth Output Option from the Options pull down menu of the Steady Flow Analysis window. Choose Critical Always Calculated, and press OK

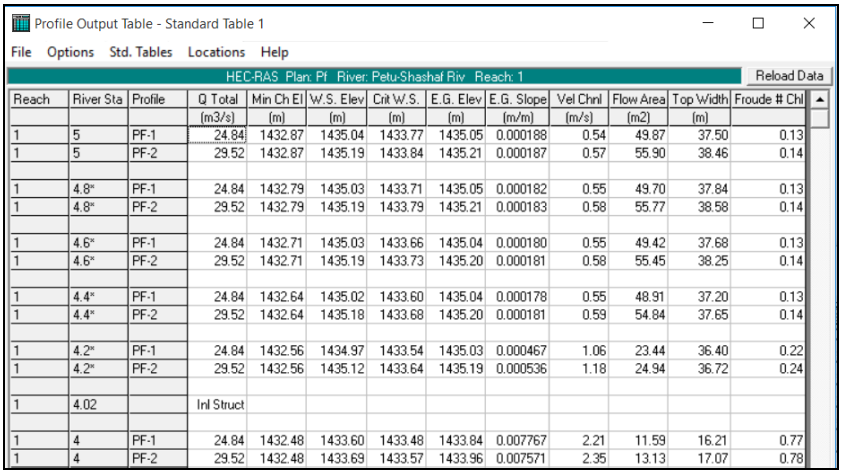


- Press Compute in the Steady Flow Analysis window to begin the HEC-RAS analysis.
- When the following screens are visible the simulation has been run



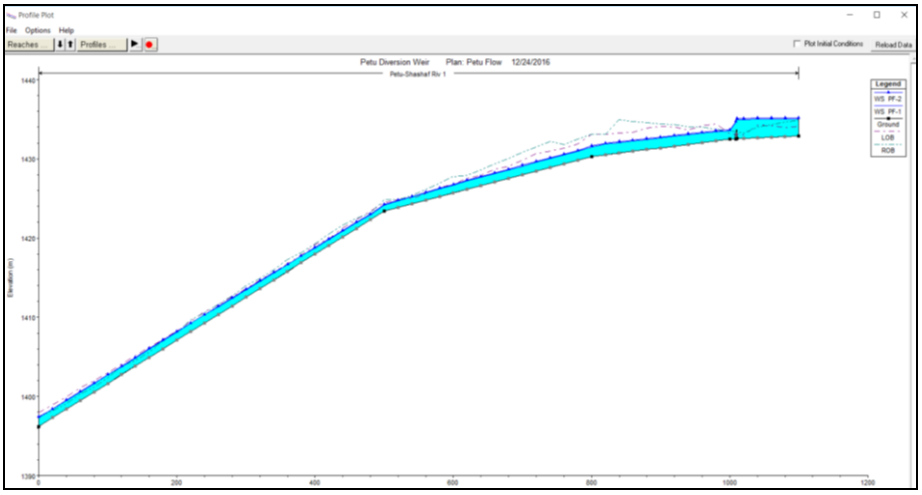
- Let's look at the characteristics of the bank full flow. Click on the tables tab of the main menu interface. Select options/profiles to view the results





Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1	5	PF-1	24.84	1432.87	1435.04	1433.77	1435.05	0.000188	0.54	49.87	37.50	0.13
1	5	PF-2	29.52	1432.87	1435.19	1433.84	1435.21	0.000187	0.57	55.90	38.46	0.14
1	4.8*	PF-1	24.84	1432.79	1435.03	1433.71	1435.05	0.000182	0.55	49.70	37.84	0.13
1	4.8*	PF-2	29.52	1432.79	1435.19	1433.79	1435.21	0.000183	0.58	55.77	38.58	0.14
1	4.6*	PF-1	24.84	1432.71	1435.03	1433.66	1435.04	0.000180	0.55	49.42	37.68	0.13
1	4.6*	PF-2	29.52	1432.71	1435.19	1433.73	1435.20	0.000181	0.58	55.45	38.25	0.14
1	4.4*	PF-1	24.84	1432.64	1435.02	1433.60	1435.04	0.000178	0.55	48.91	37.20	0.13
1	4.4*	PF-2	29.52	1432.64	1435.18	1433.68	1435.20	0.000181	0.59	54.84	37.65	0.14
1	4.2*	PF-1	24.84	1432.56	1434.97	1433.54	1435.03	0.000467	1.06	23.44	36.40	0.22
1	4.2*	PF-2	29.52	1432.56	1435.12	1433.64	1435.19	0.000536	1.18	24.94	36.72	0.24
1	4.02		Inl Struct									
1	4	PF-1	24.84	1432.48	1433.60	1433.48	1433.84	0.007767	2.21	11.59	16.21	0.77
1	4	PF-2	29.52	1432.48	1433.69	1433.57	1433.96	0.007571	2.35	13.13	17.07	0.78

- This table provides water surface elevation, velocity, Froude number, area, width, energy grade line etc. Many more options are available under options/define table.
- we can go back to the main menu and the plot profile tab to examine the flow profile



3.3 CASE STUDY FOR PETU IRRIGATION CANAL & DROP STRUCTURES

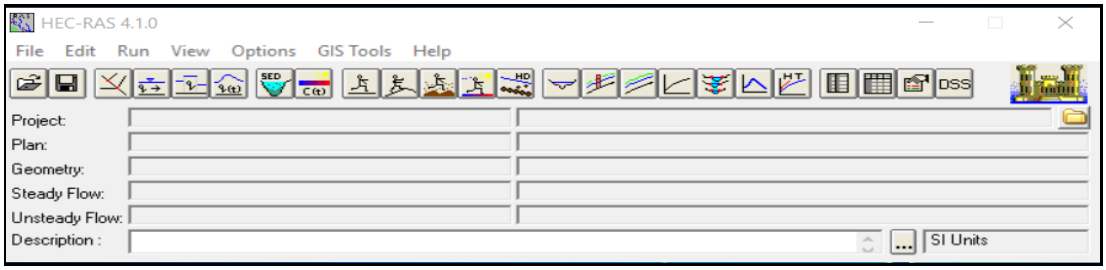
3.3.1 Preparation of working environment

This practical exercise will help how to model Irrigation canal and Drop Structures

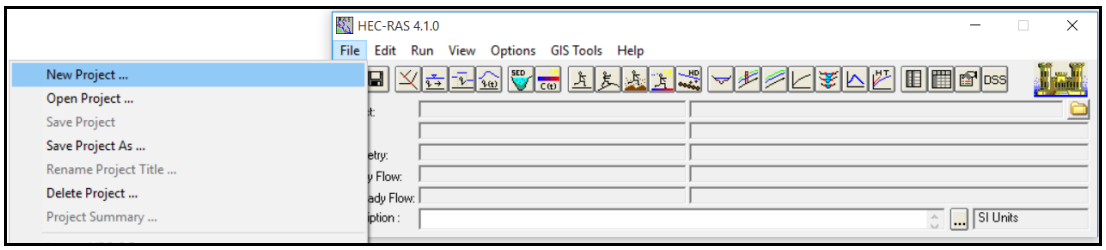
3.3.2 Getting started

Defining a project

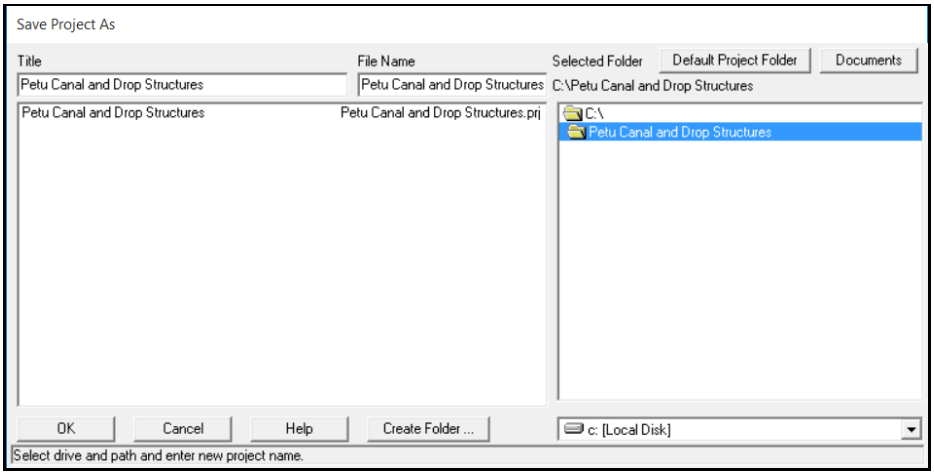
- Find the HEC-RAS folder in the Start Menu and click on HEC-RAS to start the program



- Select New Project from the File pull down menu in the main HEC-RAS window



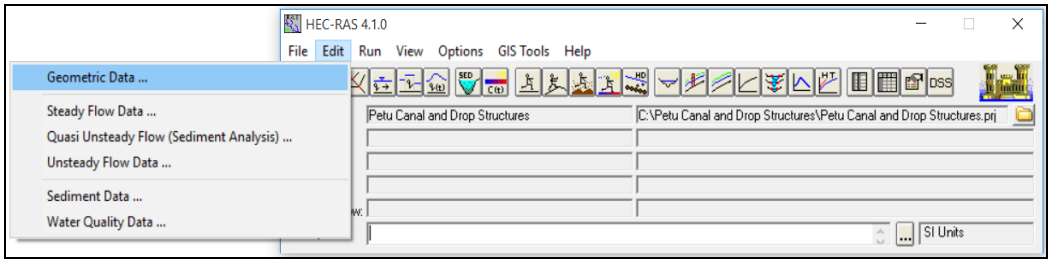
- Select a drive, and select a path by double clicking in the directory box of the New Project window. For this example, double click on the data subdirectory for c:\Petu Diversion Weir folder\ Enter a title Petu Canal and Drop Structure and the filename is Petu Canal and Drop Structure. prj Click OK



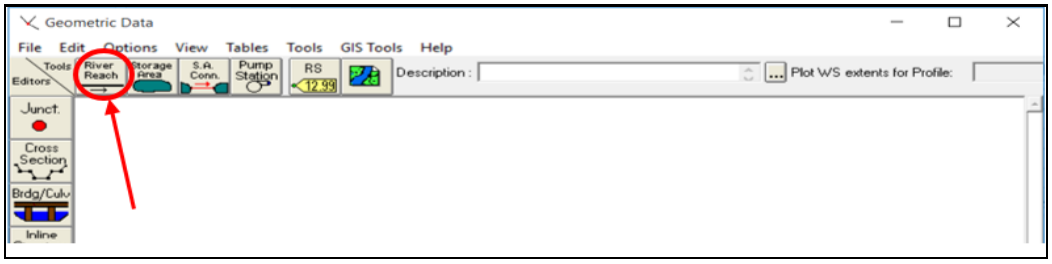
- The English System of units is the default. To use the Metric System, select Unit System from the Options pull down menu in the main HEC-RAS window to change from the English System to the Metric System.

3.3.3 Incorporation cross sectional data

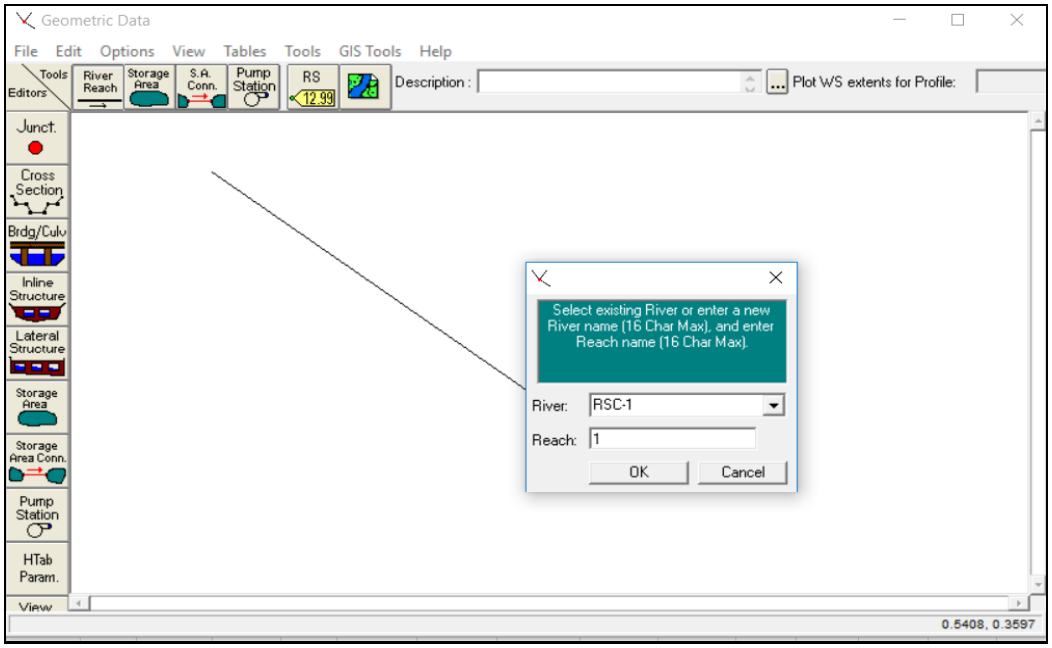
- Select Geometric data from the Edit pull down menu in the main HEC-RAS window



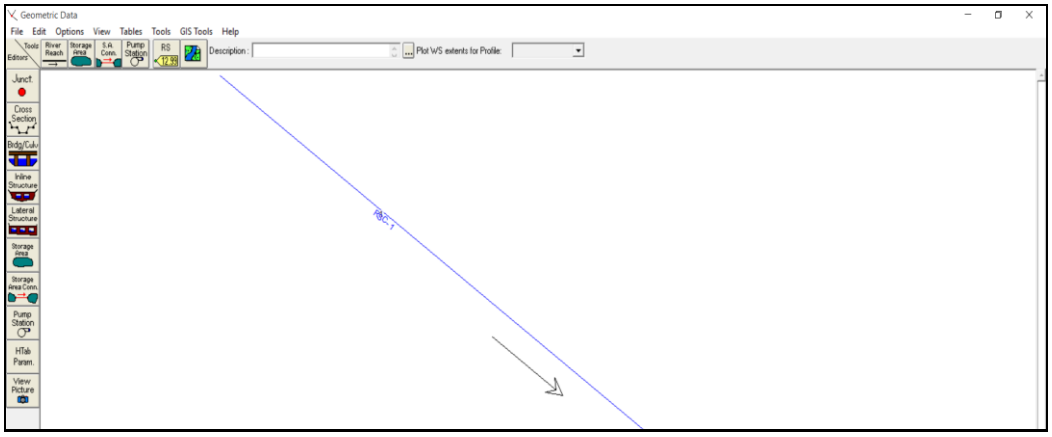
- In the Geometric Data window, click on the River Reach tool with the mouse and draw the following river schematic by clicking the left mouse button and dragging the reach in the direction of the flow.



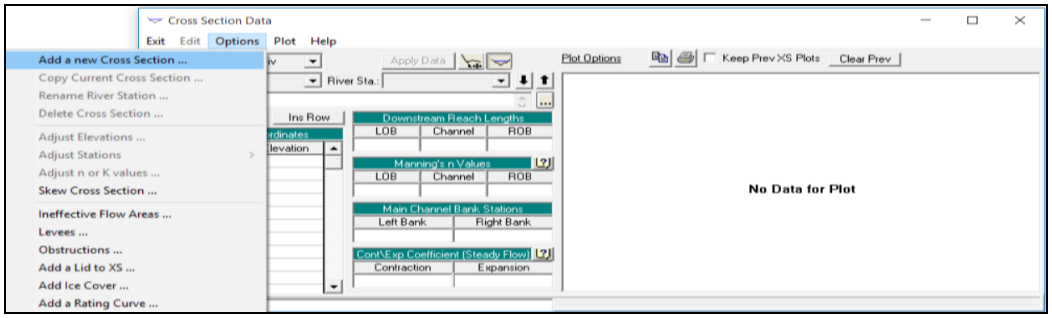
- Double-click the mouse to end the reach. Give each reach a name RSC-1 Canal.



- Click on the Cross Section tool on the left side of the Geometric Data window

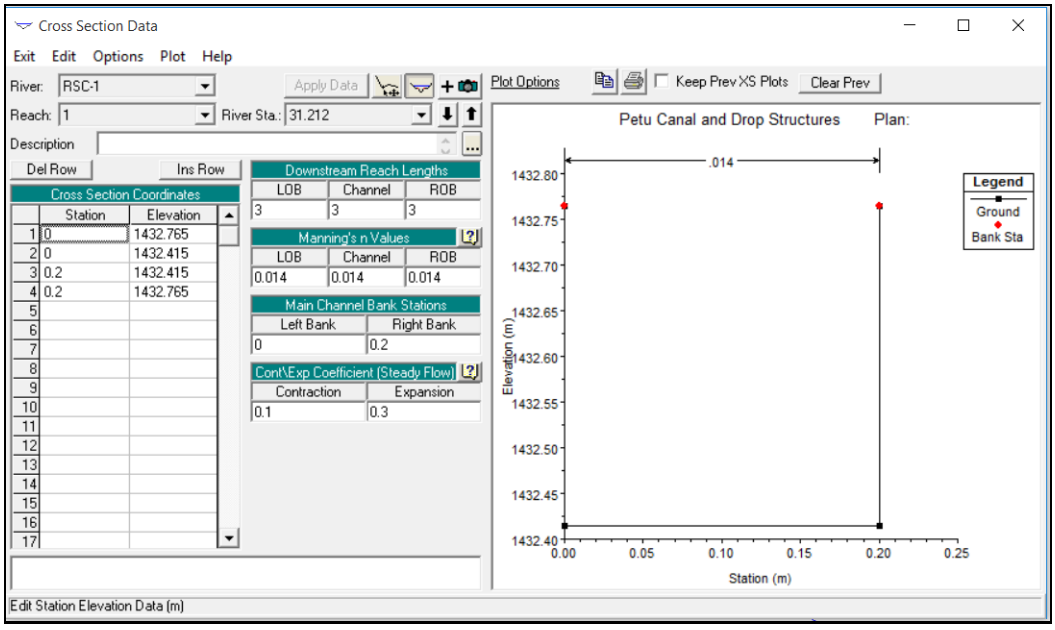


- Select Add a new Cross Section from the Options pull down menu in the Cross Section Data window and enter the river station label. HEC-RAS requires that canal cross-sections be entered starting upstream using the highest number as a "river station" label and proceeding downstream in the direction of flow

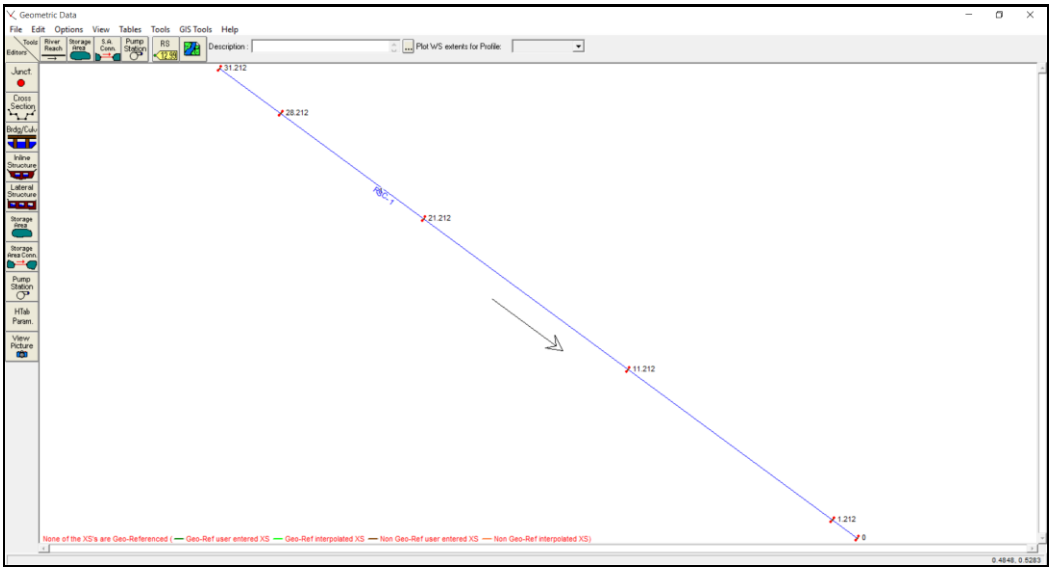


- Enter data provided below for the Upstream reach (Reach 31.212)
- Downstream reach length = 3
- Manning's Value = 0.014
- Main channel reach station, Left bank =0.00 and Right Bank = 0.2
- Contraction coefficients = 0.1 and Expansion coefficients =0.3

Station	31.212		28.212		21.212		11.212		1.212		0
Distance to D/S	3		7		10		10		1.212		0
0	1432.765	0	1432.315	0	1429.765	0	1426.765	0	1423.765	0	1423.583
0	1432.415	0	1431.965	0	1429.415	0	1426.415	0	1423.415	0	1423.233
0.2	1432.415	0.2	1431.965	0.2	1429.415	0.2	1426.415	0.2	1423.415	0.2	1423.233
0.2	1432.765	0.2	1432.315	0.2	1429.765	0.2	1426.765	0.2	1423.765	0.2	1423.583



- Repeat the above Steps until all canal stations for the reach (from reach-28.212 up to reach-0) are entered. Then, change the Reach using the Reach pull-down menu and enter data for the rest of the reaches. Press the apply data button after each cross section is entered.
- After all the cross section data is entered, select Exit Cross Section Editor from the Exit pull down menu in the Cross Section Data window
- Your main geometry menu should now look like this



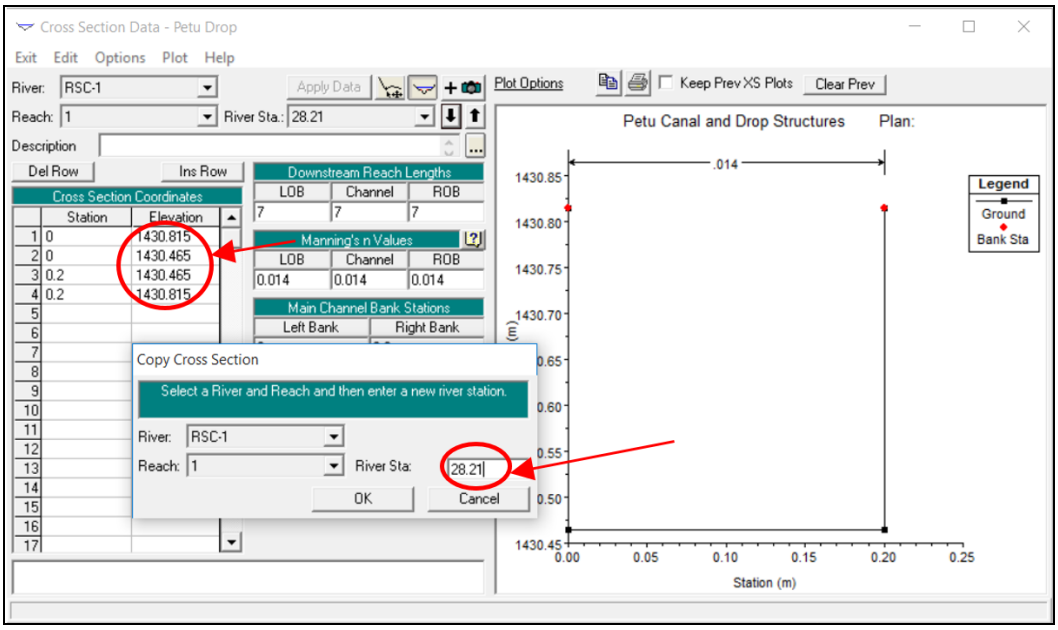
3.3.4 Incorporating drop into a HEC-RAS analysis

Hec-Ras requires two cross section u/s and d/s of Drop structure located at reach- 28.212, 21.212 and 11.212 to do so

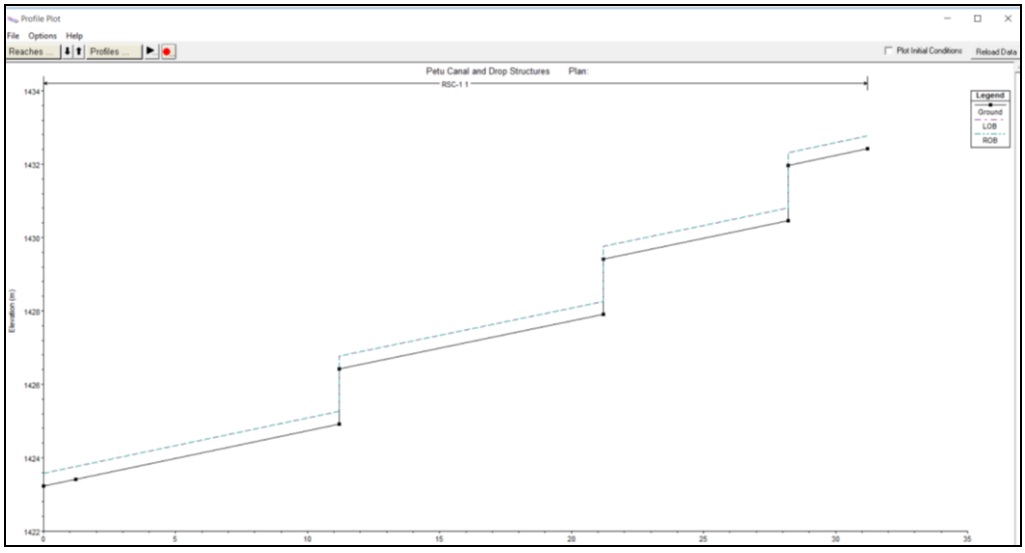
- In order to insert Drop Structures the cross section should be adjusted as follows
- Click cross section tab
- Select cross section at station 28.212
- From option drop down menu select copy current cross section
- Enter 28.21 at river station

- Since the values are inherited from the u/s cross section i.e the drop height is 1.5 and subtract from elevation values as given in the table
- Change D/s reach length for station 28.212 = 0.002 and for copied cross section leave it as it is.

Station	New Cross Section	D/s Reach Length	CBL U/S of Drop	CBL D/S of Drop	TBL U/S of Drop	TBL D/S of Drop
28.212	28.21	0.002	1431.965	1430.465	1432.315	1430.815
21.212	21.21	0.002	1429.415	1427.915	1429.765	1428.265
11.212	11.21	0.002	1426.415	1424.915	1426.765	1425.265

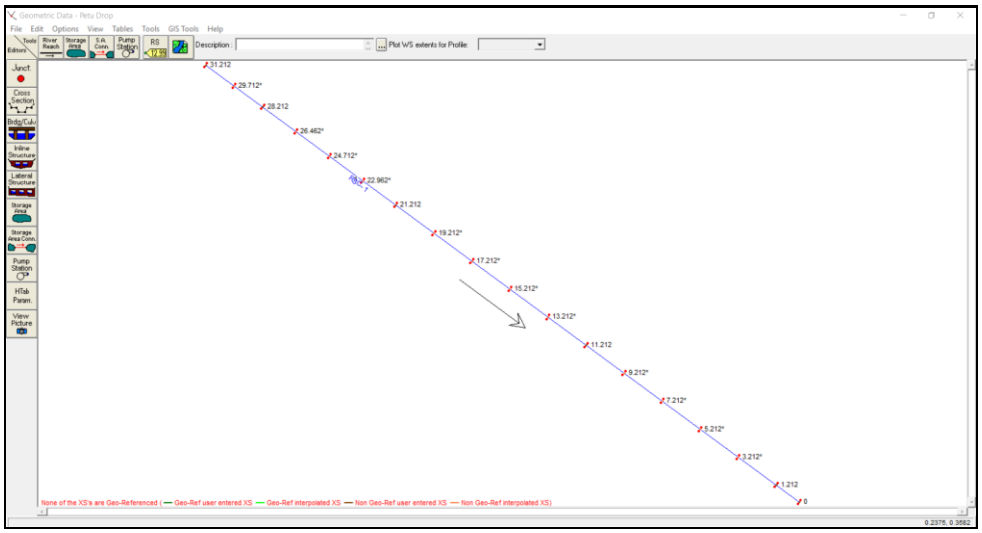


- Repeat the same steps for stations 21.212 and 11.212 as station 28.212.
- Your Canal profile plot should now look like this

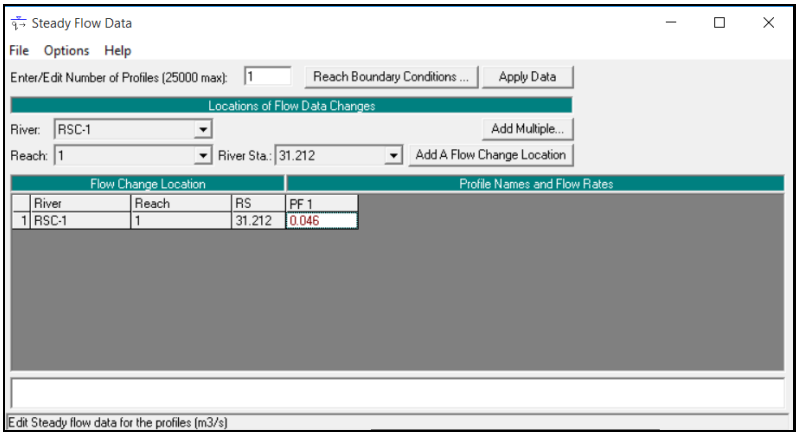


- Click tools in geometric data and select XS interpolation
- Click in interpolation and for max distance between XS's insert 2
- In Reach drop down menu select All Reach
- Click interpolate Xs's
- Click Tables in geometric data and select Manning's n or K value

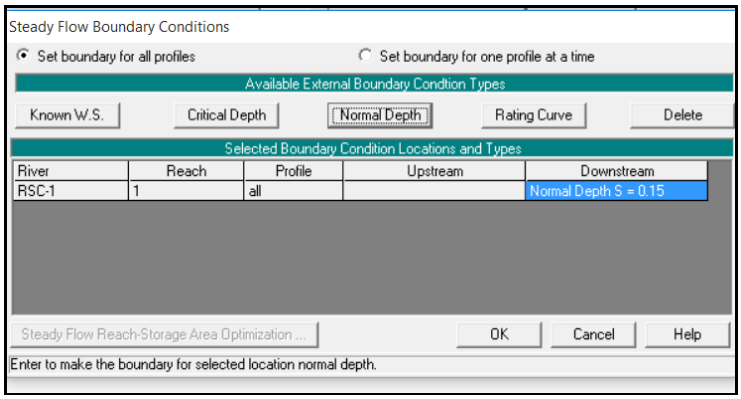
- Click and select tabs n#1, n#2 and n#3
- Click Set Values and insert value = 0.014
- Click Ok and make sure all cross sections have manning's value entered
- Your main geometry menu should now look like this



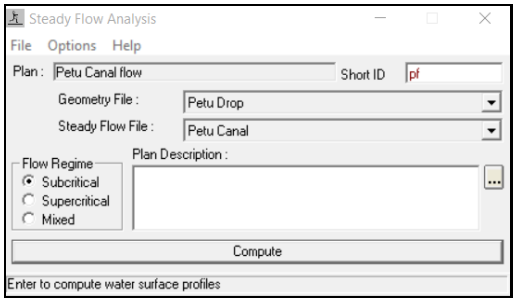
- Choose Exit Geometry Data Editor from the File pull down menu of the Geometric Data Window.
- Save the project.
- In the main HEC-RAS window, select Steady Flow Data from the Edit pull down menu to enter flow and boundary conditions.
- Enter a 1 in the "Number of profiles to be calculated" input for the two profiles modeled.
- Enter the flow at the farthest upstream station of each reach for each profile to be modeled. Once a flow value is entered at the upstream end of a reach. For PF-1 insert flow = 0.046 at station 31.212, which is the designed discharge.



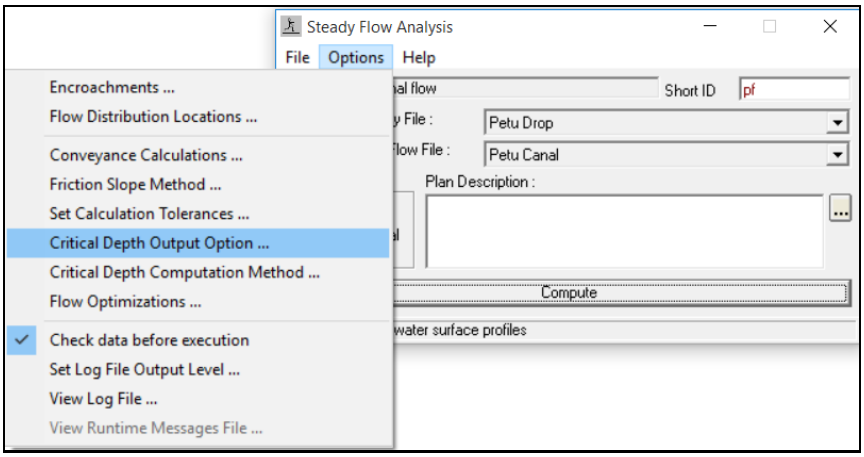
- Click on the Reach Boundary Conditions button to enter the steady flow boundary conditions window.
- For Canal modeling the flow is assumed to be steady and uniform, thus the flow which will have subcritical sections, select downstream boundary condition.
- For Down Stream select Normal Depth = 0.15. (Refer Petu Design Report)



- Select Ok and Exit boundary condition to return to Steady Data Flow window
- Select Exit Flow Data editor from the File pull down menu of the Steady Data Flow window to return to main HEC-RAS window.
- Select Save Project from the File pull down menu in the main HEC-RAS window to save all geometric and flow data.
- Select Steady Flow Analysis from the Simulate pull down menu of the main HEC-RAS window. Choose Subcritical Flow Regime.



- Select Critical Depth Output Option from the Options pull down menu of the Steady Flow Analysis window. Choose Critical Always Calculated, and press OK



- Press Compute in the Steady Flow Analysis window to begin the HEC-RAS analysis.
- When the following screens are visible the simulation has been run
- Click on the tables tab of the main menu interface. Select options/profiles to view the results

Profile Output Table - Standard Table 1

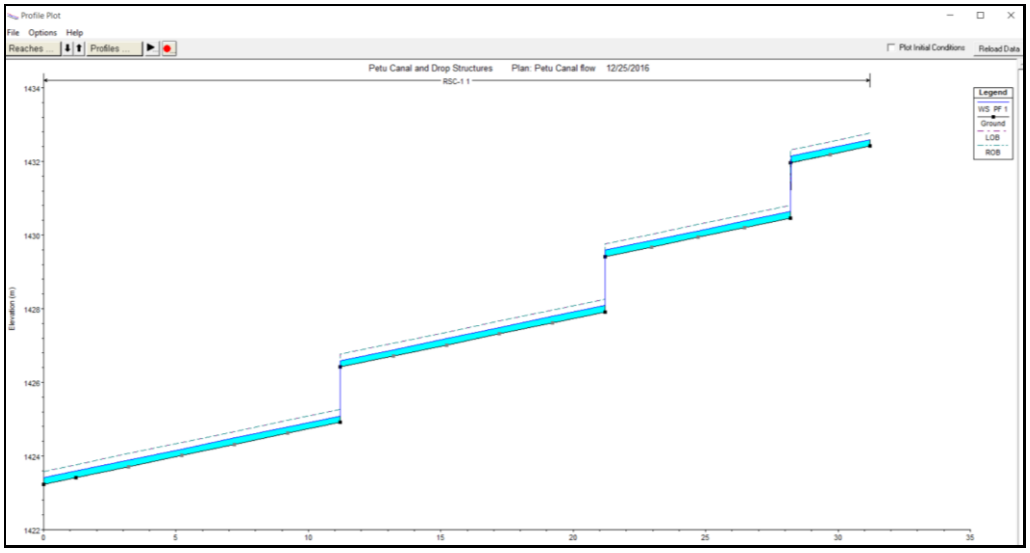
File Options Std. Tables Locations Help

HEC-RAS Plan: pf River: RSC-1 Reach: 1 Profile: PF 1 Reload Data

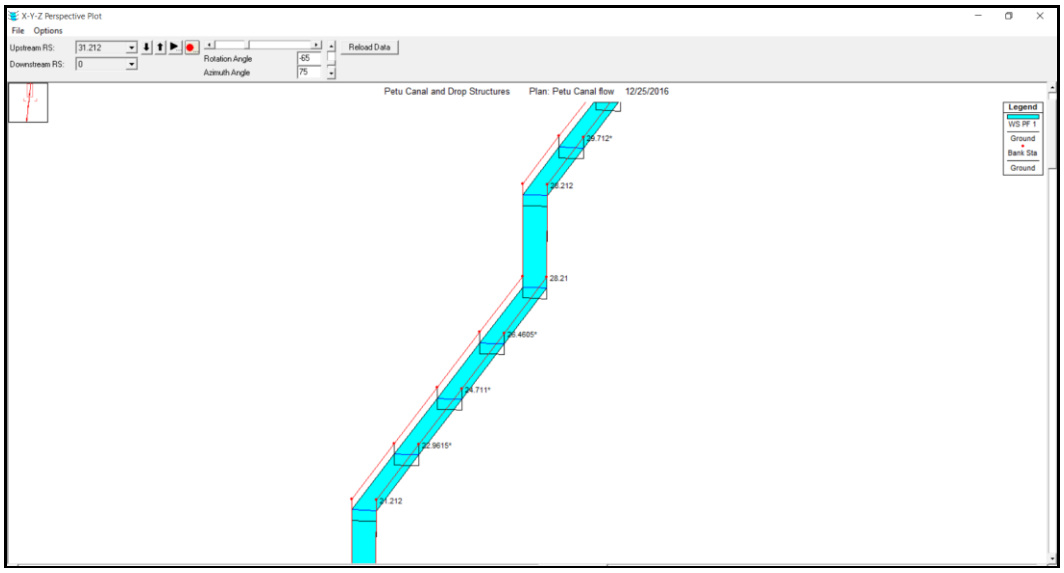
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1	31.212	PF 1	0.05	1432.42	1432.59	1432.59	1432.68	0.013136	1.31	0.04	0.20	0.99
1	29.712*	PF 1	0.05	1432.19	1432.36	1432.36	1432.45	0.013473	1.32	0.03	0.20	1.01
1	28.212	PF 1	0.05	1431.97	1432.14	1432.14	1432.23	0.013164	1.31	0.04	0.20	1.00
1	28.21	PF 1	0.05	1430.47	1430.64	1430.64	1430.73	0.013473	1.32	0.03	0.20	1.01
1	26.4605*	PF 1	0.05	1430.20	1430.38	1430.38	1430.47	0.013388	1.32	0.03	0.20	1.01
1	24.711*	PF 1	0.05	1429.94	1430.11	1430.11	1430.20	0.013473	1.32	0.03	0.20	1.01
1	22.9615*	PF 1	0.05	1429.68	1429.85	1429.85	1429.94	0.013164	1.31	0.04	0.20	1.00
1	21.212	PF 1	0.05	1429.42	1429.59	1429.59	1429.68	0.013136	1.31	0.04	0.20	0.99
1	21.21	PF 1	0.05	1427.92	1428.09	1428.09	1428.18	0.013136	1.31	0.04	0.20	0.99
1	19.2104*	PF 1	0.05	1427.62	1427.79	1427.79	1427.88	0.013136	1.31	0.04	0.20	0.99
1	17.2108*	PF 1	0.05	1427.32	1427.49	1427.49	1427.58	0.013164	1.31	0.04	0.20	1.00
1	15.2112*	PF 1	0.05	1427.02	1427.19	1427.19	1427.28	0.013136	1.31	0.04	0.20	0.99
1	13.2116*	PF 1	0.05	1426.72	1426.89	1426.89	1426.98	0.013473	1.32	0.03	0.20	1.01
1	11.212	PF 1	0.05	1426.42	1426.59	1426.59	1426.68	0.013473	1.32	0.03	0.20	1.01
1	11.21	PF 1	0.05	1424.92	1425.09	1425.09	1425.18	0.013164	1.31	0.04	0.20	1.00
1	9.2104*	PF 1	0.05	1424.62	1424.79	1424.79	1424.88	0.013136	1.31	0.04	0.20	0.99
1	7.2108*	PF 1	0.05	1424.32	1424.49	1424.49	1424.58	0.013473	1.32	0.03	0.20	1.01
1	5.2112*	PF 1	0.05	1424.02	1424.19	1424.19	1424.28	0.013164	1.31	0.04	0.20	1.00
1	3.2116*	PF 1	0.05	1423.72	1423.89	1423.89	1423.98	0.013136	1.31	0.04	0.20	0.99
1	1.212	PF 1	0.05	1423.42	1423.59	1423.59	1423.68	0.013164	1.31	0.04	0.20	1.00
1	0	PF 1	0.05	1423.23	1423.41	1423.41	1423.50	0.013136	1.31	0.04	0.20	0.99

Total flow in cross section.

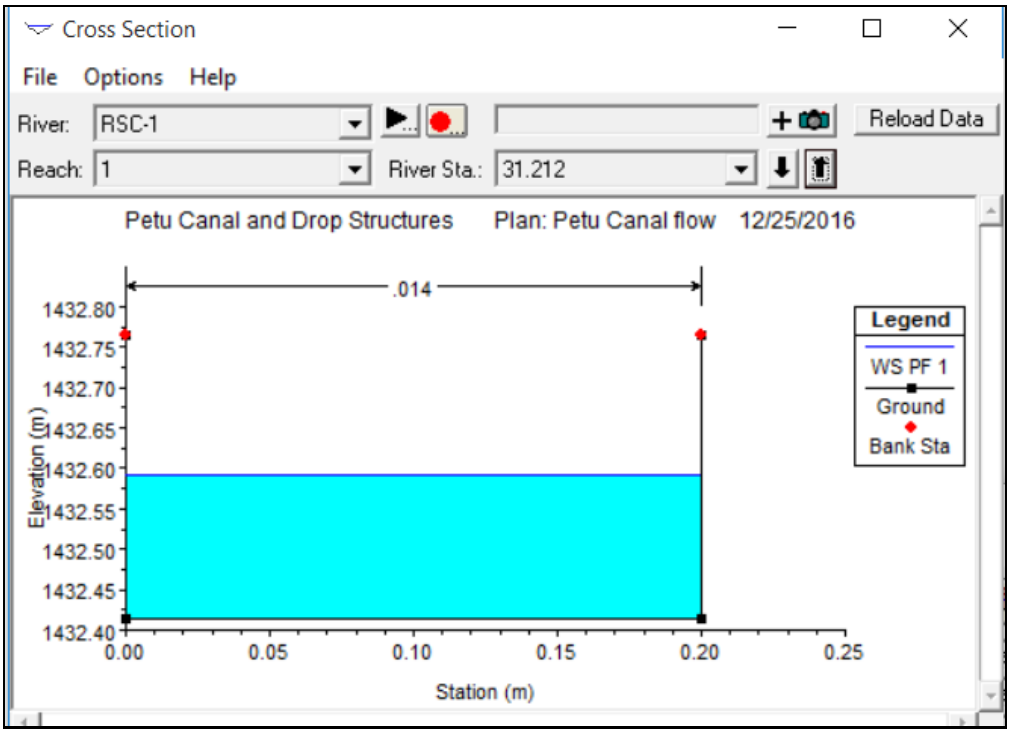
- This table provides water surface elevation, velocity, Froude number, area, width, energy grade line etc. Many more options are available under options/define table.
- we can go back to the main menu and the plot profile tab to examine the flow profile



- On the main menu click view 3D multiple cross section tab to visualize the canal flow in three-dimension perspective.



- On the main menu click view cross section tab



You are done!!!

4 MANNUAL FOR Z-PROFILE, L-SEC

4.1 BASIC KNOWLEDGE OF Z-PROFILE AND L-SEC

4.1.1 The Z-profile & L-sec software suite

Z-Profile is an Auto-LISP and L-Sec is a VB.net routines routine to facilitate the generation of profile drawings from data prepared in Excel spreadsheets. It has been tested for compatibility with AutoCAD and IntelliCAD. to meet the needs of irrigation and drainage projects, for which large numbers of profile drawings are required.

4.1.2 Purpose

Both Z-Profile and L-Sec are application software's that are used to prepare profile drawing including:

- Irrigation and Drainage Canals Profiles
- Sprinkler and Drip Main and Sub Main Profiles
- Water supply Delivery and distribution profiles
- Road Profiles

4.1.3 Scope

This guideline covers the basic procedures for Diversion weir, Irrigation canal and selected Irrigation canal structures (Case study of Petu SSI Project).

4.1.4 Computer requirements

Pentium III with Microsoft, Windows XP, Vista or Windows 7, 1024x768 display or higher

4.2 CASE STUDY FOR PETU CANAL PROFILE PREPARATION

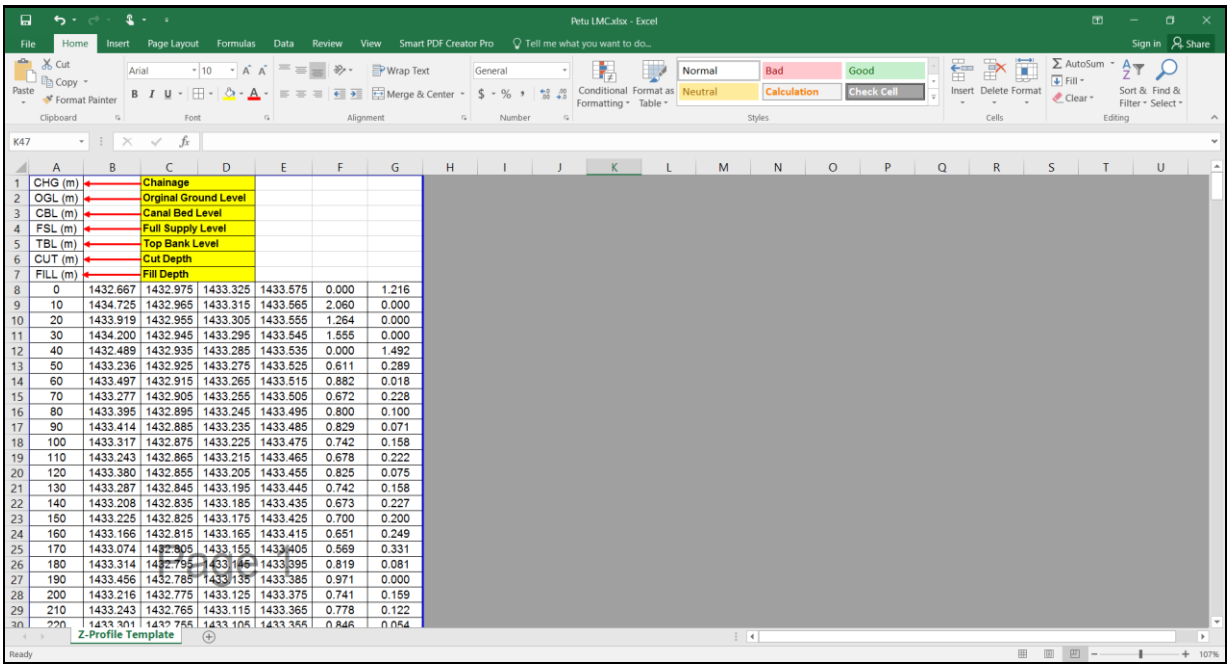
4.2.1 Preparation of working environment

This practical exercise will help how to prepare Irrigation and drainage canal profile drawing preparation for Petu SSIP.

4.2.2 Getting started for Z-Profiles

Installation
For AutoCAD users, copy Zprofile.dcl and Zprofile.lsp into the C:\Program Files (x86)\AutoCAD \support directory.

Data preparation
Z-Profile will handle up to 9 sets of data. The first column contains the X-axis (chainage/ station) data. The other columns contain level data. A typical calculation spreadsheet is shown in Figure below.



	A	B	C	D	E	F	G
1	CHG (m)	←	Chainage				
2	OGL (m)	←	Orginal Ground Level				
3	CBL (m)	←	Canal Bed Level				
4	FSL (m)	←	Full Supply Level				
5	TBL (m)	←	Top Bank Level				
6	CUT (m)	←	Cut Depth				
7	FILL (m)	←	Fill Depth				
8	0	1432.667	1432.975	1433.325	1433.575	0.000	1.216
9	10	1434.725	1432.965	1433.315	1433.565	2.060	0.000
10	20	1433.919	1432.955	1433.305	1433.555	1.264	0.000
11	30	1434.200	1432.945	1433.295	1433.545	1.555	0.000
12	40	1432.489	1432.935	1433.285	1433.535	0.000	1.492
13	50	1433.236	1432.925	1433.275	1433.525	0.611	0.289
14	60	1433.497	1432.915	1433.265	1433.515	0.882	0.018
15	70	1433.277	1432.905	1433.255	1433.505	0.672	0.228
16	80	1433.395	1432.895	1433.245	1433.495	0.800	0.100
17	90	1433.414	1432.885	1433.235	1433.485	0.829	0.071
18	100	1433.317	1432.875	1433.225	1433.475	0.742	0.158
19	110	1433.243	1432.865	1433.215	1433.465	0.678	0.222
20	120	1433.380	1432.855	1433.205	1433.455	0.825	0.075
21	130	1433.287	1432.845	1433.195	1433.445	0.742	0.158
22	140	1433.208	1432.835	1433.185	1433.435	0.673	0.227
23	150	1433.225	1432.825	1433.175	1433.425	0.700	0.200
24	160	1433.166	1432.815	1433.165	1433.415	0.651	0.249
25	170	1433.074	1432.805	1433.155	1433.405	0.569	0.331
26	180	1433.314	1432.795	1433.145	1433.395	0.819	0.081
27	190	1433.456	1432.785	1433.135	1433.385	0.971	0.000
28	200	1433.216	1432.775	1433.125	1433.375	0.741	0.159
29	210	1433.243	1432.765	1433.115	1433.365	0.778	0.122

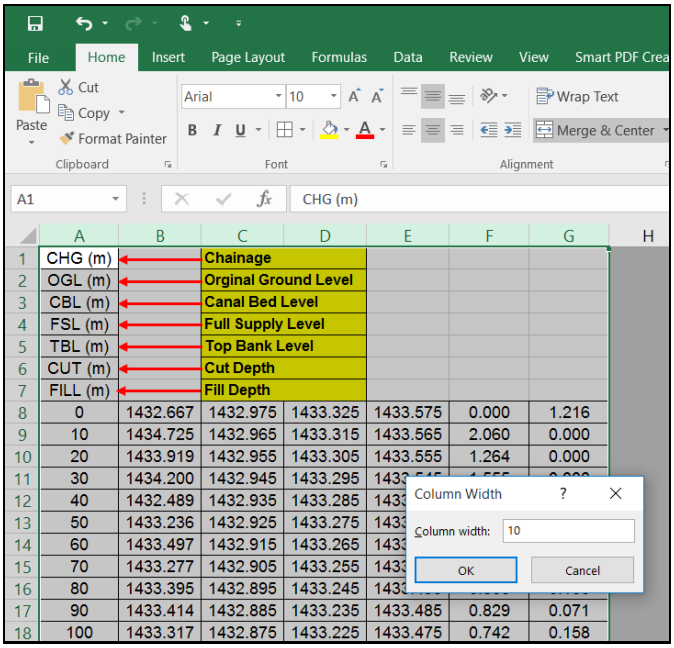
Zprofile can handle blank data in any of the columns, i.e. there does not need to be a complete set of data for each chainage.

The data have to be input as a fixed format text file containing

I. The data title (as required on the drawing) for each column;
II. Each data column 9 characters wide.

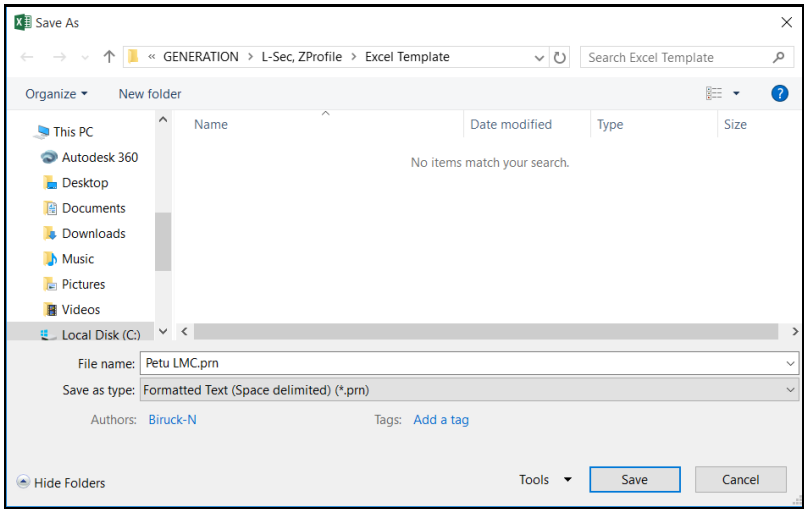
The process to create this file from an Excel spreadsheet is

- Select the visible columns and change the width to 10 (Format > Column > Width)
- Insert rows for the data column headings and type in the headings in the first visible column



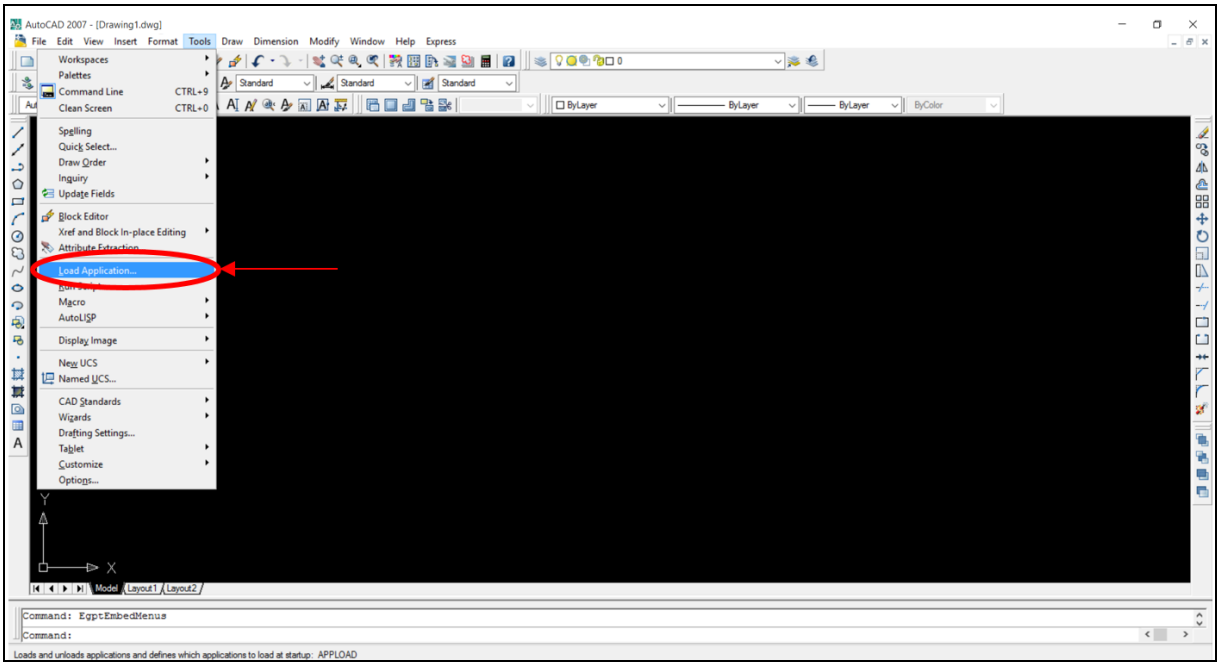
	A	B	C	D	E	F	G	H
1	CHG (m)	←	Chainage					
2	OGL (m)	←	Orginal Ground Level					
3	CBL (m)	←	Canal Bed Level					
4	FSL (m)	←	Full Supply Level					
5	TBL (m)	←	Top Bank Level					
6	CUT (m)	←	Cut Depth					
7	FILL (m)	←	Fill Depth					
8	0	1432.667	1432.975	1433.325	1433.575	0.000	1.216	
9	10	1434.725	1432.965	1433.315	1433.565	2.060	0.000	
10	20	1433.919	1432.955	1433.305	1433.555	1.264	0.000	
11	30	1434.200	1432.945	1433.295	1433			
12	40	1432.489	1432.935	1433.285	1433			
13	50	1433.236	1432.925	1433.275	1433			
14	60	1433.497	1432.915	1433.265	1433			
15	70	1433.277	1432.905	1433.255	1433			
16	80	1433.395	1432.895	1433.245	1433			
17	90	1433.414	1432.885	1433.235	1433.485	0.829	0.071	
18	100	1433.317	1432.875	1433.225	1433.475	0.742	0.158	

- Note: Each Columns should be filled as indicated below
  - Column A = Chainage Data
  - Column B = Original Ground Data
  - Column C = Canal Bed Level Data
  - Column D = Full Supply Level Data
  - Column E = Top Bank Level Data
  - Column F = Cut Depth Data
  - Column G = Fill Depth Data
  - Remember the file name, location and number of columns of data
  - Recommended data range is 50
- Save the file as Formatted Text (space delaminated). This will receive a. prn suffix by default.

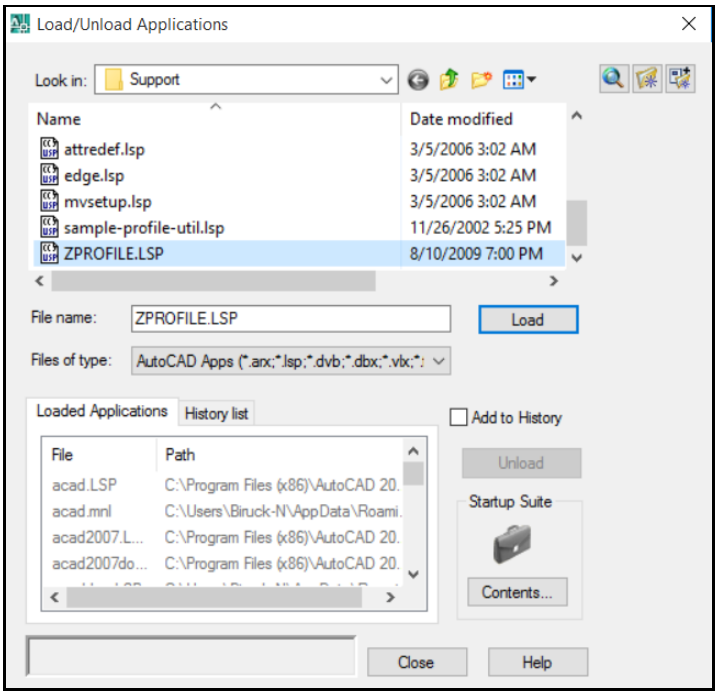


4.2.3 Plotting a long section with Z-Profile

- Open the AutoCAD program and from the Tools menu select Load application

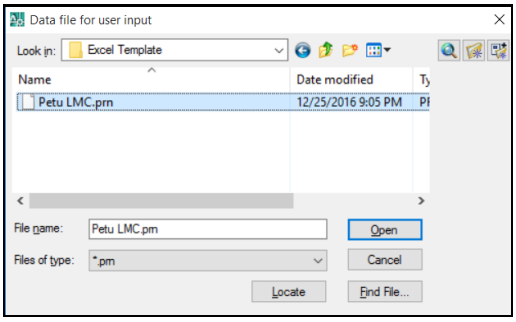


- Type Zprofile.lsp in the file name and press Load

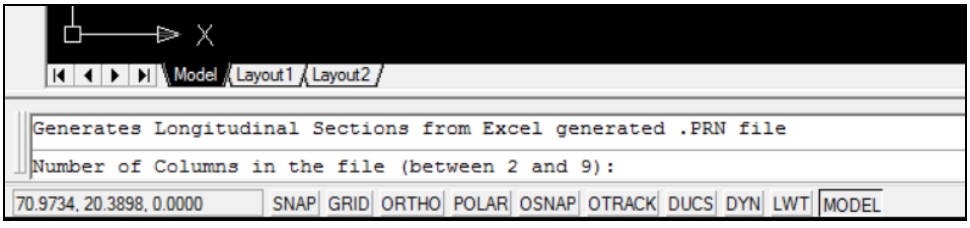


- Type Zprofile to run the program press Enter

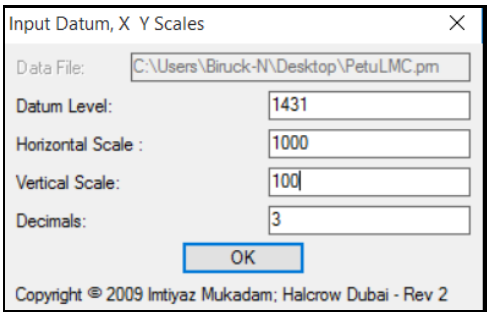
- Select the data file and press Open



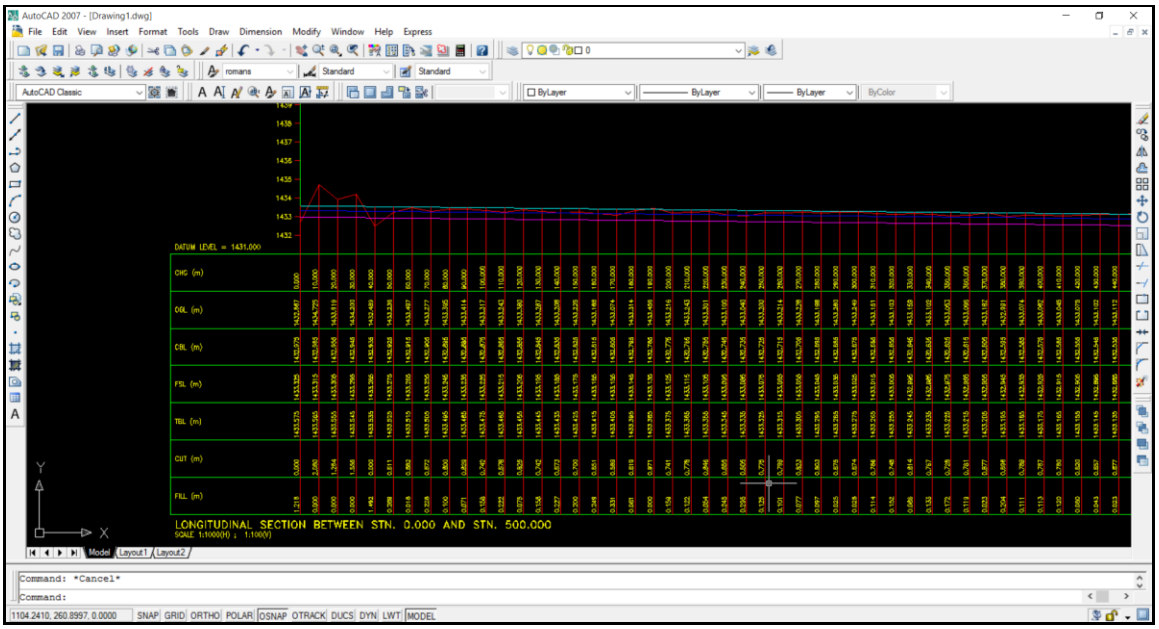
- Enter 7 as number of columns and press Enter



- Zprofile then loads the data and presents a dialogue box with suggested default values for the scales or it can be adjusted as required.



- Zprofile will then draw the profile

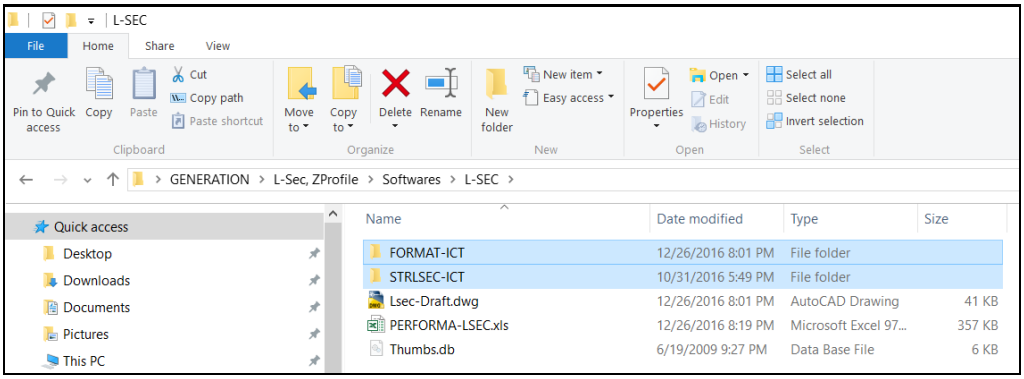


- The profile will then need to be edited to suit the needs of the project

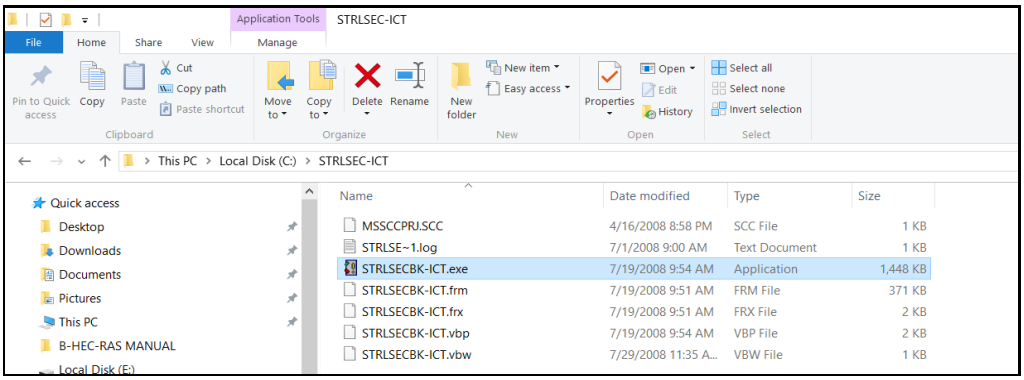
4.2.4 Getting started for L-Sec

Installation

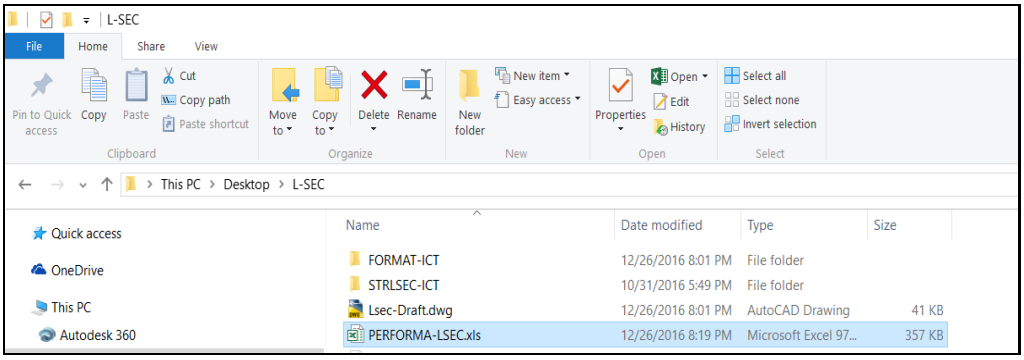
- For AutoCAD users, copy FORMAY-ICT and STRLSEC-ICT into the C:\ directory.



- Copy and paste STRLSECBK-ICT.exe from STRLSECBK-ICT folder on the desktop

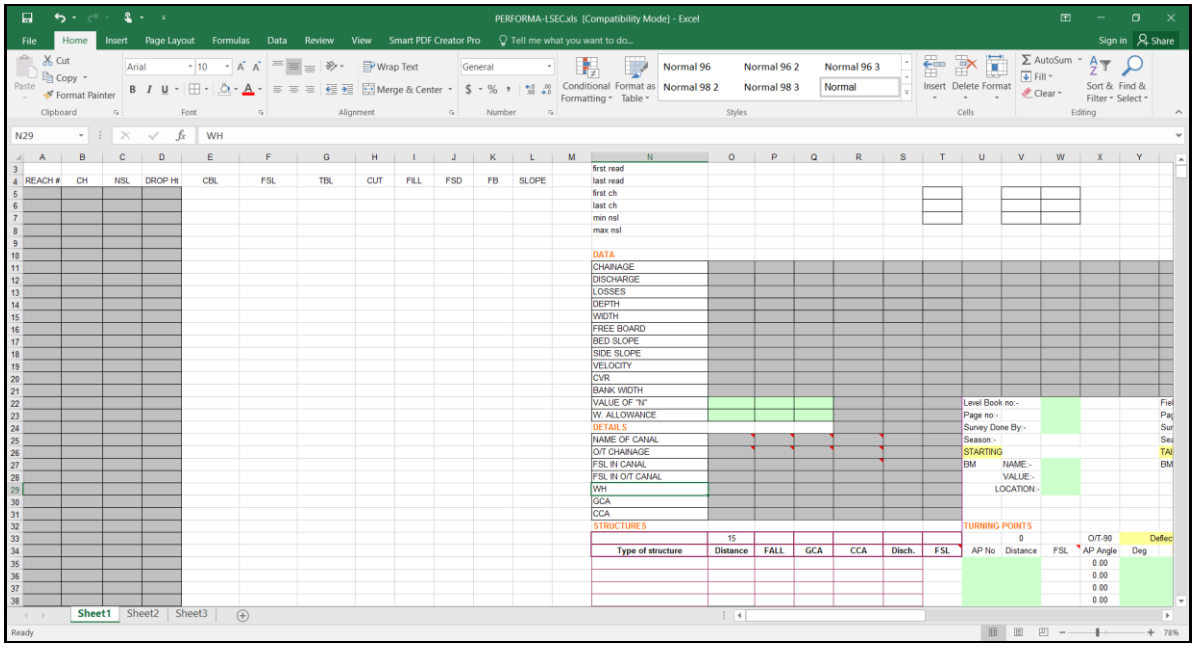


- Similarly Copy and paste PERFORMA-LSEC.xls from L-sec folder on the desktop



- Now you are ready to prepare data to prepare profile drawing

L-Sec will handle up to 7 sets of data. It is important to recall the columns are assigned to specific data. A typical L-Sec spreadsheet is shown in Figure below.



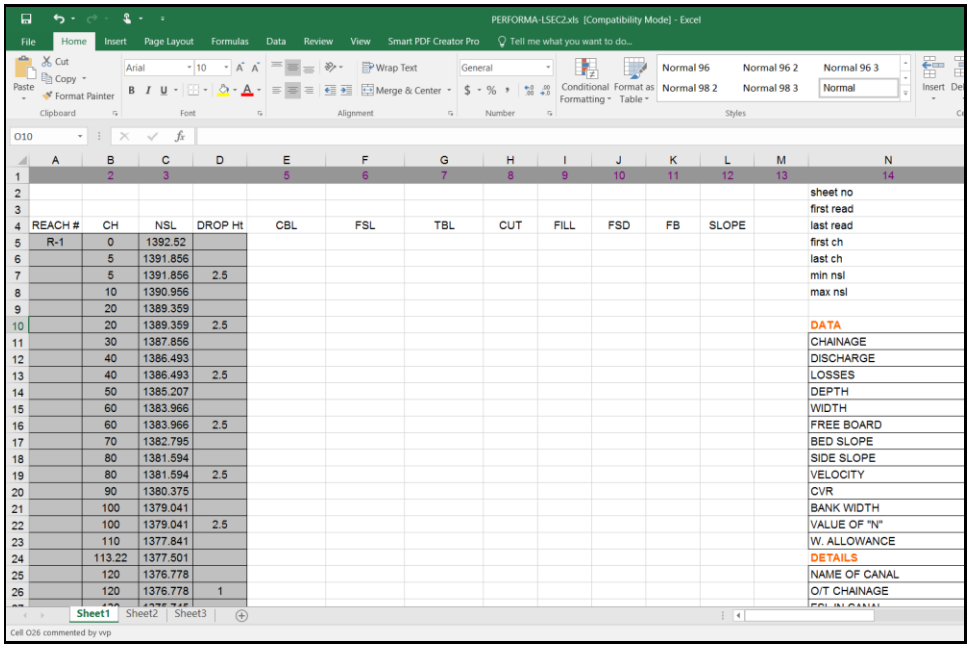
Brief Description Items in Performa spread Sheet

- REACH # = is a column in which Reach number is entered (R-1, R-2…)
- CH = is a column in which Chainage or Station data is entered (0,20,40…)
- NSL = is a column in which Original ground data is entered (1432,1433,1425….)

- DROP Ht = is a column in which Fall/Head loss data is entered (0.5,1,1.5….)
- CBL = is a column in which Designed Canal Bed Level data is entered (1430.5,1430.2,1430.1….)
- FSL = is a column in which Designed Full Supply Level data is entered (1431.0,1430.7,1430.6….)
- TBL = is a column in which Designed Top Bank Level data is entered (1431.0,1430.7,1430.6….)
- CUT = is a column in which Cut depth data is entered (0.2,0.85,0.45….)
- FILL = is a column in which Fill height data is entered (0.5,0.75,0.55….)
- FSD = is a column in which Full Supply Depth data is entered (0.5,0.4,0.35….)
- FB = is a column in which Free Board data is entered (0.3,0.25,0.15….)
- SLOPE = is a column in which Longitudinal Slope data is entered (500,400,150….)
- CHAINAGE = is a raw in which Station at the Reach location is entered (0,20,40…)
- DISCHARGE = is a raw in which discharge at the respective Reach is entered (0.4,0.6,0.2…)
- LOSSES = is a raw in which Head loss at the respective Reach is entered (0.1,0.15,0.2…)
- DEPTH = is a raw in which Full Supply Depth at the respective Reach is entered (0.1,0.2,0.3…)
- WIDTH = is a raw in which Canal bed width at the respective Reach is entered (0.1,0.2,0.3…)
- FREE BOARD = is a raw in which Free Board at the respective Reach is entered (0.1,0.2,0.3…)
- BED SLOPE = is a raw in which Free Board at the respective Reach is entered (500,400,150….)
- SIDE SLOPE = is a raw in which Side Slope at the respective Reach is entered (1,1.5,2….)
- VELOCITY = is a raw in which velocity at the respective Reach is entered (0.6,0.5,0.9….)
- CVR = is a raw in which Critical Velocity Ratio at the respective Reach is entered (0.9,0.95,1….)
- BANKWIDTH = is a raw in which Bank width at the respective Reach is entered (0.5,1,1.5….)
- VALUE OF "N" = is a raw in which Manning's value at the respective Reach is entered (0.025….)
- W. ALLOWANCE = is a raw in which Canal Duty at the respective Reach is entered (1.2,1.5….)
- NAME OF CANAL = is a raw in which the name of a canal is entered (LMC-1, RMC-1….)
- O/T CHAINAGE = is a raw in which Off taking canal Chainage is entered (0,20,40…)
- FSL IN CANAL = is a raw in which Full Supply Level of parent canal is entered (1431.0,1430.7,1430.6….)
- FSL IN O/T CANAL = is a raw in which Full Supply Level of off taking canal is entered
- WH = is a raw in which working head is entered
- GCA = is a raw in which Gross command area is entered at the respective Reach is entered (40,25….)
- CCA = is a raw in which Cultivable command area is entered at the respective Reach is entered (40,25….)
- Type of structure = is a column in which the name of structure at the respective reach is entered (Drop, TO…)

Data preparation

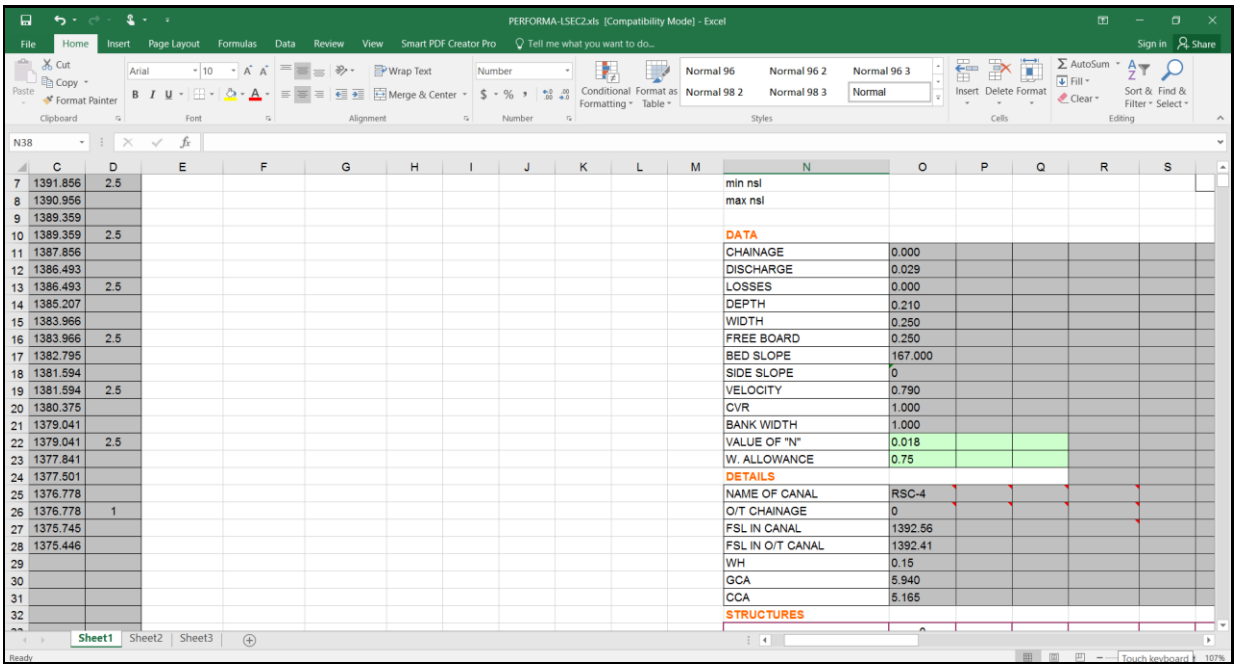
- For this exercise RSC-4 canal from Petu SSIP is selected
- Salient Features of RSC-4 (Refer Petu SSIP Design report)
  - Number of Reach = 1
  - CCA = 5.165
  - Manning's n =0.018
- At **REACH #** cell: A5 enter R-1 since it has only one reach
- Copy and Paste Cum.Dis (m) data from RSC-1.xls to **CH** column of PERFORMA.xls
- Copy and Paste OGL (m) data from RSC-1.xls to **NSL** column of PERFORMA.xls
- Drop structures exist at chainage 5, 20, 40, 60, 80, 100 and 120 with drop height of 1-2.5 m and enter the drop height at column of **DROP Ht** of PERFORMA.xls with corresponding chainage



REACH #	CH	NSL	DROP Ht	CBL	FSL	TBL	CUT	FILL	FSD	FB	SLOPE
R-1	0	1392.52									
	5	1391.856									
	5	1391.856	2.5								
	10	1390.956									
	20	1389.359									
	20	1389.359	2.5								
	30	1387.856									
	40	1386.493									
	40	1386.493	2.5								
	50	1385.207									
	60	1383.966									
	60	1383.966	2.5								
	70	1382.795									
	80	1381.594									
	80	1381.594	2.5								
	90	1380.375									
	100	1379.041									
	100	1379.041	2.5								
	110	1377.841									
	113.22	1377.501									
	120	1376.778									
	120	1376.778	1								

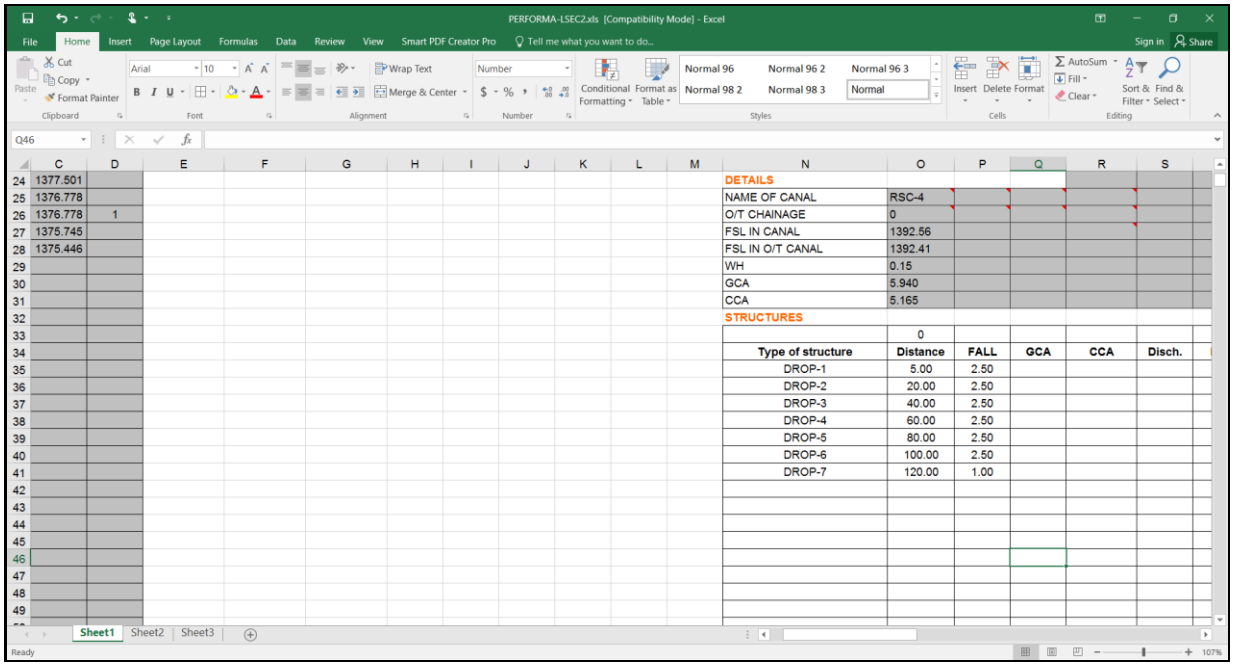
sheet no	
first read	
last read	
first ch	
last ch	
min nsl	
max nsl	
DATA	
CHAINAGE	
DISCHARGE	
LOSSES	
DEPTH	
WIDTH	
FREE BOARD	
BED SLOPE	
SIDE SLOPE	
VELOCITY	
CVR	
BANK WIDTH	
VALUE OF "N"	
W. ALLOWANCE	
DETAILS	
NAME OF CANAL	
O/T CHAINAGE	

- In similar pattern for **DATA** and **DETAIL** columns enter the corresponding data values
  - CHAINAGE = 0 (beginning of the reach)
  - DISCHARGE = 0.029
  - LOSSES = 0
  - DEPTH = 0.210
  - WIDTH = 0.250
  - FREE BOARD = 0.250
  - BED SLOPE = 167 i.e. 1/0.006
  - SIDE SLOPE = 0 i.e. Vertical cross
  - VELOCITY = 0.79
  - CVR = 1 or enter allowable value for respective canal lining
  - BANKWIDTH = 0.5
  - VALUE OF "N" = 0.018
  - W. ALLOWANCE = 0.75
  - O/T CHAINAGE = 0
  - FSL IN CANAL = 1392.56
  - FSL IN O/T CANAL = 1392.41
  - WH = 0.15
  - GCA = 5.940
  - CCA = 5.165



- For **STRUCTURE** data column enter values from the table to the respective location

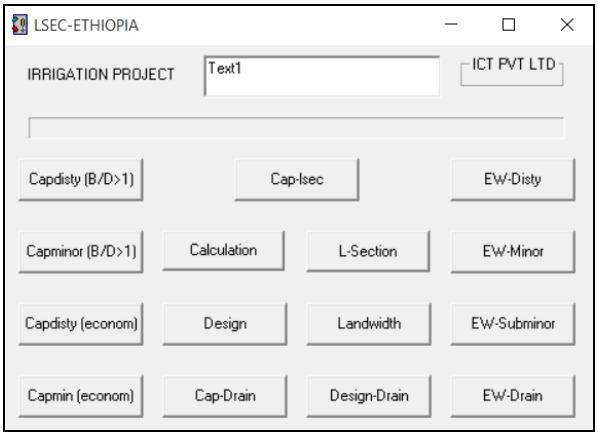
Type of structure	Distance	FALL
DROP-1	5.00	2.50
DROP-2	20.00	2.50
DROP-3	40.00	2.50
DROP-4	60.00	2.50
DROP-5	80.00	2.50
DROP-6	100.00	2.50
DROP-7	120.00	1.00



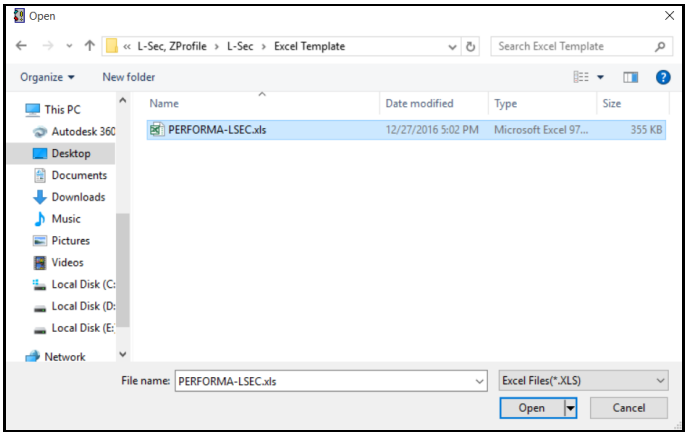
- Now it is ready to continue the calculation and Plotting the Longitudinal section
- *N.B. L-sec program unlike Z-profile is designed for Horizontal scale =300 and Vertical scale =100, whenever we need to change the scale we have to do it manually.*
- Save the file in any location that is comfortable for you

4.2.5 Plotting a long section with L-Sec

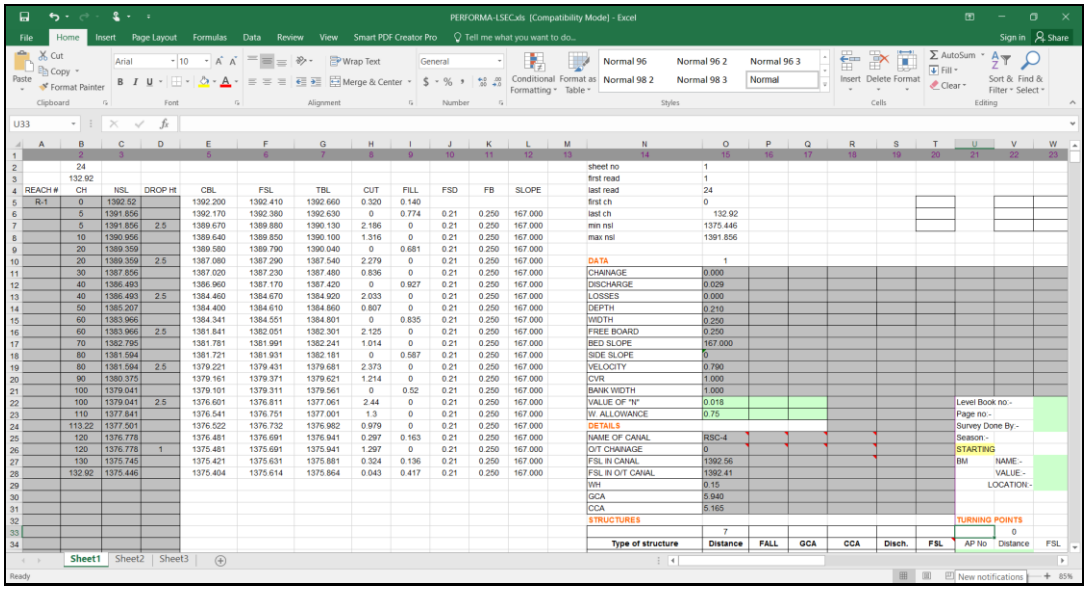
- Open Auto CAD window
- Double click STRLSECBK-ICT.exe from desktop and the following window will popup



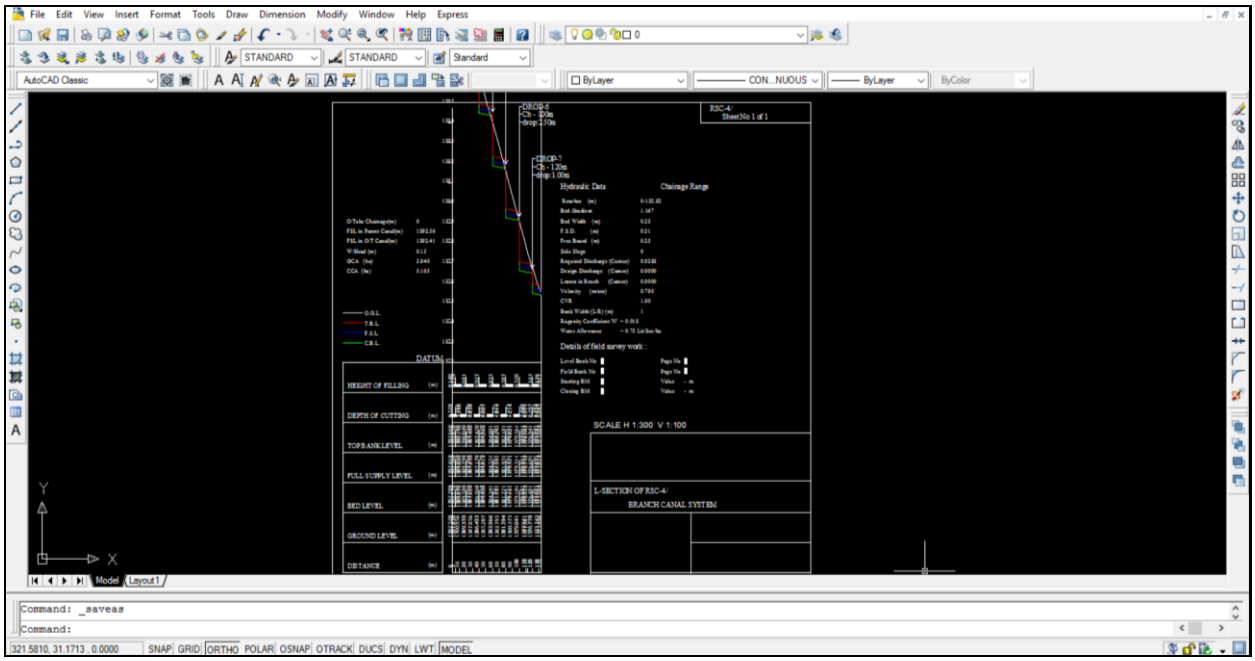
- Click Calculation button and select the PERFORMA-LSEC.xls file in which previously prepared.



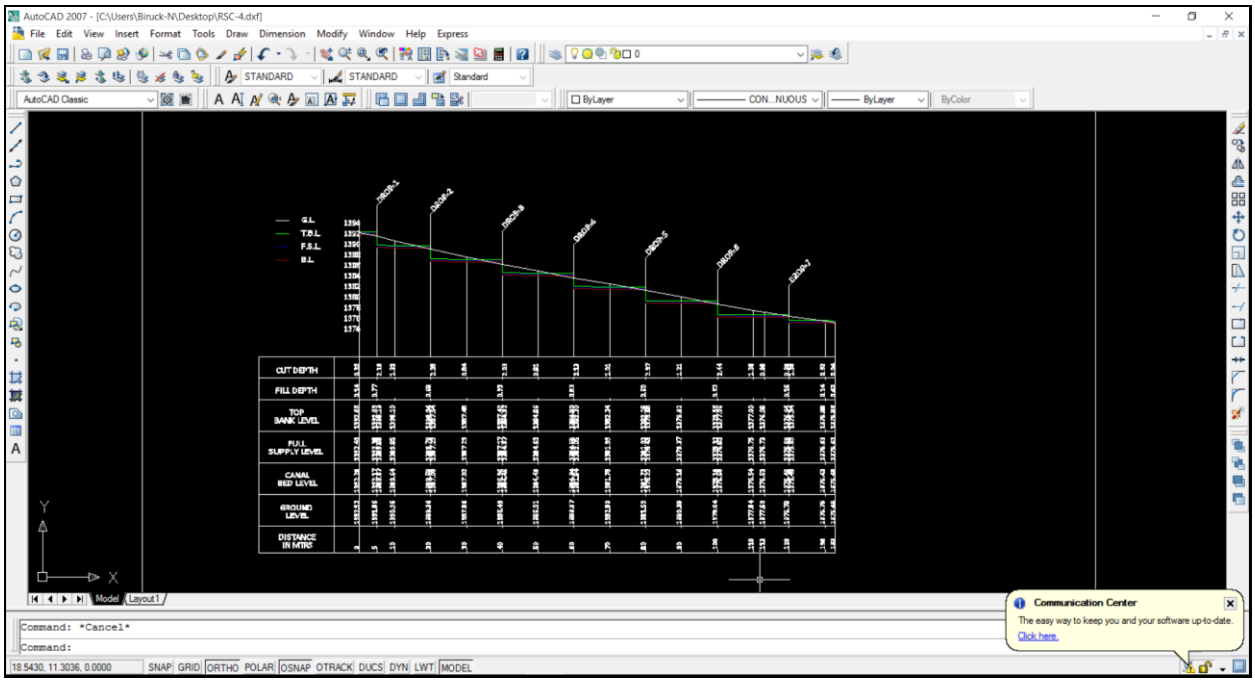
- When automatic calculation completed it will fill, CBL, FSL…. As shown in the figure



- Click L-section button again select the PERFORMA-LSEC.xls file in which the calculation has already carried out.
- N.B. don't forget to open blank AutoCAD window
- The initial Profile Drawing output should look like this and it needs manual editing i.e the scale and the fonts.



- The Final Profile Drawing output after editing the fonts and scale (H=700, V=500) Should look like this.



You are done!!!!

5 MANNUAL FOR STABILITY ANALYSIS OF MICRO DAM

5.1 BASIC KNOWLEDGE OF GEOSTUDIO

5.1.1 The geo studio software suite

It includes the following software products:

- SLOPE/W for slope stability analysis
- SEEP/W for groundwater seepage analysis
- SIGMA/W for stress and deformation analysis
- QUAKE/W for dynamic earthquake analysis
- TEMP/W for thermal analysis
- CTRAN/W for contaminant transport analysis
- AIR/W for air flow analysis
- VADOSE/W for vadose zone and soil cover analysis

5.1.2 Purpose

Geo-Studio is application software that is used to model almost any geotechnical problem including:

- Slope stability problems involving earth and rock slopes, including sloping Excavations, embankments, anchors, soil nails and geo-fabrics
- Seepage affected by infiltration, drains, and injection wells
- Deformation resulting from staged loading, excavations, and fill placement or removal
- Earthquake-induced deformation and pore-water pressure generation
- Contaminant transport problems
- Thermal conduction and transient
- Freeze-thaw problems
- Unsaturated soil behavior and more…

5.1.3 Scope

This guideline covers the basic procedures for Stability analysis of Micro Dam (Case study of Shimburit Earth Dam).

5.1.4 Computer requirements

Pentium III with Microsoft, Windows XP, Vista or Windows 7, (recommended: Intel dual-core processor with 1GB of RAM), 1024x768 display (recommended: 1280x1024 or higher).

5.2 CASE STUDY FOR STABILITY ANALYSIS OF SHIMBURIT EARTH DAM

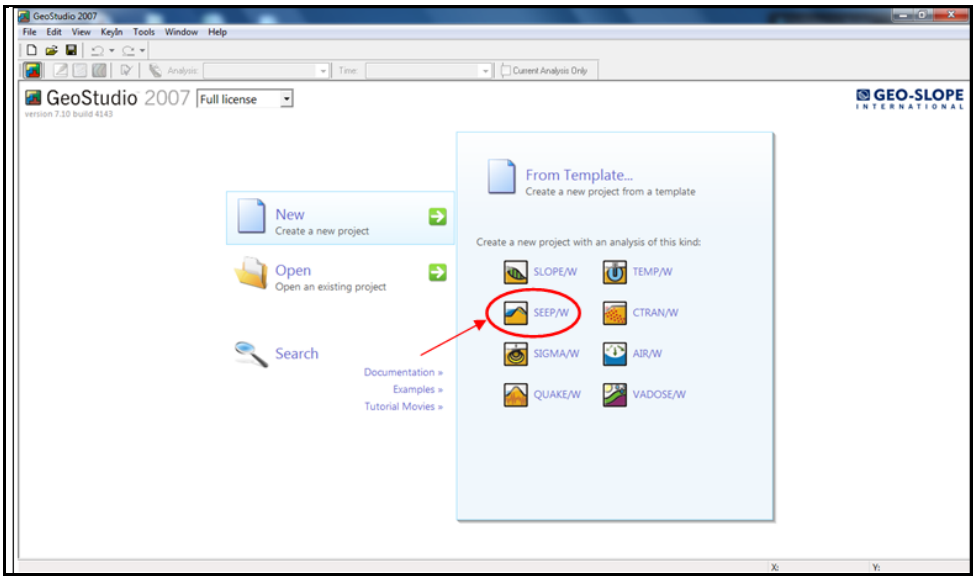
5.2.1 Preparation of working environment

This practical exercise will help to obtain the minimum factor of safety and the critical surface profile

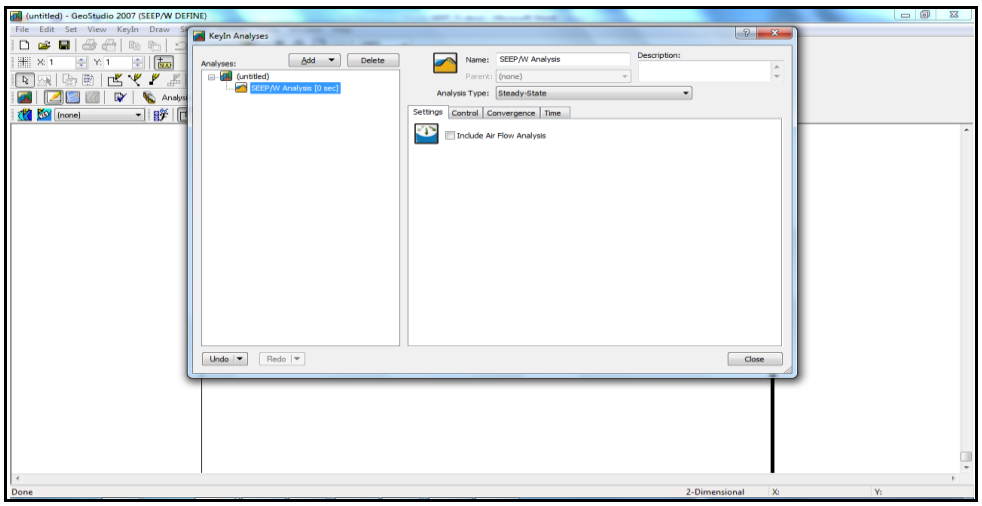
5.2.2 Getting started

Defining a project

- Creating a new SEEP/W project from the Start Page of GeoStudio



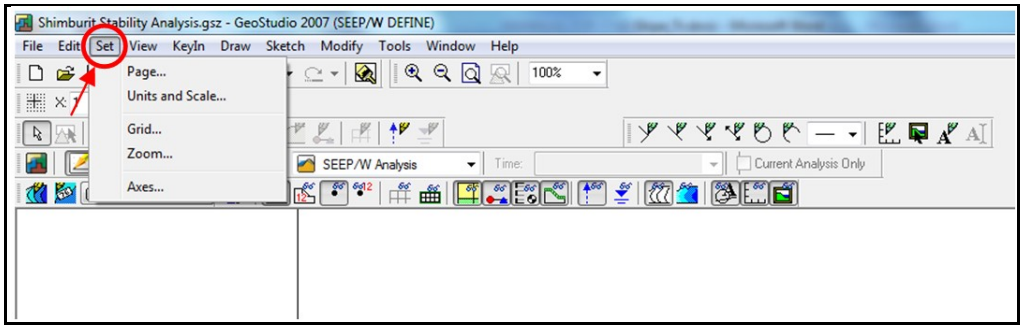
- Click SEEP/W to start a new project



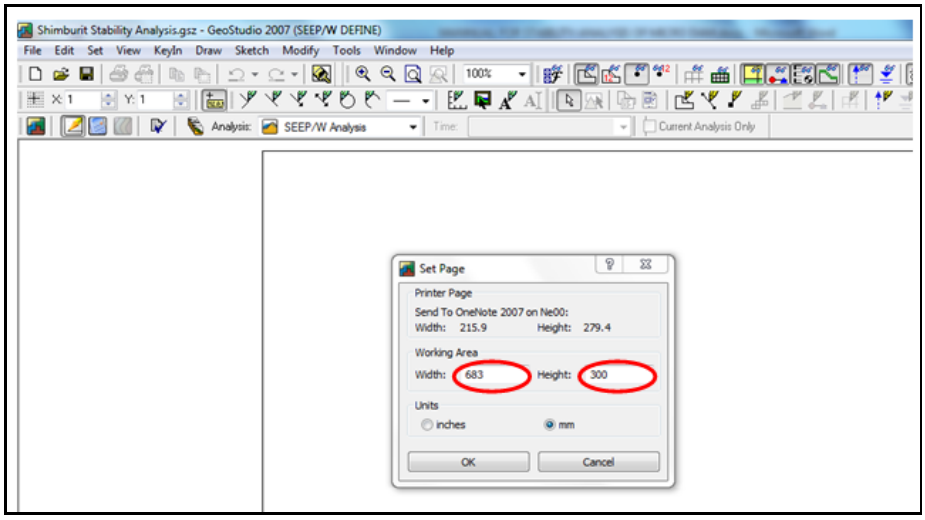
- Write the name of analysis as SEEP/W, and description as Shimburit Micro Dam.
- Analysis as: Steady-State Seepage Analysis and Description as SEEP/W Exercise
- Adapt the default values for the rest

Setting

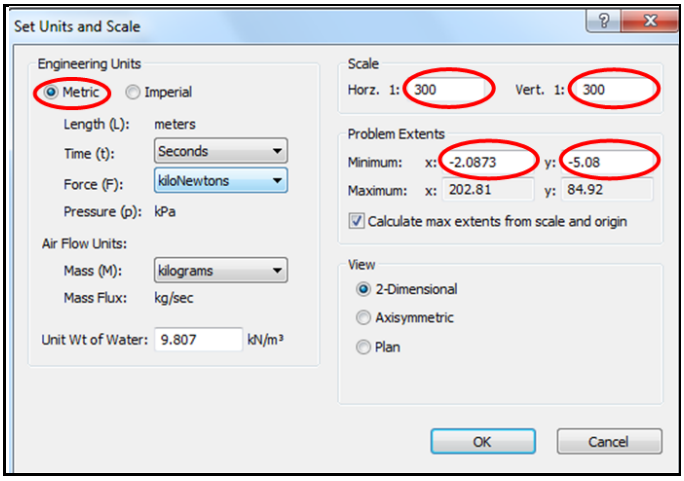
- Click set dialog box and select Page



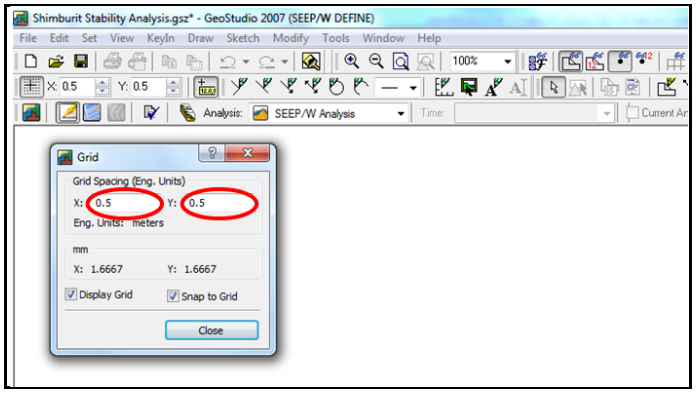
- Click mm to set dimension in SI unit, Width 683mm and Height 300mm ,Click Ok



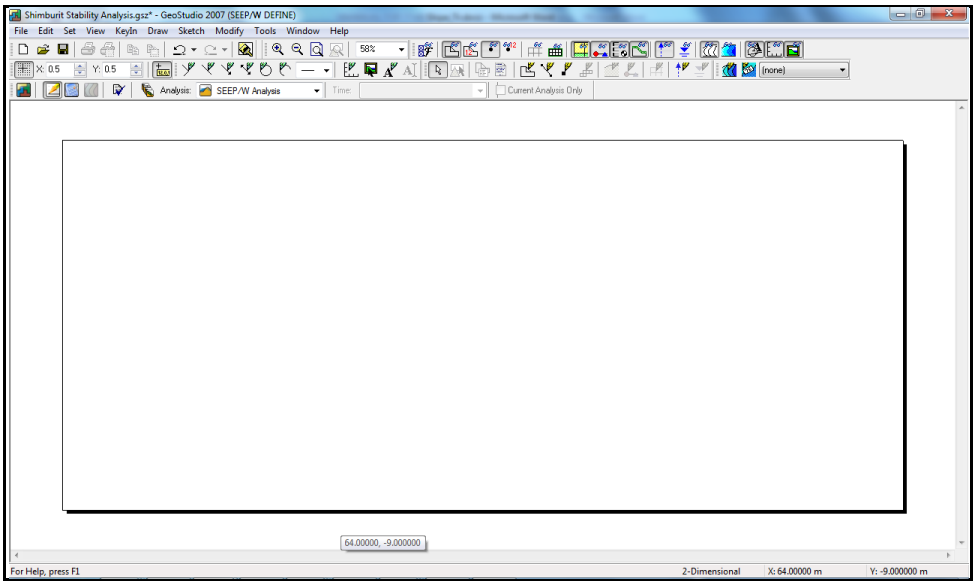
- Click set dialog box and select Units and Scale
- Choose SI Units for tick box
- Set scale for both horizontal and vertical as 1:300
- For Problem extents insert minimum X = -2.0873 and minimum Y= -5.08 the maximum extent computes automatically, Click ok



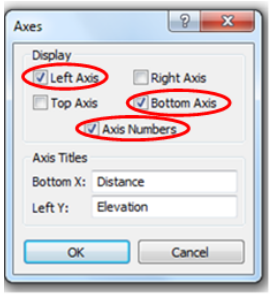
- Click set dialog box and select Grid
- Make the X:Y, aspect ratio 0.5:0.5, Tick both display grid and snap to grid and Close

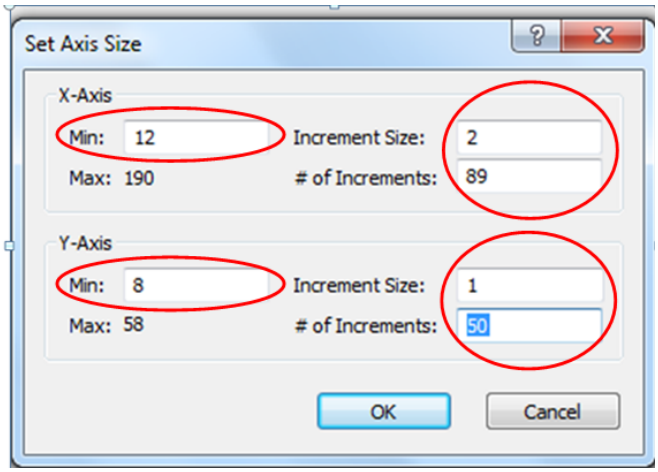


- Your final working area should look like this. It is recommended to save your file frequently

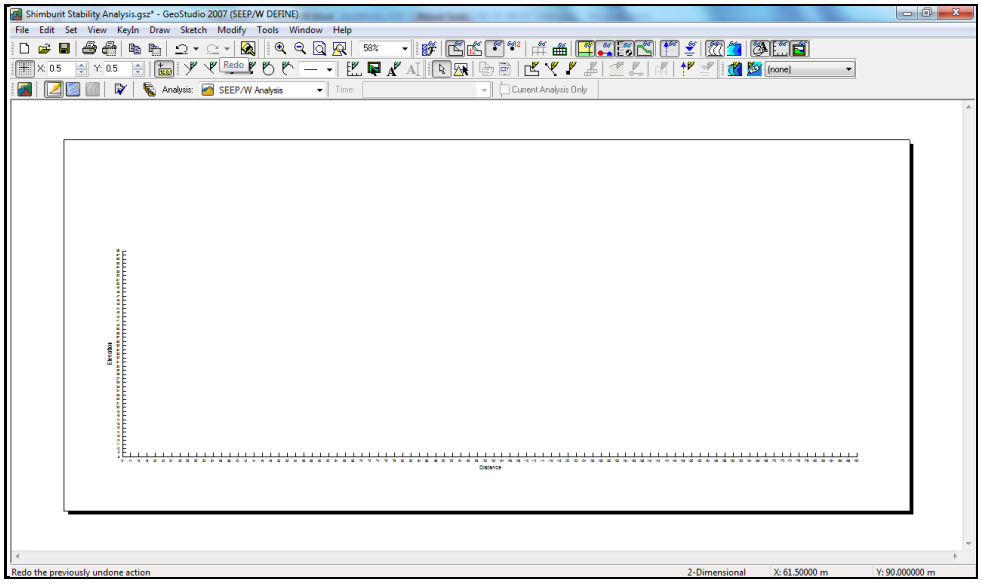


- Click set dialog box and select Axes
- Tick Left Axes, Bottom Axes and Axis Number then Click ok





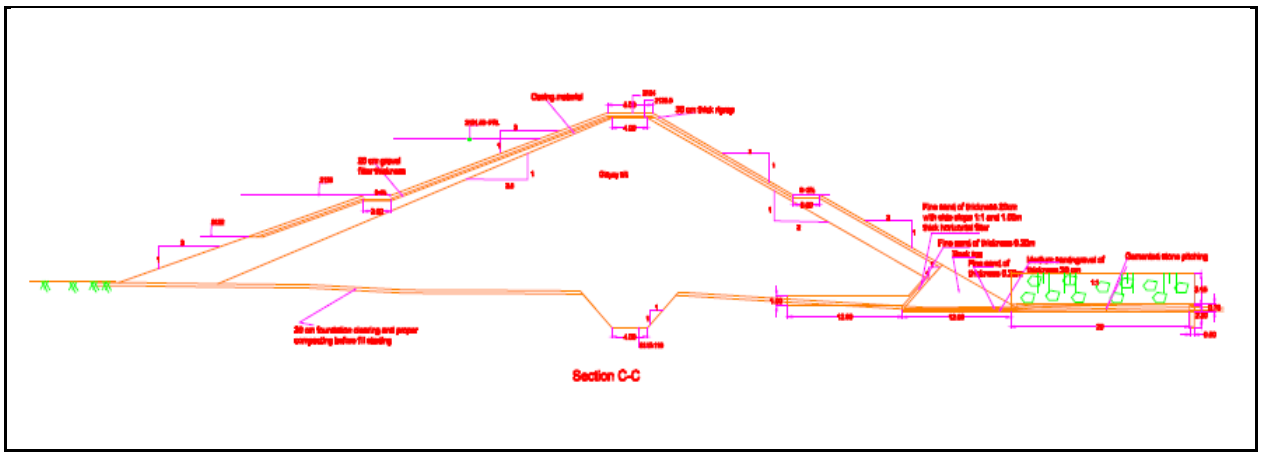
- On Set Axis size dialogue insert
  - X axis Min =12, Increment Size = 2 and # of increment = 89
  - Y axis Min = 8, Increment Size = 1 and # of increment = 50
- After Clicking ok Your final working area should look like this



5.2.3 Defining the geometry

Before defining the geometry in SEEP/W, it is convenient to first sketch the problem. It is planned to analyze the stability of a homogenous dam (refer Shimburit Dam Drawing).

- Dam height = 16.0 m
- Free board = 2.3 m
- Reservoir depth = 11m
- Top width = 5.0m
- U/s slope H:V = 3:1 and D/S slope H:V= 2:1
- It is going to rest on 4m soil and then competent rock beyond.

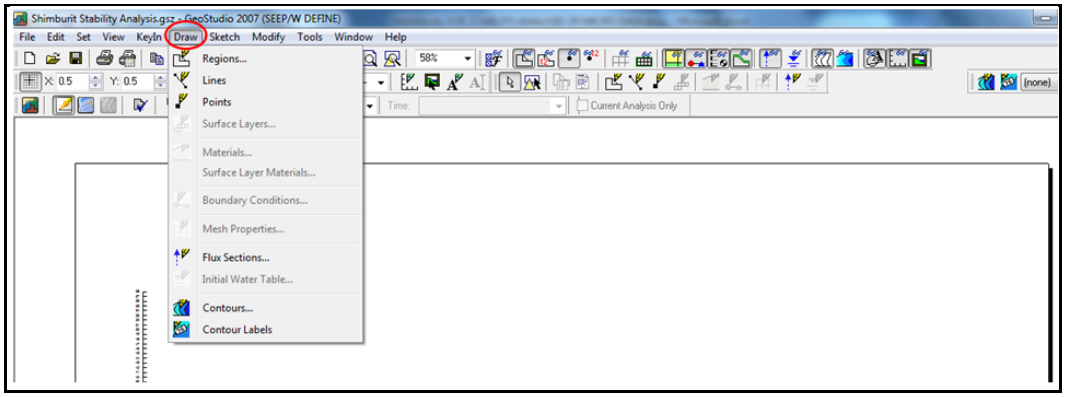


When creating the Shimburit model (Refer Drawing), first draw the geometry; create and assign materials, draw pore-water pressure conditions and draw the slip surface geometry, which will control the mode of failure you are going to analyze. The lines are considered as objects, which can be adjusted or deleted using the Modify: Objects command

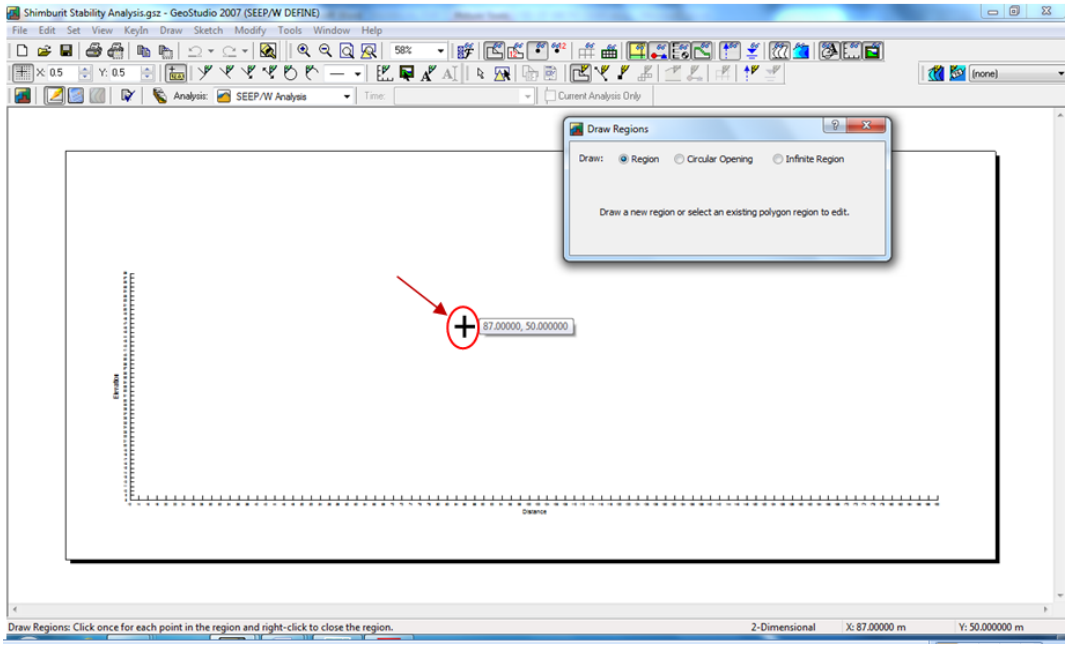
Drawing Geometry

Start by drawing the geometry of Individual embankment dam regions.

- Click Draw dialog box and select Region



When you click the region command you will get cross hair that will be used for plotting the region.



For this exercise there are six regions

- Region 1: Embankment Material
- Region 2: Filter Material (Fine Sand)
- Region 3: Filter Material (Medium Sand and Gravel)
- Region 4: Rock Toe Material
- Region 5: Foundation Material
- Region 6: Competent rock

Region will be created by clicking the coordinates that will define the required geometry and Click the left mouse button to create region points. Once the polygon region has been closed, you can either continue to draw additional regions, or you can exit the draw regions mode. Move the cursor to the following coordinates respectively in clockwise direction.

Regions	Material	Points
Region 1	Foundation Material-1	1,2,3,4
Region 2	Foundation Material-2	5,6,7,8
Region 3	Filter Material-1- (Fine Sand)	9,3,4,10,11,12,13,14,15
Region 4	Filter Material-2- (Medium Sand and Gravel)	13,16,17,18,19,20,15,14
Region 5	Filter Material-3- (Fine Sand)	20,21,22,19
Region 6	Closely Jointed Basalt Rock	7,23,24,25,26,18,19,22,21,20,15,9,3,2,27,28,5,8

Regions	Material	Points
Region 7	Embankment Material	29,30,31,32,33,34,16,13,12,11,10,4,1,2,27,28,5,6,7,35
Region 8	Rock Toe Material	17,16,34,18

1) Foundation material-1

- Draw region using X-Y values for Foundation Material-1 Staring from point 1 - point 4
- Click left mouse and then click right mouse to finish Foundation Material-1 region

	X (m)	Y (m)
Point 1	112.3887	19.0198
Point 2	112.1417	18.7870
Point 3	124.6833	18.1180
Point 4	124.6821	18.3899

2) Foundation material-2

- Draw region using X-Y values for Foundation Material-2 Staring from point 5 - point 8
- Click left mouse and then click right mouse to finish Foundation Material-2 region

	X (m)	Y (m)
Point 5	101.8302	18.695443
Point 6	101.4858	19.02025
Point 7	50.0877	20.0200
Point 8	50.0892	19.71985

3) Filter material-1- (Fine Sand)

- Draw region using X-Y values for Filter Material-1 Staring from point 9 - point 15
- Click left mouse and then click right mouse to finish Filter Material-1 region

	X (m)	Y (m)
Point 9	124.6838	17.7507
Point 3	124.6833	18.1180
Point 4	124.6821	18.3899
Point 10	124.6794	18.7459
Point 11	138.1737	18.7430
Point 12	139.9533	20.5016
Point 13	140.1273	20.4128
Point 14	137.4558	17.7514
Point 15	137.4558	17.7365

4) Filter material-2- (medium sand and gravel)

- Draw region using X-Y values for Filter Material-2 Staring from point 13 - point 16
- Click left mouse and then click right mouse to finish Filter Material-2 region

	X (m)	Y (m)
Point 13	140.1273	20.4128
Point 16	140.4216	20.266
Point 17	137.6864	17.5417
Point 18	150.2709	17.5388
Point 19	150.2719	17.3932
Point 20	137.454	17.3896
Point 15	137.455	17.7365
Point 16	140.4216	20.266

5) Filter material-3- (Fine sand)

- Draw region using X-Y values for Filter Material-2 Staring from point 20 - point 19
- Click left mouse and then click right mouse to finish Filter Material-3 region

	X (m)	Y (m)
Point 20	137.454	17.3896
Point 21	137.4527	17.1885
Point 22	150.2814	17.1819
Point 19	150.2719	17.3932

6) Closely jointed basalt rock

- Draw region using X-Y values for Basalt Rock Staring from point 7 - point 8
- Click left mouse and then click right mouse to finish Basalt Rock region

	X (m)	Y (m)
Point 7	50.0877	20.02
Point 23	25.0877	20.07
Point 24	25.1877	12.045
Point 25	175.0794	12.045
Point 26	175.2127	17.52
Point 18	150.2709	17.5389
Point 19	150.272	17.3932
Point 22	150.2814	17.1819
Point 21	137.4528	17.1885
Point 20	137.454	17.3896
Point 15	137.4558	17.7366
Point 9	124.6838	17.7507
Point 3	124.6833	18.118
Point 2	112.1418	18.7871
Point 27	108.8874	15.7198
Point 28	104.9862	15.7195
Point 5	101.8303	18.6954
Point 8	50.0892	19.7199

7) Embankment material

- Draw region using X-Y values for Embankment material Staring from point 29 - point 35
- Click left mouse and then click right mouse to finish Embankment material region

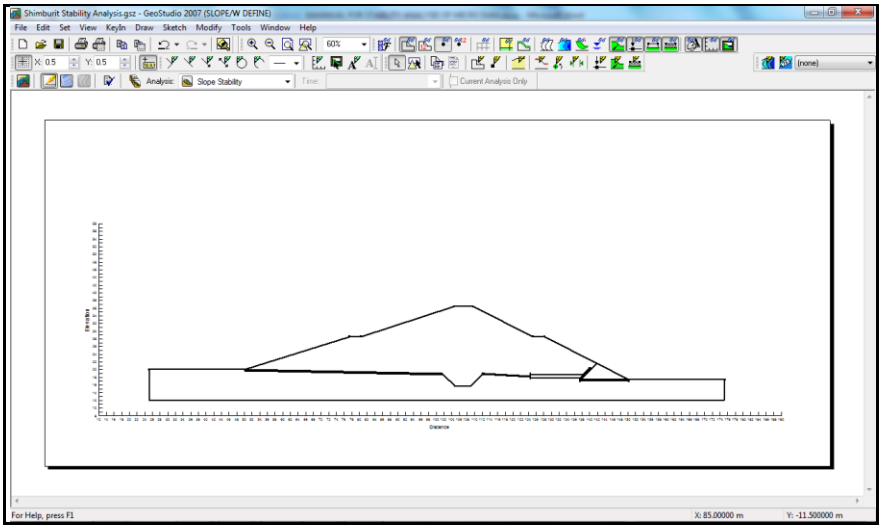
	X (m)	Y (m)
Point 29	80.3875	28.4706
Point 30	104.5954	36.5198
Point 31	109.5867	36.5196
Point 32	125.2863	28.519
Point 33	128.2866	28.5198
Point 34	141.8844	21.7296
Point 16	140.4216	20.266
Point 13	140.1273	20.4129
Point 12	139.9533	20.5017
Point 11	138.1737	18.7431
Point 10	124.6794	18.7459
Point 4	124.6821	18.39
Point 1	112.3887	19.0198
Point 2	112.1418	18.7871
Point 27	108.8874	15.7198
Point 28	104.9862	15.7195
Point 5	101.8303	18.6954
Point 6	101.4858	19.0203
Point 7	50.0877	20.02
Point 35	77.3926	28.4695

8) *Rock toe material*

- Draw region using X-Y values for Rock Toe Material Staring from point 17 - point 18
- Click left mouse and then click right mouse to finish Basalt Rock region

	X (m)	Y (m)
Point 17	137.6865	17.5417
Point 16	140.4216	20.2660
Point 34	141.8844	21.7296
Point 18	150.2709	17.5389

- Your final Drawing area should look like this.

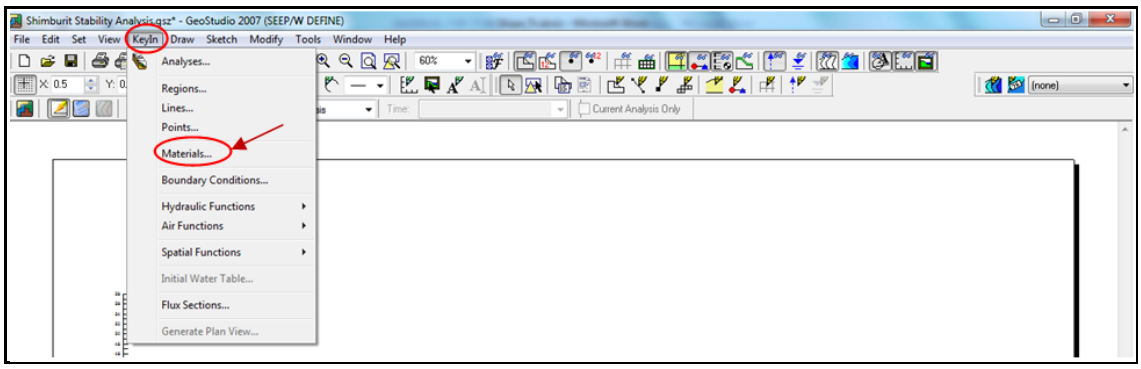


5.2.4 Creating materials

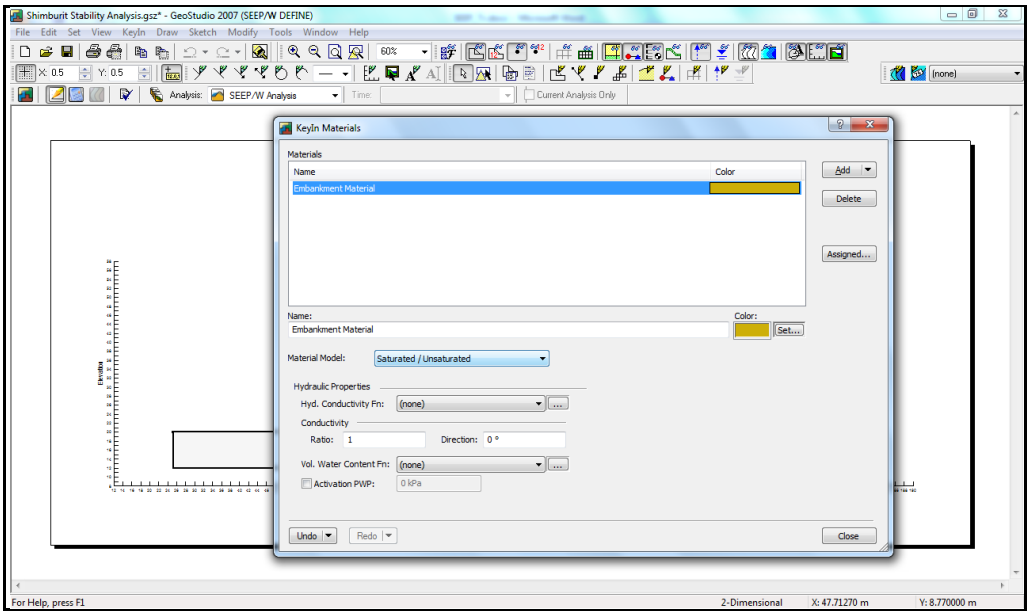
Materials are first created and then assigned to geometry objects.

Creating material

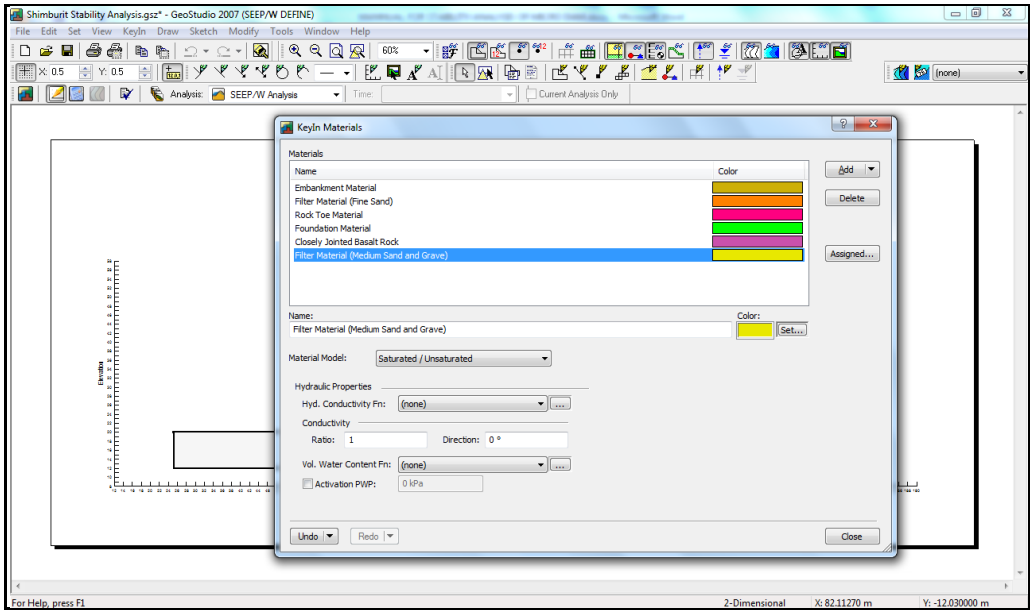
- Click on KEYIN and click Materials



- For the first region add a new material, name it as Embankment Material
- Material model from the drop down list as Saturated/Unsaturated
- Hydraulic Property as default or none



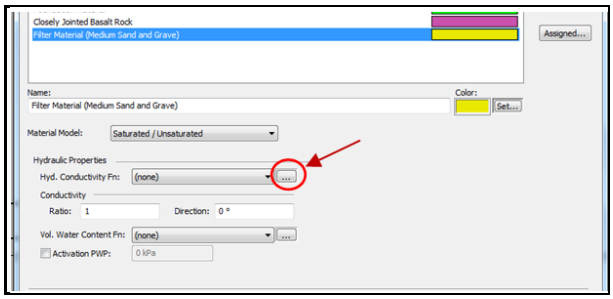
- For the rest of regions repeat the same step



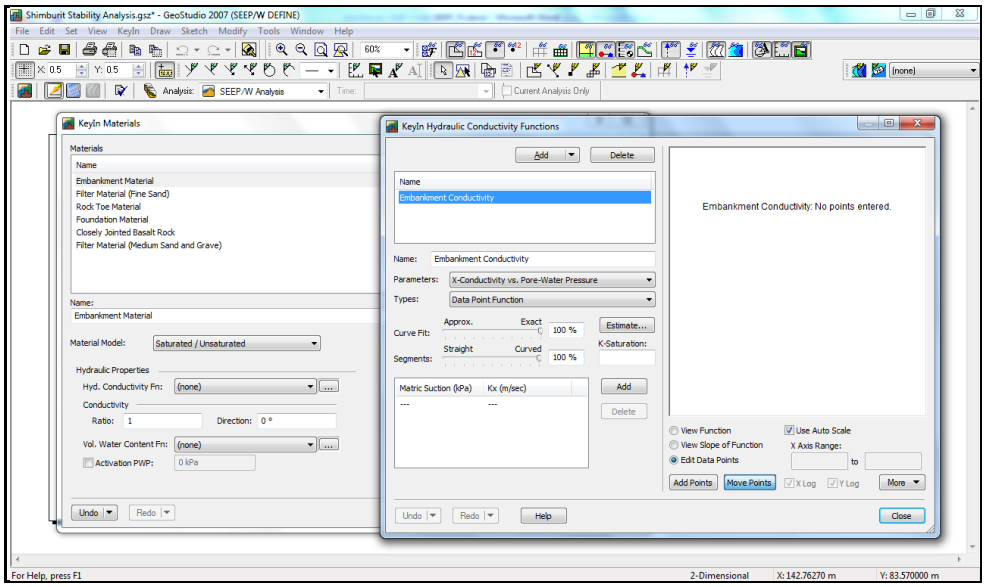
Setting the hydraulic conductivity function

For a steady-state analysis, only a conductivity function needs to be defined.

The "dot-dot-dot" button is used extensively in GeoStudio to indicate that additional features can be accessed. Click on this button to create a hydraulic conductivity function.



- Click on the "add" button, give the function a name as **Embankment Conductivity** and select the type from the dropdown list **Data Point Function**.

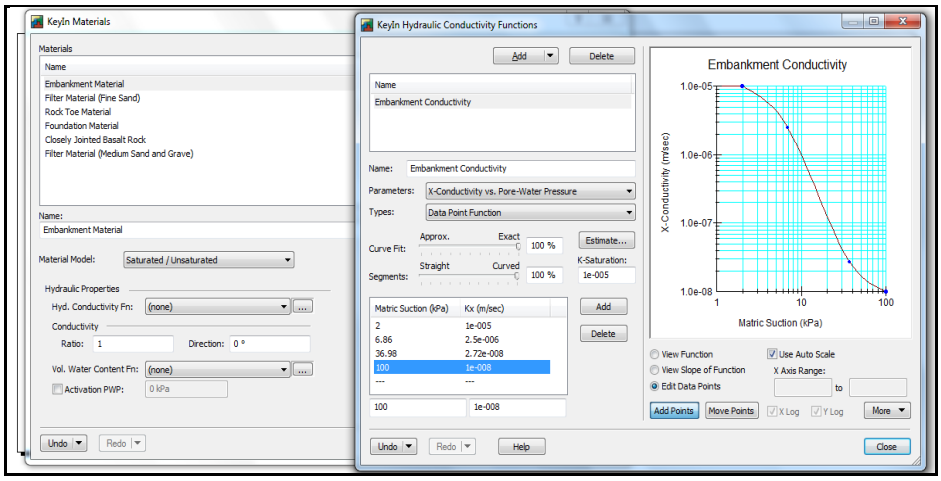


We are defining a data point function of Matric suction, which is a positive value, and a hydraulic conductivity. Often a 2-point function is sufficient as a starting point. Additional points can be added and adjusted by editing the function directly. It is also possible to insert the hydraulic function using the conductivity script function that will be given separately.

- Click Matric Suction and conductivity box to insert the following 4 points for embankment conductivity

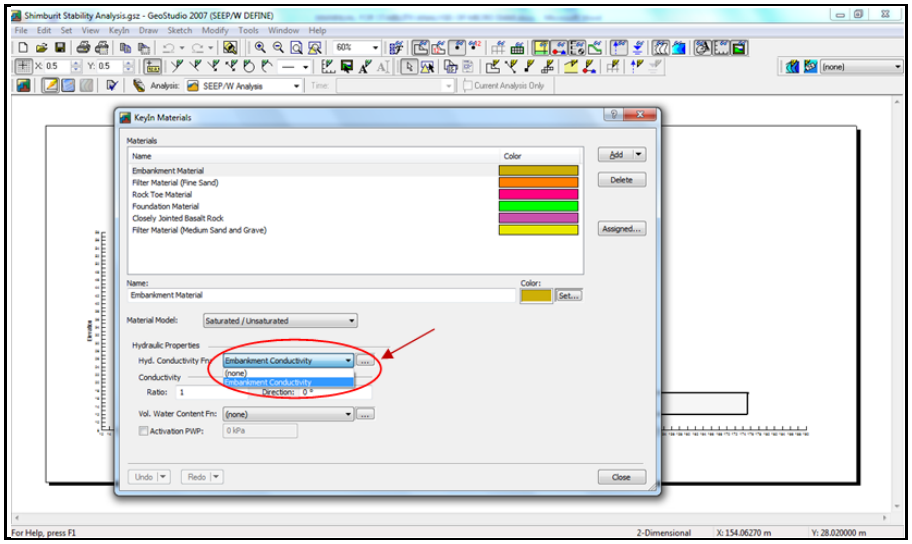
✓ ***Hydraulic conductivity values for Fine Sand Material***

Matric Suction (kPa)	Kx (m/s)
2	1e-5
6.86	2.50e-6
36.98	2.72e-8
100	1e-8



Click the **edit data points** at the bottom and then the **add points** to edit the graph and insert additional points. It is possible to adjust the graph by pulling the added points by clicking **move points** button.

Once you are happy with your function, you can then close the KEYIN: Hydraulic conductivity dialogue box to be returned to the KEYIN: Materials Properties view. From the Hydraulic properties functions (Hydraulic Conductivity function) click the dropdown menu to change it into Embankment Conductivity.



- Click Matric Suction and conductivity box to insert the following 4 points for the rest of materials as given in a table.

✓ ***Hydraulic conductivity values for Filter Material (Fine Sand)***

Matric Suction (kPa)	Kx (m/s)
2	0.0001
6.2	3.69e-05
20.81	5.12e-06
100	1.00e-06

✓ ***Hydraulic conductivity values for Filter Material (Medium Sand and Gravel)***

Matric Suction (kPa)	Kx (m/s)
2	0.001
8.55	0.000313
34.95	5.45e-05
100	1.00e-05

✓ ***Hydraulic conductivity values for Rock Toe Material***

Matric Suction (kPa)	Kx (m/s)
2	0.1
5.61	0.064795
19.24	0.021258
100	0.01

✓ ***Hydraulic conductivity values for Foundation Material***

Matric Suction (kPa)	Kx (m/s)
2	1e-007
5.80	2.3053445e-008
22.32	8.5039671e-010
100	1e-010

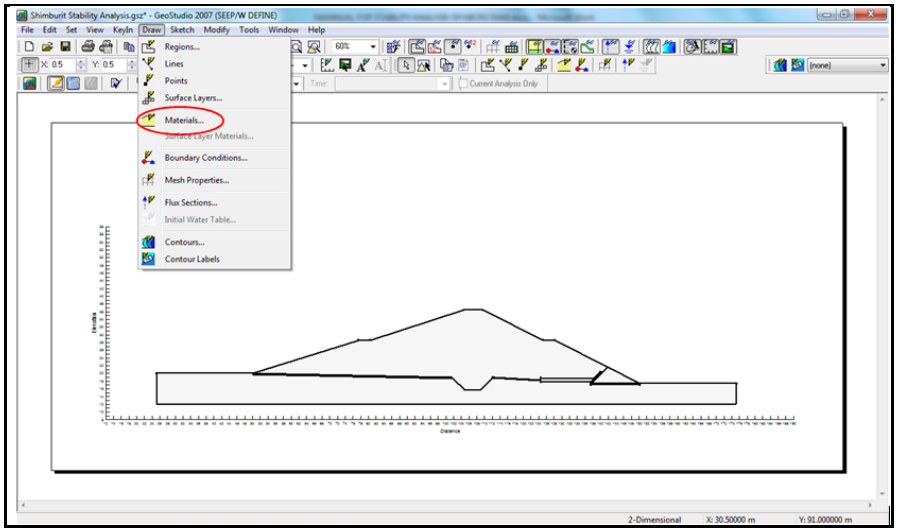
✓ ***Hydraulic conductivity values for Closely Jointed Basalt Rock***

Matric Suction (kPa)	Kx (m/s)
2	1.00e-15
6.31	4.99e-17
24.28	2.52e-19
100	1.00e-20

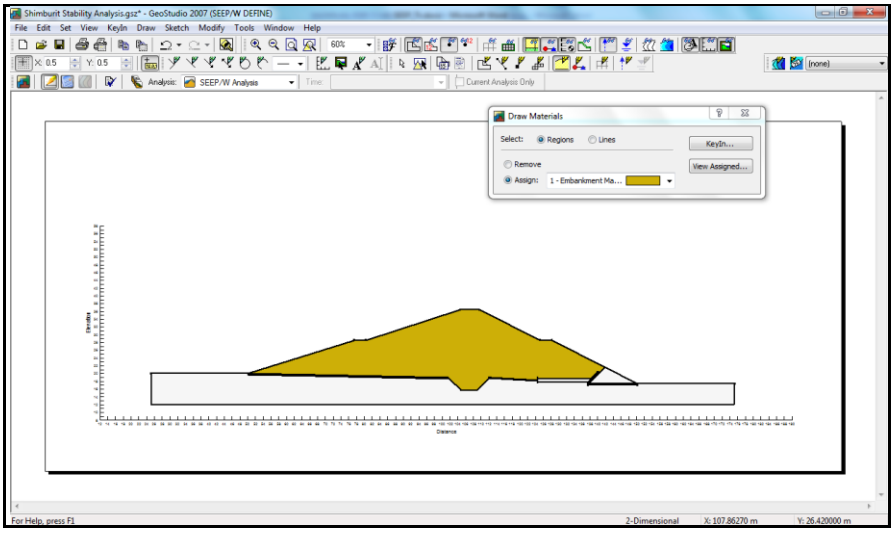
Assigning the material to the region

The function has now been assigned to the soil. The material can now be assigned to the geometry regions.

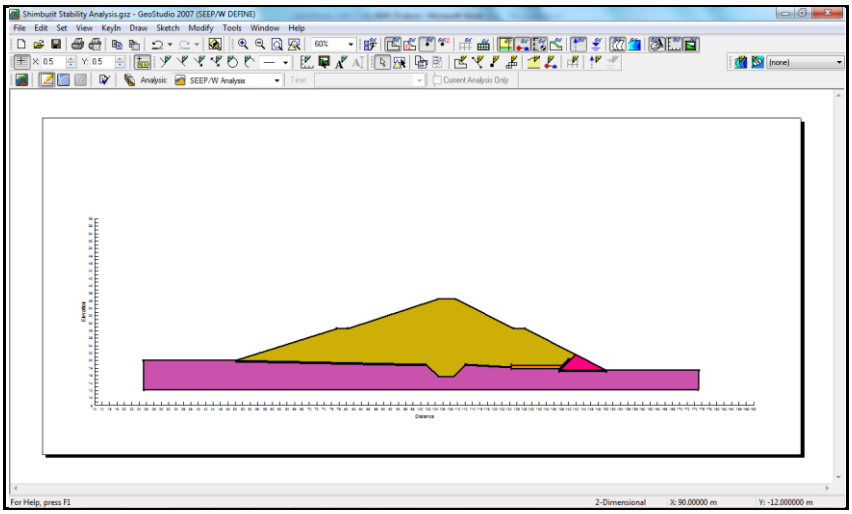
- Choose Materials from the DRAW dropdown menu to assign the material properties (hydraulic function) to the embankment soil. Later on we will also follow the same procedure to assign the hydraulic function for the foundation soil.
- Click Draw and select Material



- Make sure the assign radio button on and Embankment material is selected
- Move the cursor to Embankment region and left click
- The embankment boundary colure will be changed

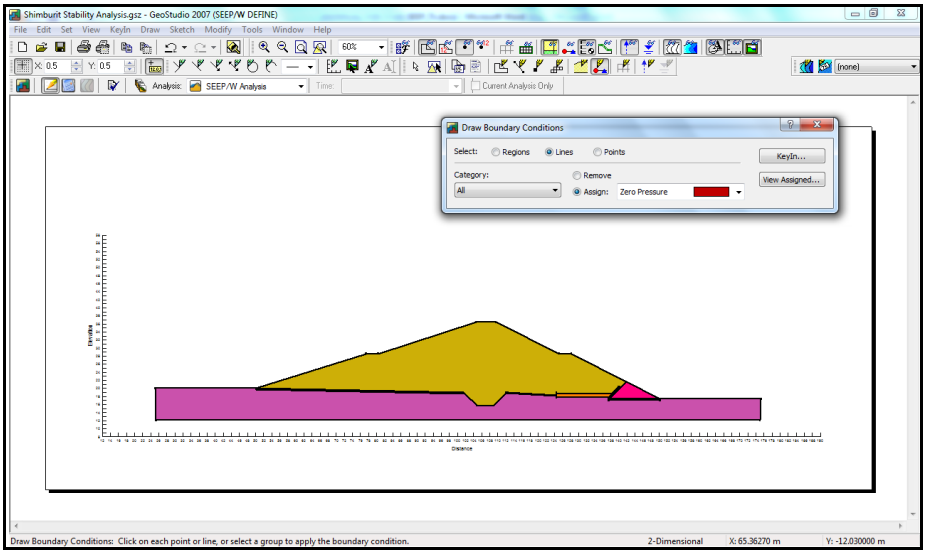


- Similarly move the cursor to filter, foundation, Basaltic rock and rock toe to assign materials in similar fashion

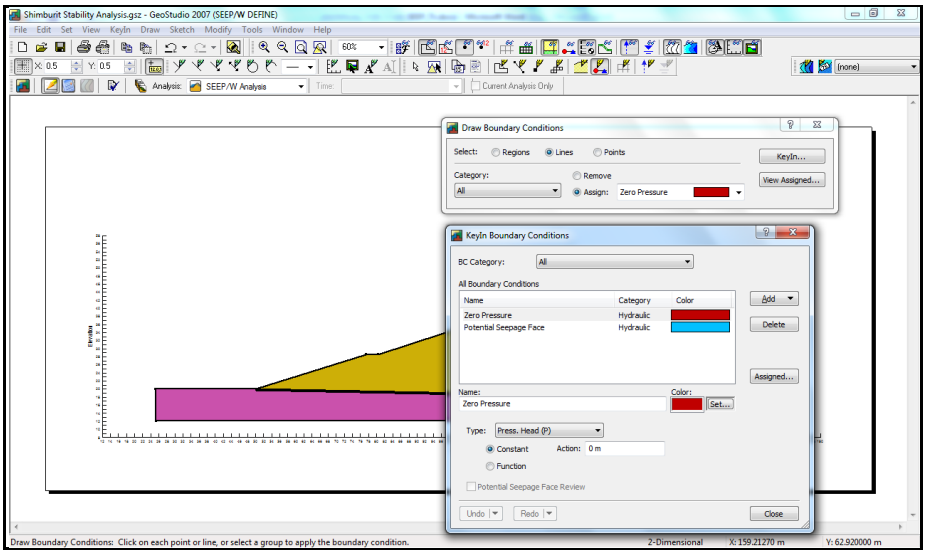


5.2.5 *Fixing boundary condition*

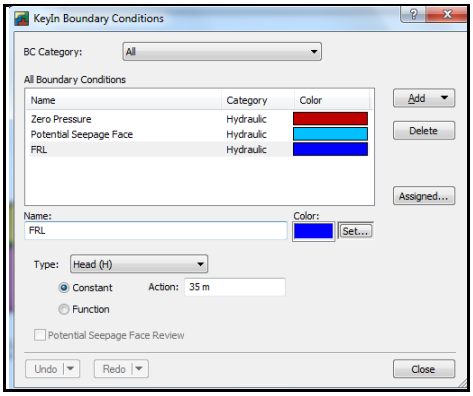
- Select Boundary Conditions from the DRAW menu



- Click KEYIN boundary conditions to assign a boundary for the reservoir



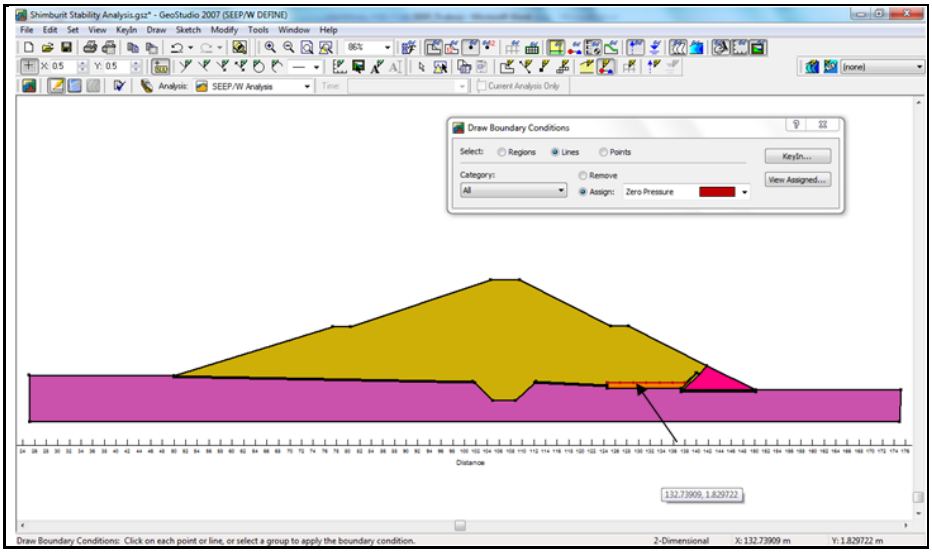
- Click add button, add new hydraulic boundary condition, give name i.e. Full reservoir =35 m from river bed level and change the colour. Make sure that on the Type pull down menu to Head (H) and insert the reservoir depth i.e. 35 m in the action box



5.2.6 *Applying boundary to the geometry*

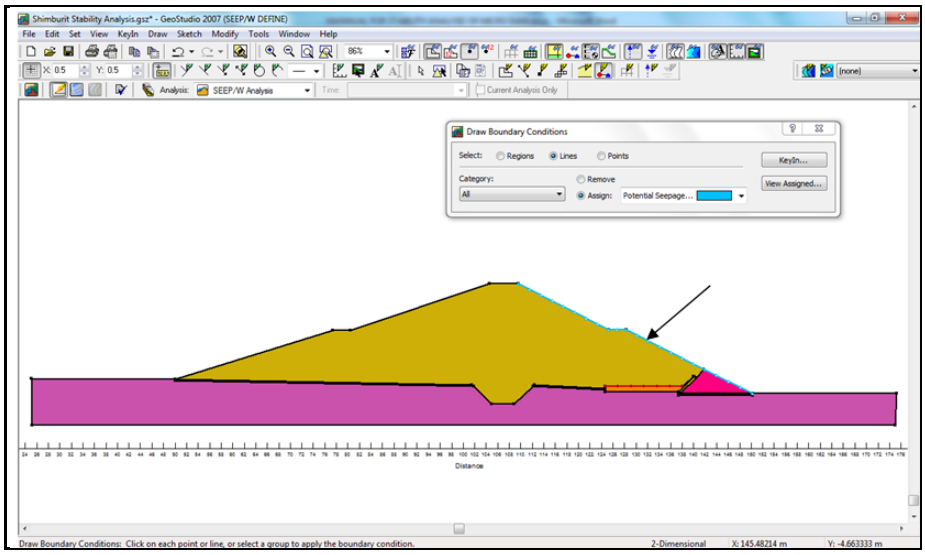
Zero pressure boundary

- A zero pressure boundary condition will be applied to the filter toe, which is a geometry line. Make sure that the select line is clicked



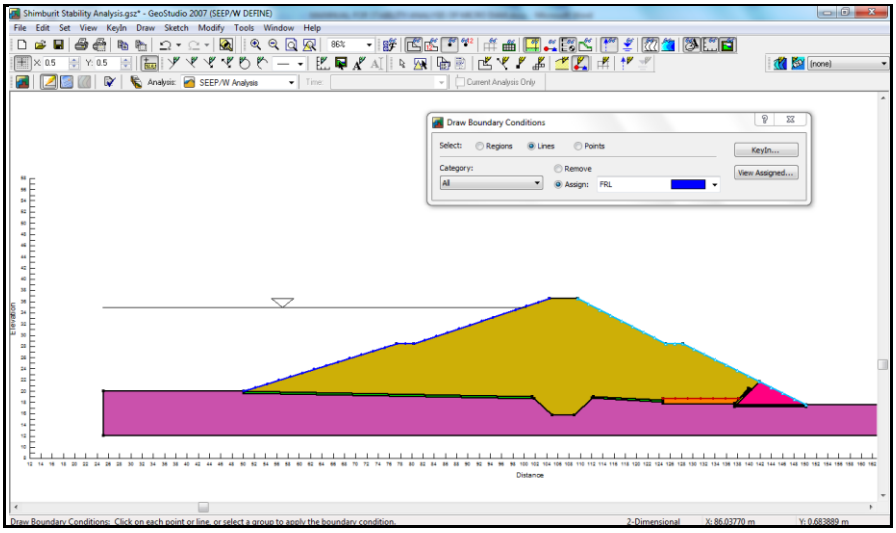
Seepage face

- A potential seepage face boundary condition will be applied to the downstream face, which is an edge. A potential seepage face is a special boundary condition that is used when you want the solver to locate the position of where a seepage face might develop.
- Select the potential seepage face from drop down menu to fix it for the downstream. Make sure that line is selected and click the downstream face of the dam.



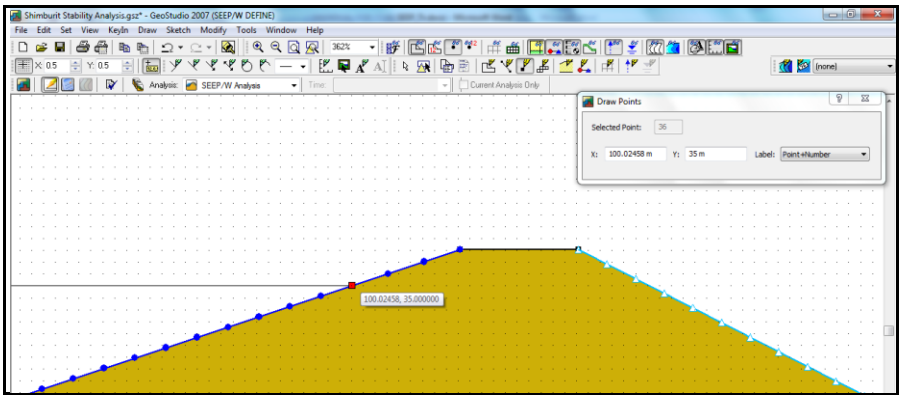
Adding reservoir

- To add the reservoir from sketch menu select polyline and draw the upstream reservoir level starting from coordinate (25, 35) to (100, 35).
- Fix the boundary by selecting FRL = 35, and make sure that line is selected. Then click the upstream face of the dam.

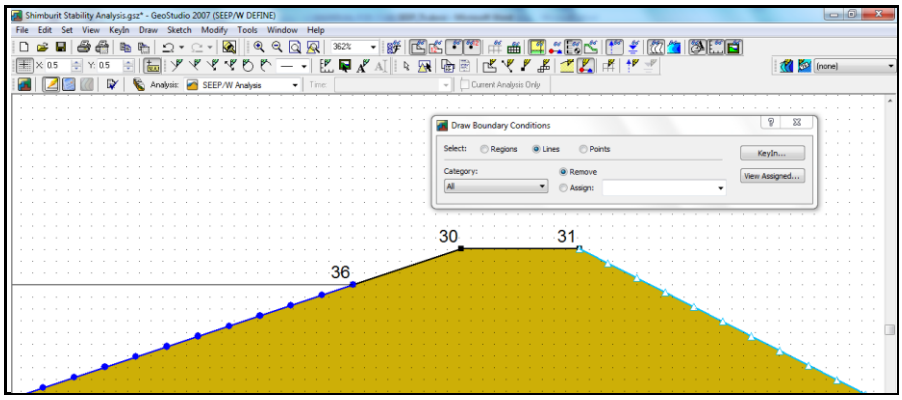


Breaking a region

- In order to locate the intersection point of the reservoir and upstream slope of the embankment you may zoom it and Click on draw points and locate exactly at the intersection the point. In this case point 35.



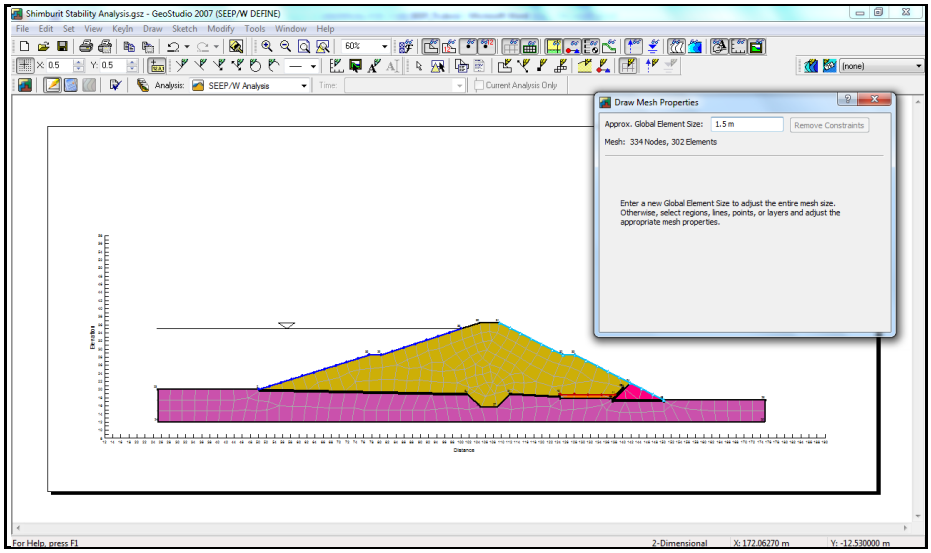
- To break up a region edge so that you can apply the boundary condition, such as the reservoir total head to only a portion of the edge (i.e. excluding the free board), you may need to insert a region point.



- Click draw boundary condition and select the reservoir boundary then click the remove icon somewhere the line below point 30 and 36. You will see a green boundary line for the upstream slope and the reservoir water boundary will end up to point 36.

Viewing the finite element

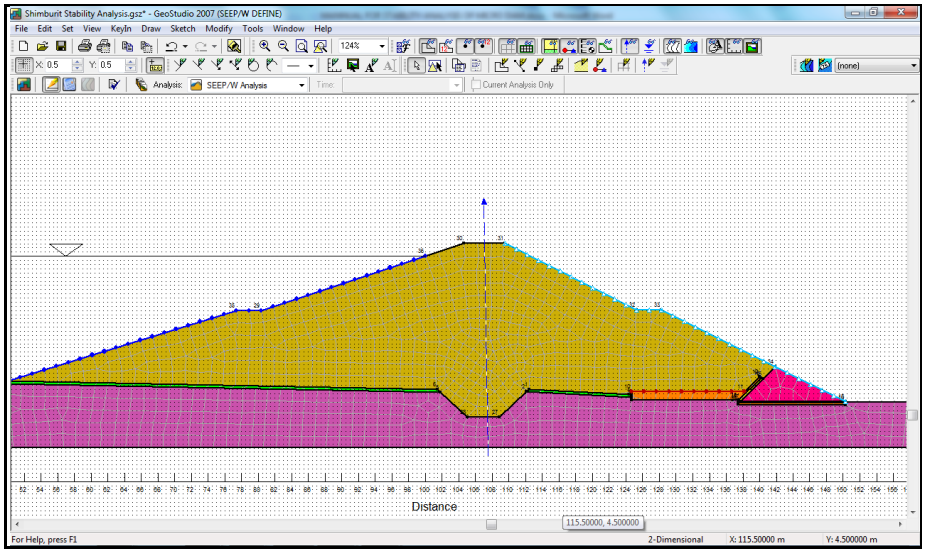
- You can view the finite element mesh using DRAW: Mesh Properties.



- Change Approximate Global element size as 1.5 m

Determining flux section

- One of the objectives of this analysis was to compute the amount of flow through the earth dam. To do this, we can use a flux section.
- Click Draw and select flux section
- Click OK button and draw the flux section at one point, you may select at the centre or axis of the dam

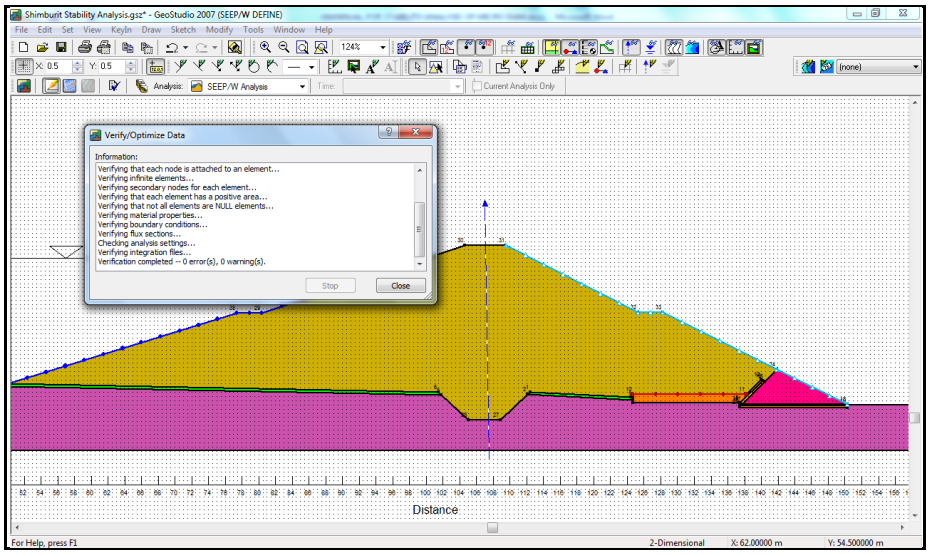


- Now it's time to solve the problem

5.2.7 Solve and contour

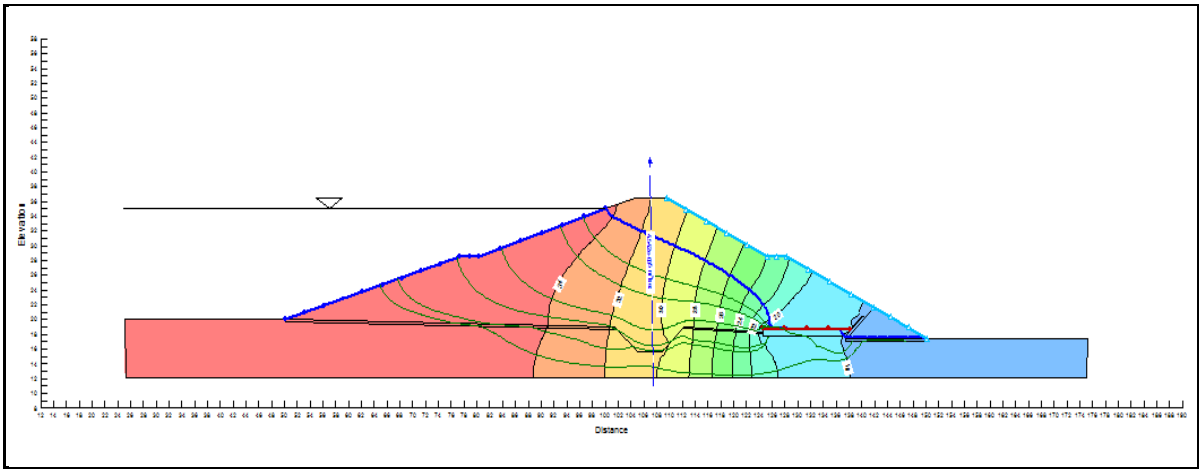
Verify/optimize

Before that you may review the data by clicking on View or Optimize icon



Solve and contouring

- The solver for SEEP/W can be launched by clicking on the “SOLVE” icon. Click the start button to activate the solver.
- You can view the results directly by clicking on the CONTOUR icon in the analysis toolbar. By default, the CONTOUR results will include velocity vectors, the location of the zero pressure contour and total head contours.
- The flux section results can be viewed by selecting flux labels from the DRAW Menu. Clicking on the flux section will make the total flux value appear



Flow path

- Flow paths represent the path that a drop of water would travel from the reservoir through the dam. Draw a flow path by using the appropriate pull down menu and then click the cursor anywhere within the profile

Additional features that you may exercise by your self

- Remember, at any time you can change the way the CONTOUR information is presented by using the View Preferences pull down menu.
- You can also retrieve information from specific locations on the profile.

- Select VIEW: Result Information and then click on the location that you're interested in. If you hold the CTRL key down, you can gather information from several different locations.
- You can label your contours using DRAW: Contour Labels.
- There are many different types of parameters you can contour. Use DRAW: Contours to view some different results. Three default contour options are available, but you can also add other options to the list using the Add button.

5.2.8 Reporting

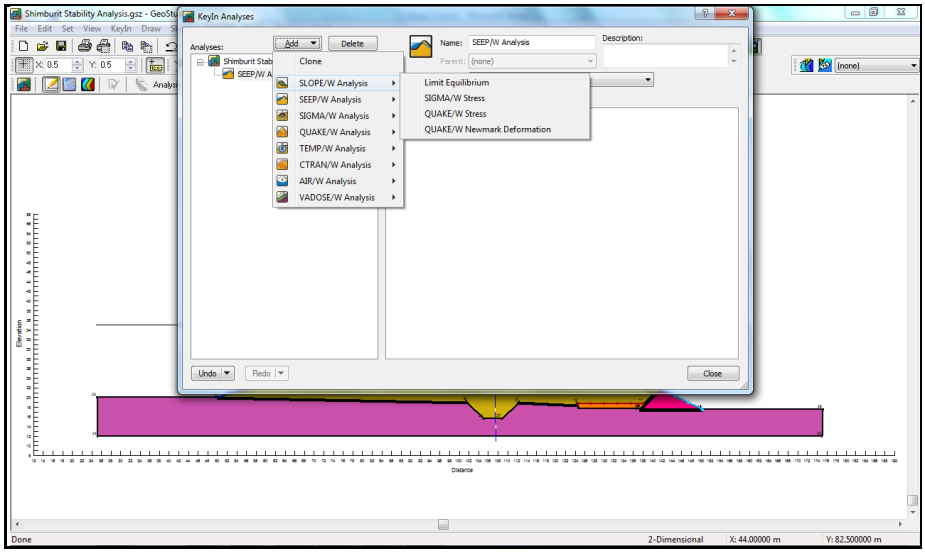
New to GeoStudio 2007 is a reporting feature. If you need to generate a report of your input data, select Report from the VIEW menu. Once you save the report file, your default word processing program will open with a generated report. You can now insert pictures, apply style templates or add and delete data.

5.2.9 Adding a new analysis

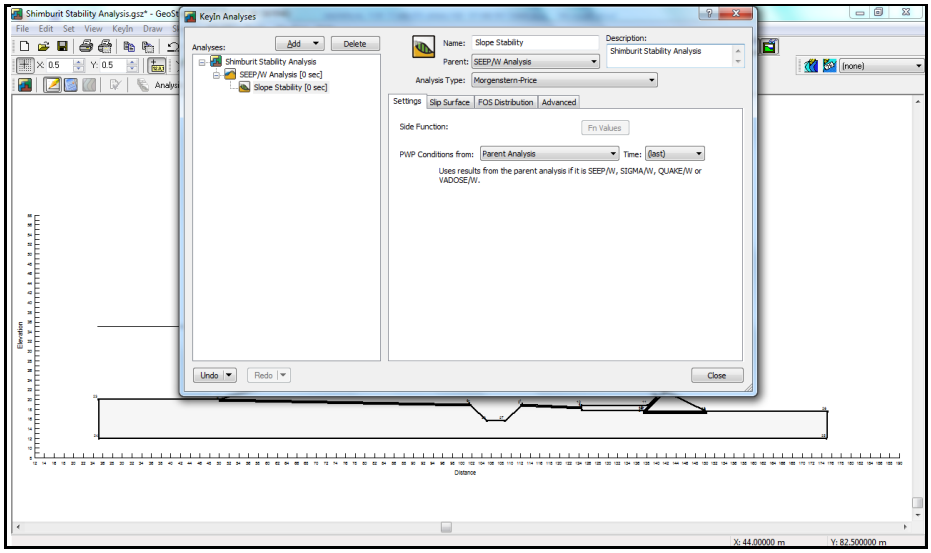
GeoStudio 2007 has the ability to run many different analyses within the same project file. The geometry is considered project specific, but you can change boundary conditions, material properties or even different types of analyses.

5.2.10 Slope/W

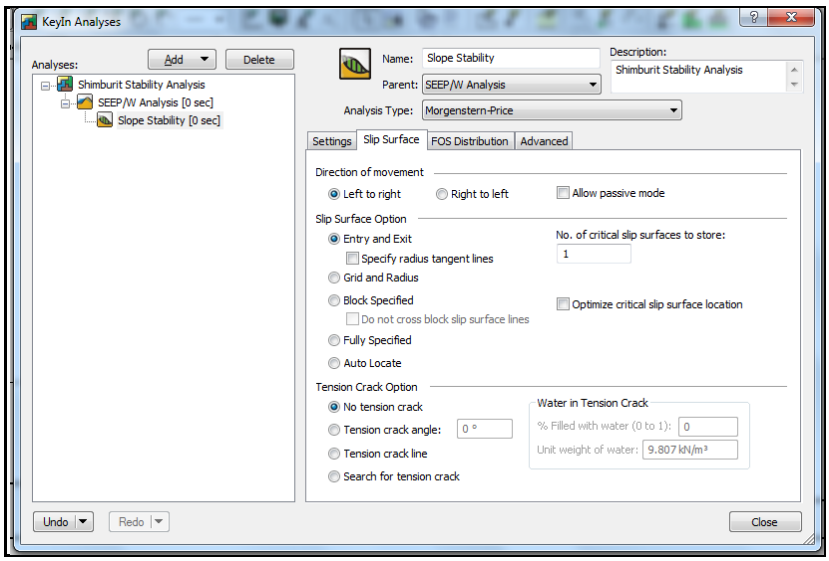
- Use the SEEP/W computed pore-water pressures in a stability analysis using SLOPE/W.
- Click on KEYIN and then analysis to use the results of SEEP/W analysis for SLOPE/W.
- Click the add button to select the type of analysis and then Limit equilibrium.



- You may give a name like slope stability analysis and description
- Select Morgenstern-Price and ensure that a half-sine function is being applied in the settings dialog box.



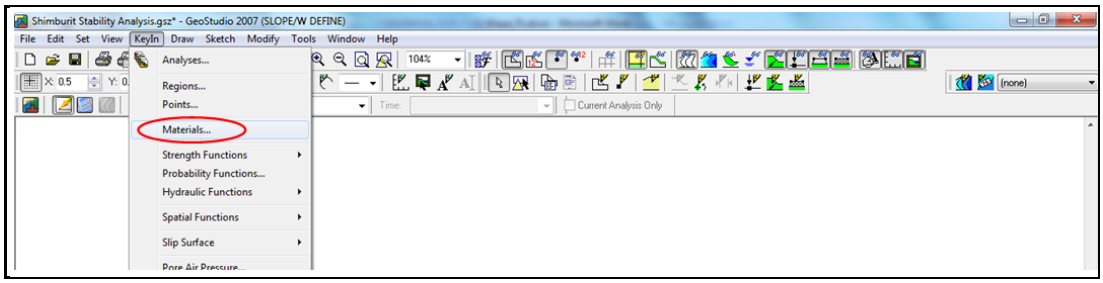
- Under the pore-water pressure (PWP) option, select parent analysis
- Under the slip surface tab, select Direction of movement left to right and Slip surface option as Entry and Exit

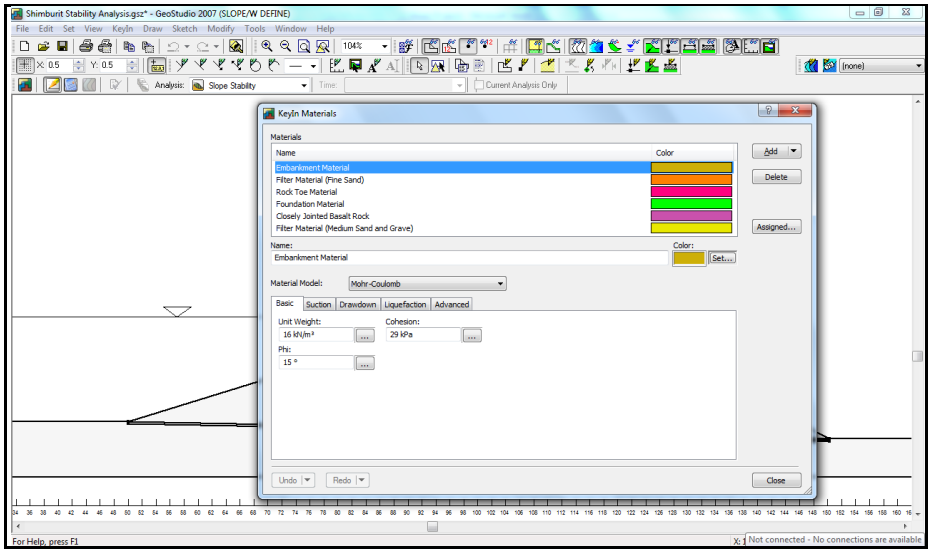


5.2.11 Assigning materials

Creating material data

- Click on KEYIN and click Materials



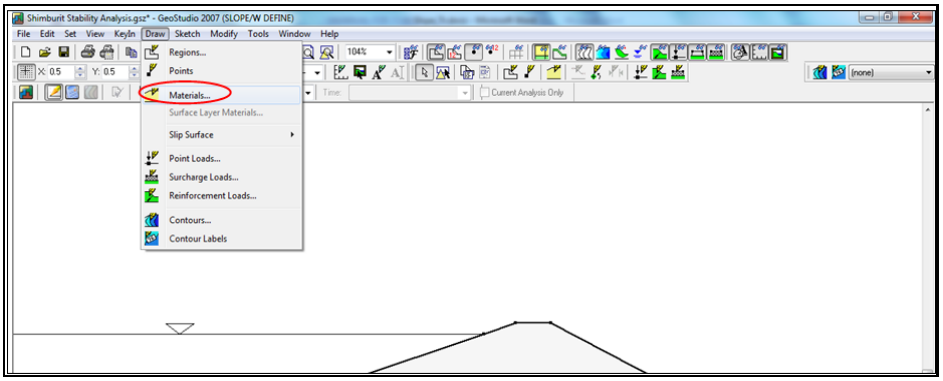


- For the first region add a new material, name it and select a strength model from the drop down list. You can use the tab key to move between the edit boxes. You may put the name as Embankment Soil, Material model as Mohr-Coulomb and Basic material properties as. You may change the colour of the soil by clicking set and select color.
  - Unit weight= 16 KN/m3,
  - Cohesion = 29 kPa and
  - Phi =15o
- To create a second material, you have choices; you can either add one, or you can clone the existing material and repeat similar steps

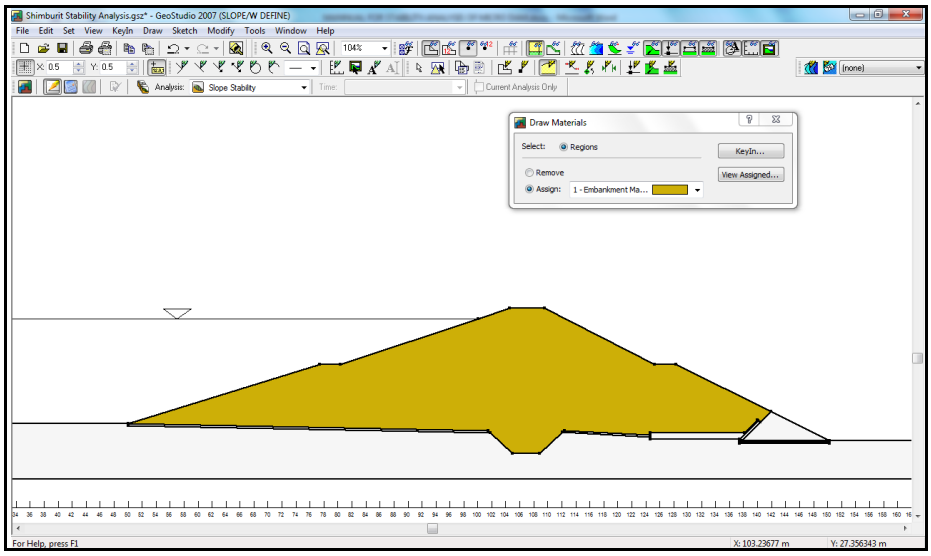
- Basic material values for Filter Material (Fine Sand)
  - Unit weight= 18 KN/m3,
  - Cohesion = 0 kPa and
  - Phi =30o
- Basic material values for Filter Material (Medium Sand and Gravel)
  - Unit weight= 20 KN/m3,
  - Cohesion = 0 kPa and
  - Phi =36o
- Basic material values for Rock Toe Material
  - Unit weight= 17 KN/m3,
  - Cohesion = 0 kPa and
  - Phi =40o
- Basic material values for Foundation Material
  - Unit weight= 17 KN/m3,
  - Cohesion = 29 kPa and
  - Phi =30o
- Basic material values for Closely Jointed Basalt Rock
  - Unit weight= 20 KN/m3,
  - Cohesion = 0 kPa and
  - Phi =40o

Assigning materials to each region

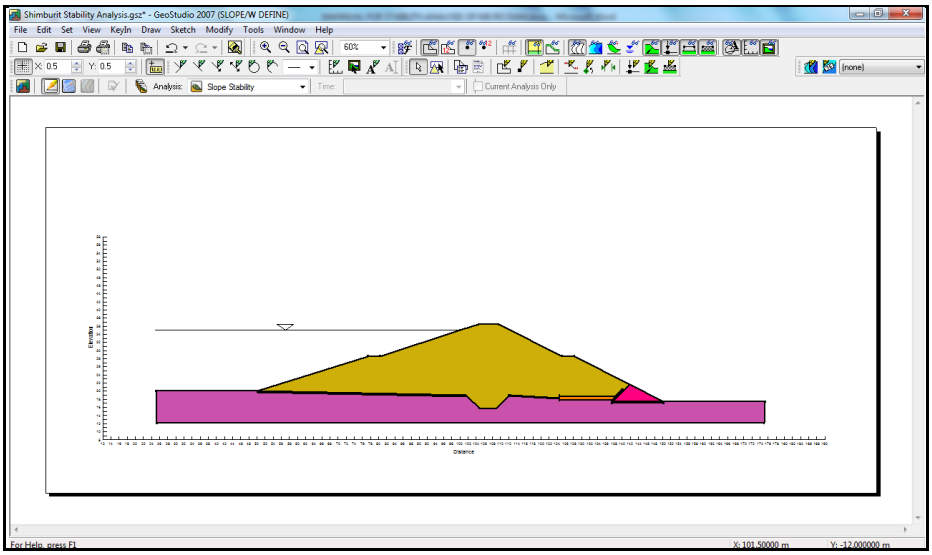
- Choose materials from the DRAW: dropdown menu



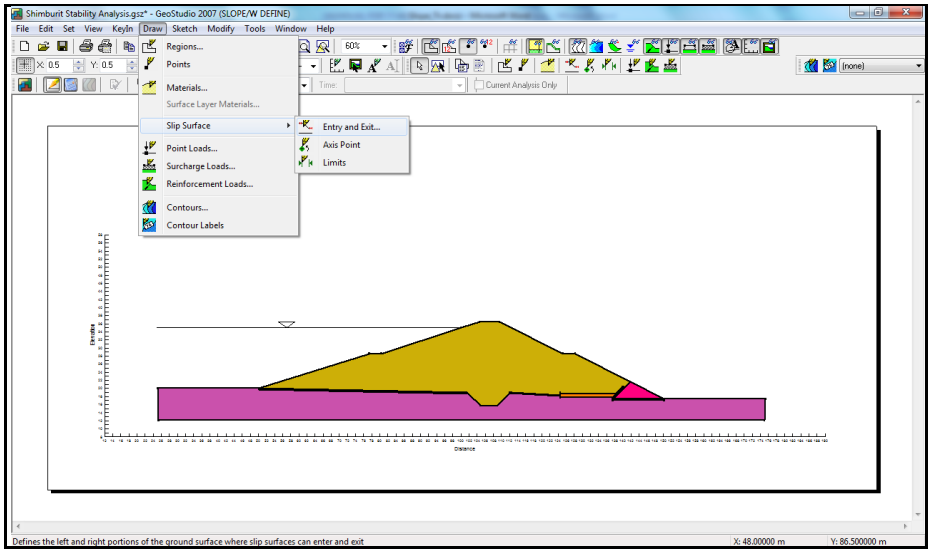
- Drag the respective material and click on respective region. The color for the region can be done by dropdown menu from assign



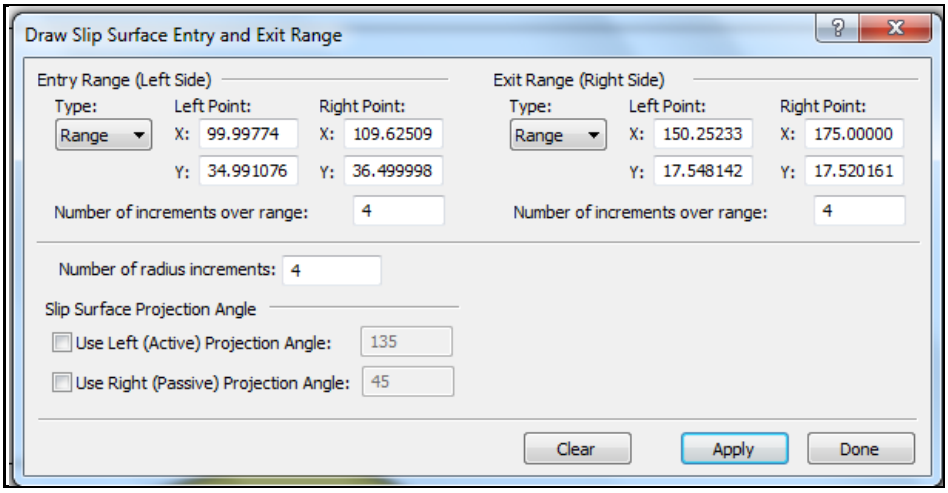
- Repeat the same procedure for the rest of the region



- Click Draw and select Slip Surface then Entry & Exit



- Insert the following ranges for Entry range (left side) and Exit Range (Right side). This is for downstream slope analysis. But for upstream side the entry will right side and exit will be the left side.



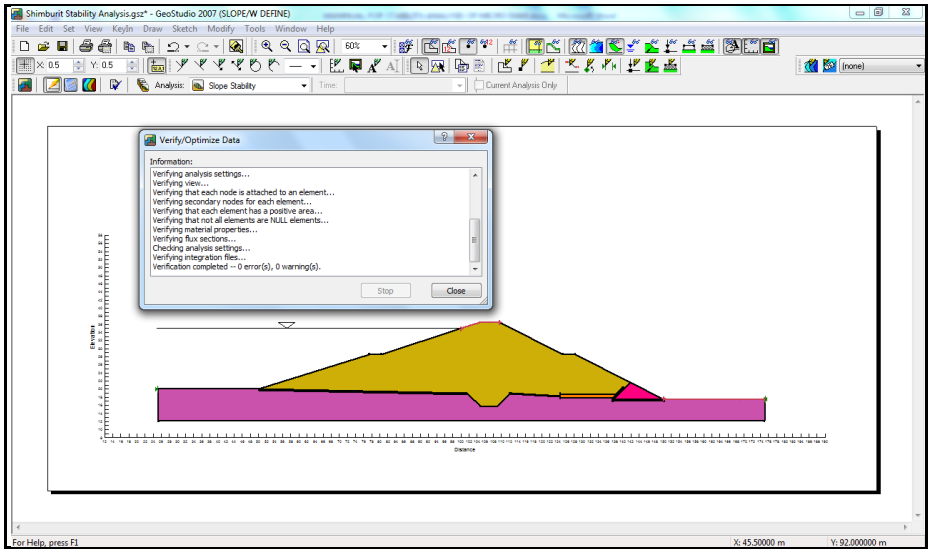
- Now the problem definition has been completed. Congratulations!!!

You can double check your input in different ways. For example:

I. Select object information from the VIEW pull down menu. Click within any region to review the soil properties for that particular region.
II. You can also view the information for any other geometric object.
III. Another way to review your input parameters is to use the DRAW: Contours feature available within DEFINE.
IV. You can contour various parameters such as soil properties and pore-water pressures. Notice that when you define a piezometric line in SLOPE/W, the software considers the pore-water pressures to be hydrostatic both below and above the piezometric line.
V. You can also label the contours.

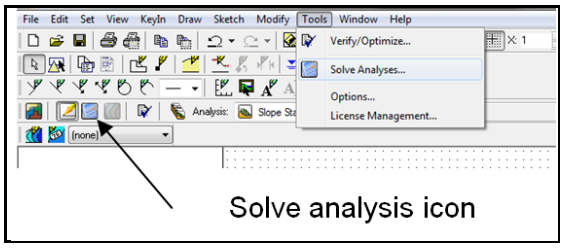
5.2.12 Verifying the input data

- Choose Verify from the TOOLS drop down list and SLOPE/W will run a number of checks to see if there are any errors or warnings.



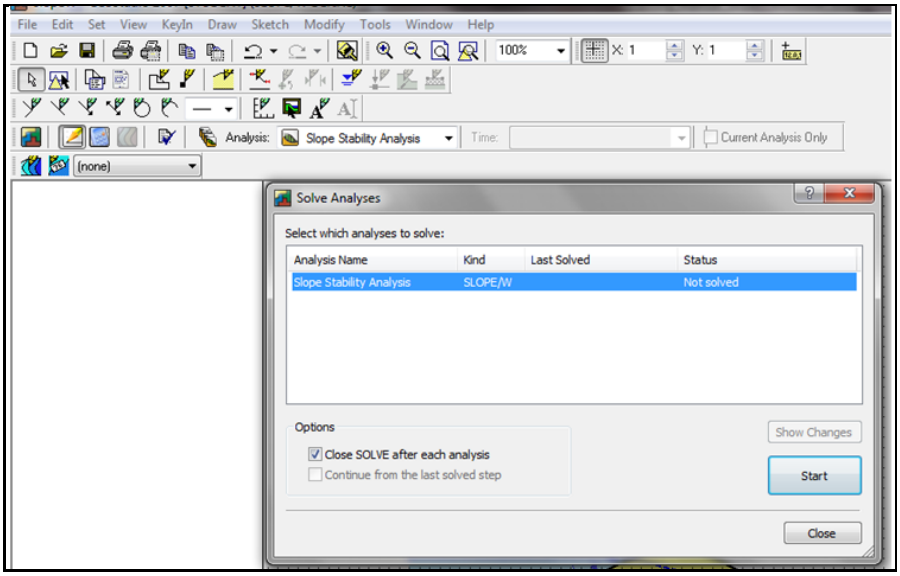
5.2.13 Solve and contour

- Click on the SOLVE icon found on the Current Analysis Toolbar.

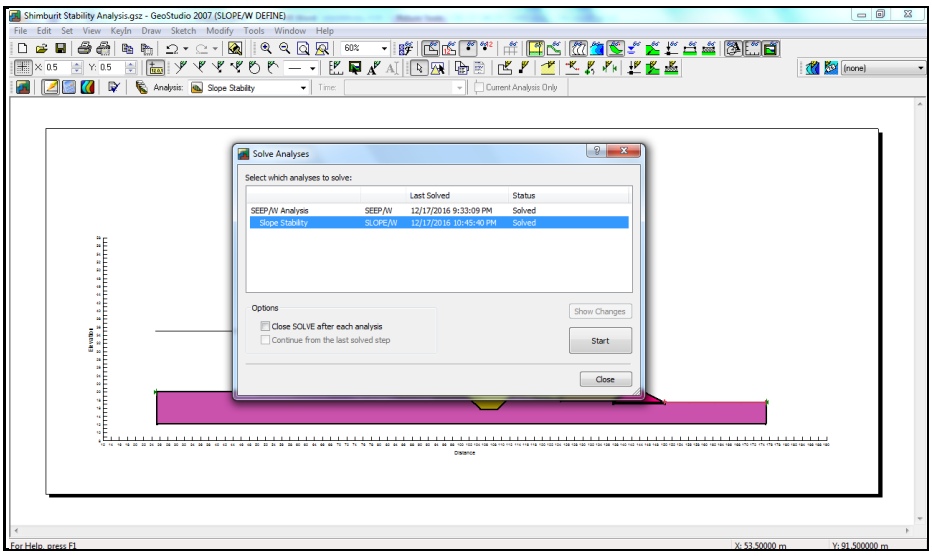


.

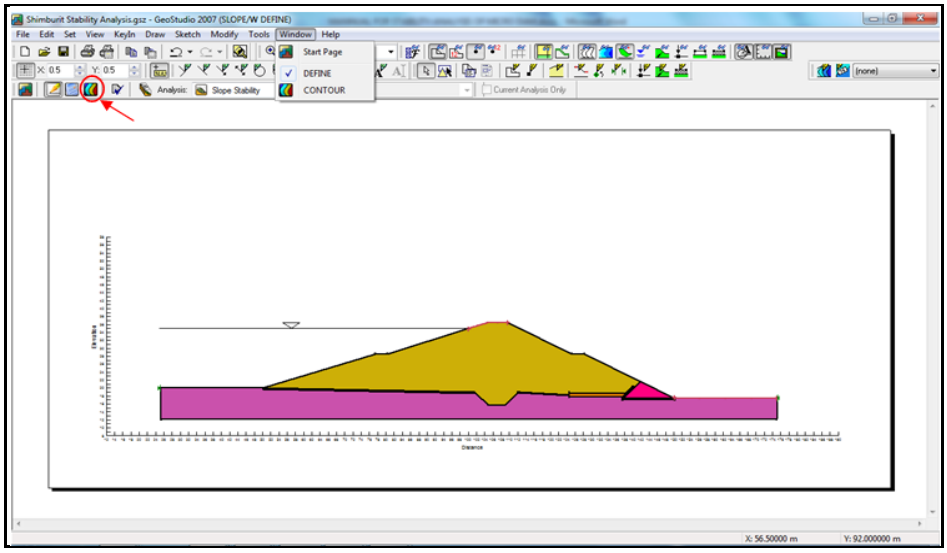
- Select the start button to activate the solver. In the solver window you will see the computed factors of safety for each of the various methods



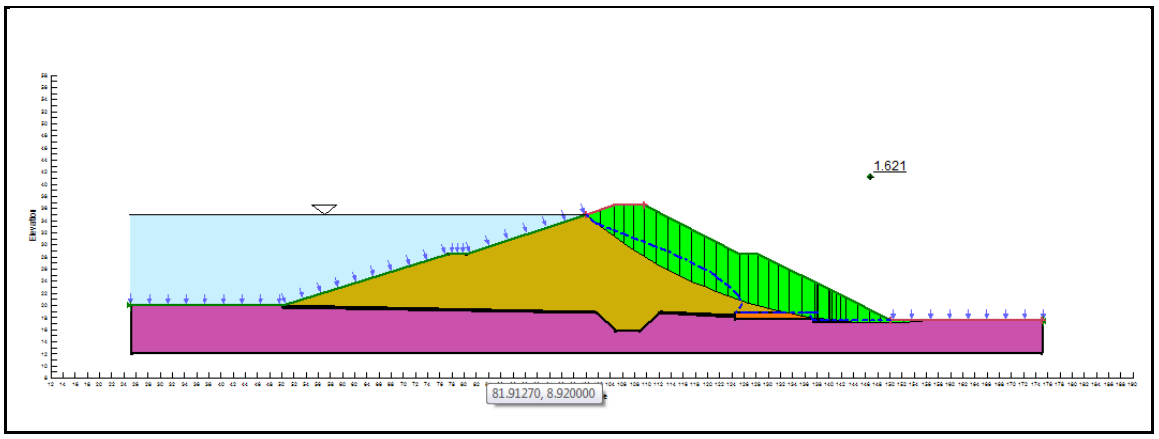
- Click the stat button to run the simulation. When the simulation is done correctly the status will be changed into Solved



- You can review the results directly by clicking on the CONTOUR icon in the current analysis toolbar.



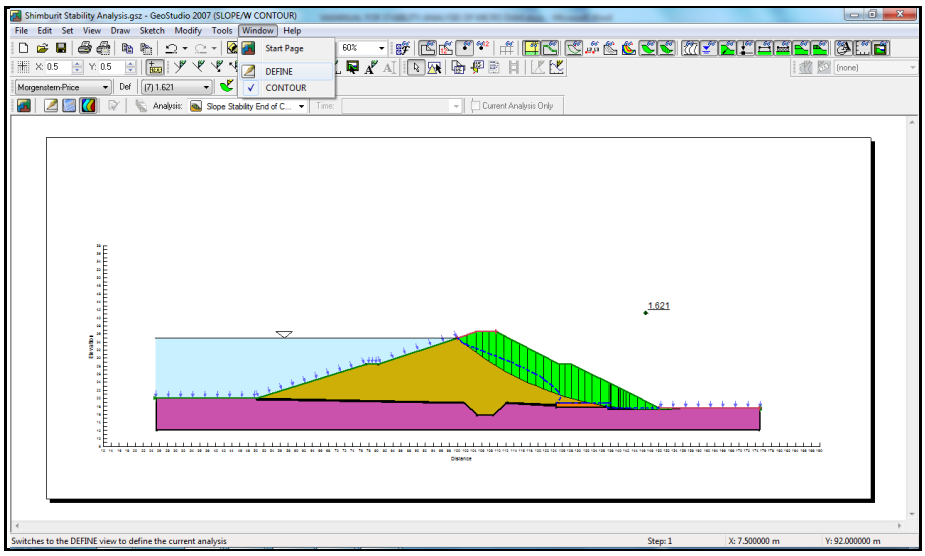
- The critical slip surface appears along with the critical factor of safety



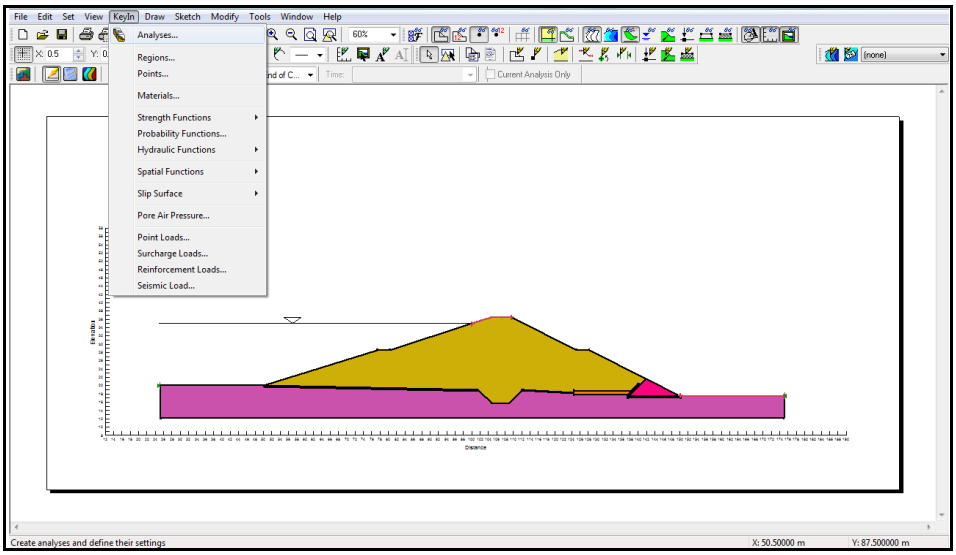
5.2.14 Stability analysis at end of construction

GeoStudio 2007 has the ability to analyze stability at the end of construction within the same project file. The geometry is considered project specific, by changing only PWP to Ru.

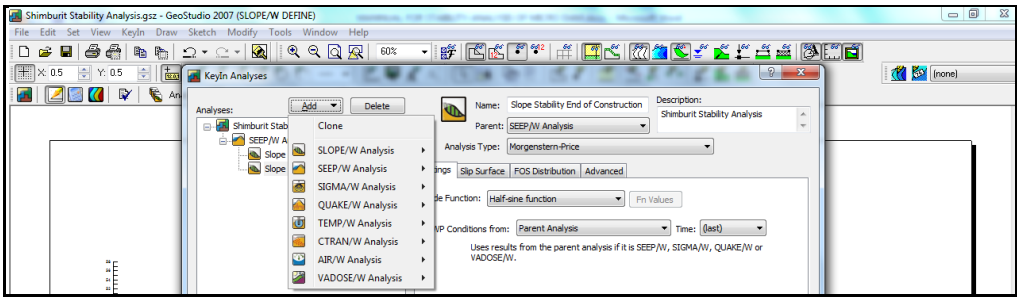
- Click window and select define



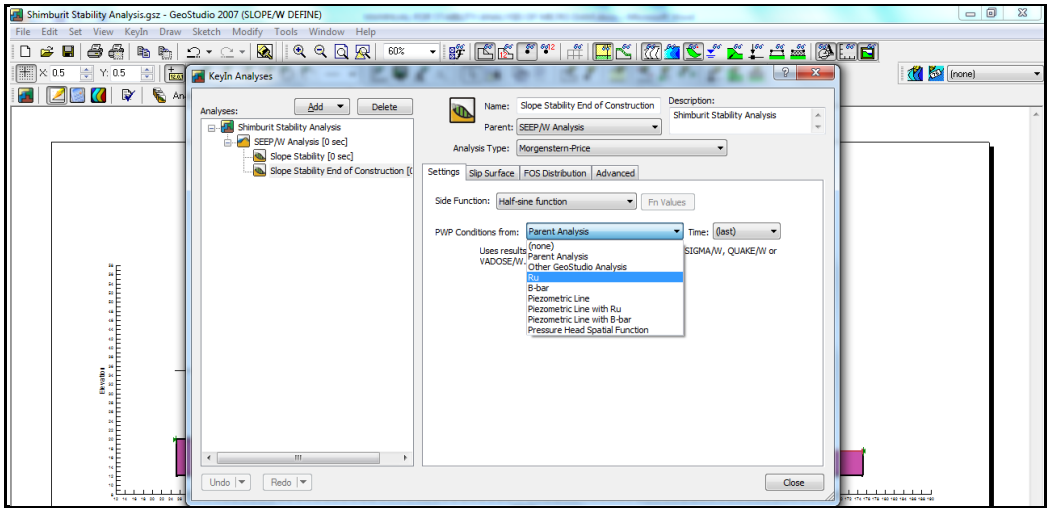
- Click KeyIn and select Analyses



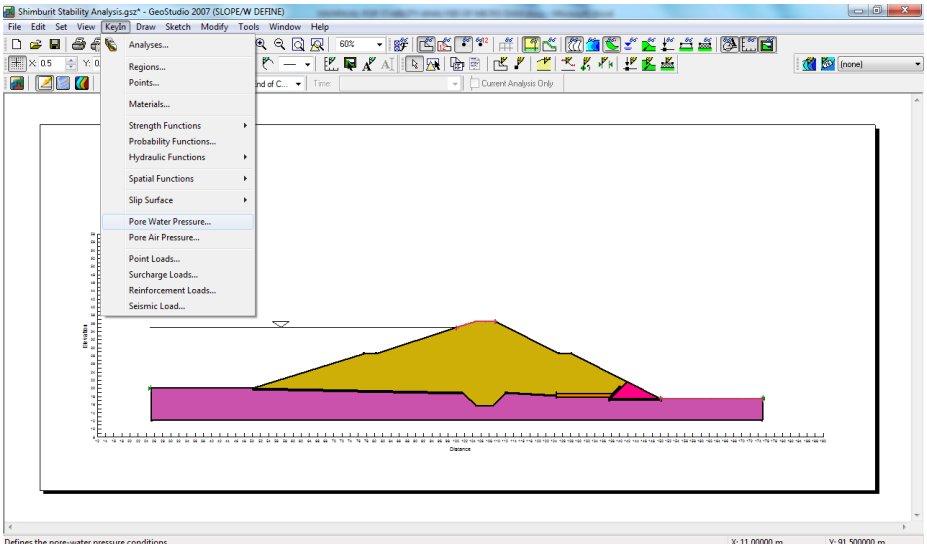
- Click add and select Clone



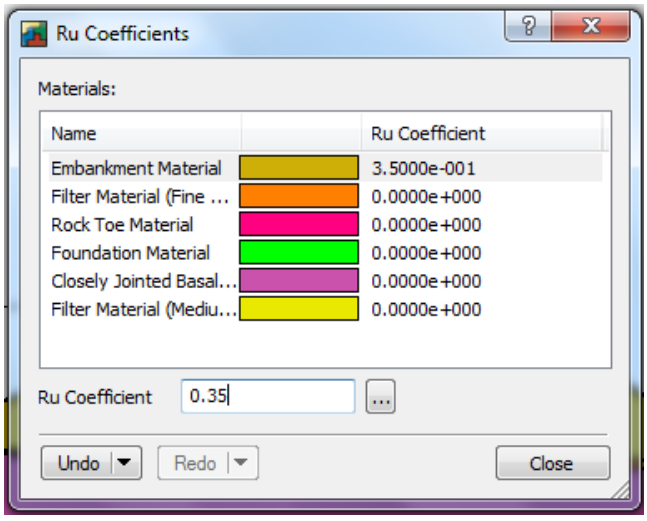
- Name it Stability analysis at end of construction
- Select Ru from PWP drop down menu



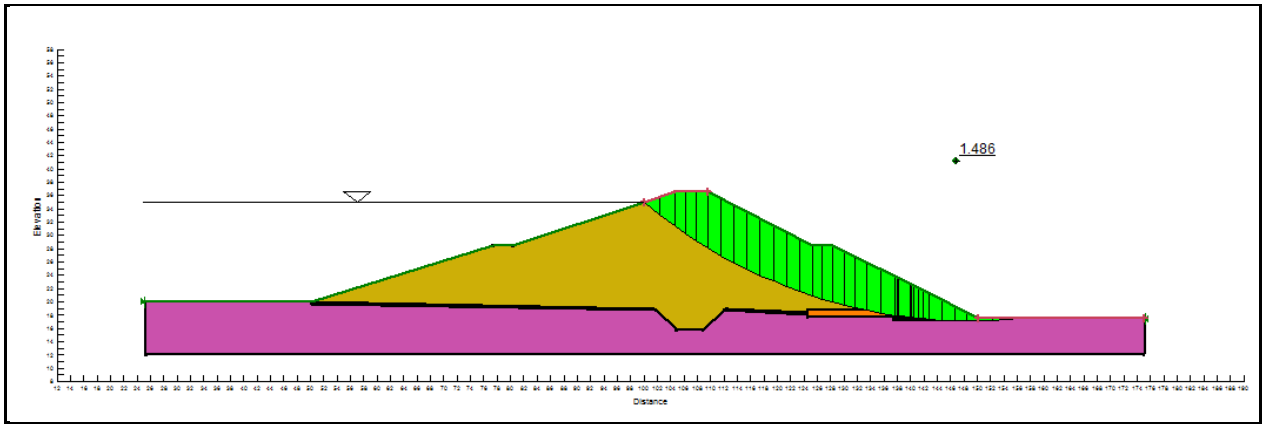
- Click KeyIn and select pore water pressure



- Insert 0.35 for embankment material and 0 for other materials then close



- Using similar steps verify and solve
- Click contour



5.2.15 Stability analysis results

The summary of results of the stability analysis conducted for the different loading conditions presented and comparison of the computed minimum factor of safeties with that of the required factor of safeties are presented in Table. According to the result the dam is stable for the two loading conditions.

Loading condition	Recommended FoS_{min}	Computed FoS
End of construction	1.3	1.48
Steady state seepage at normal level	1.5	1.62

You are done!!!

6 MANNUAL FOR MS-PROJECT

6.1 BASIC KNOWLEDGE OF MS-PROJECT

6.1.1 The MS-project software suite

Microsoft Project, the project management software program by Microsoft, is a very handy tool for project a manager that helps them develop a schedule, assign resources to tasks, track the progress, manage the budget, and analyze workloads for an ongoing project.

Microsoft Project is a specialized database that stores and presents thousands of pieces of data related to your project. These pieces of information interrelate and affect each other in a multitude of ways. Under-lying this project database is the scheduling engine, which crunches the raw project data you enter and presents the calculated results to you.

You can then manipulate and display this calculated data in various views to analyze the planning and progress of your project. This information helps you make decisions vital to the project's success.

6.1.2 Purpose

Microsoft Project is application software that is used to aid most of Projects including:

- Study and Design Projects
- Construction projects so on…

6.1.3 Scope

This guideline covers the basic procedures of construction project planning for irrigation and head work (Case study of Didiga SSI Project).

6.1.4 Computer requirements

Pentium III with Microsoft, Windows 2000 and above, (recommended: Intel processor with 512 MB of RAM), 1024x768 display.

6.2 CASE STUDY FOR DIDIGA SSIP CONSTRUCTION SCHEDULING

6.2.1 Preparation of working environment

This practical exercise will help how to prepare Construction Scheduling using for Didiga SSIP.

6.2.2 Defining project scope

To define the project scope and communicate it to other key stakeholders, you develop and record the scope statement. The scope statement should include the following:

- Project justification
- Product description
- Project constraints or limitations
- Project assumptions
- Project deliverables

- Project objectives

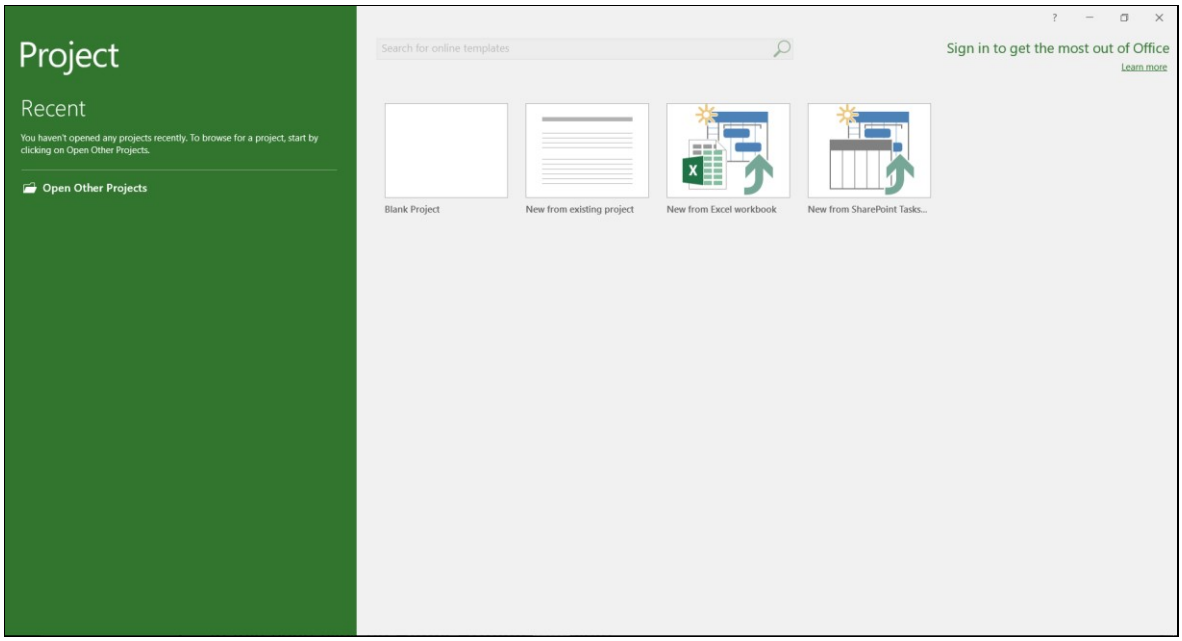
This Sample construction scheduling project is based on the assumption that:

- Active involvement of the local community in the construction process
- Utilize minimal use of Machinery
- Construction activities starts from head work and proceed towards the irrigation system

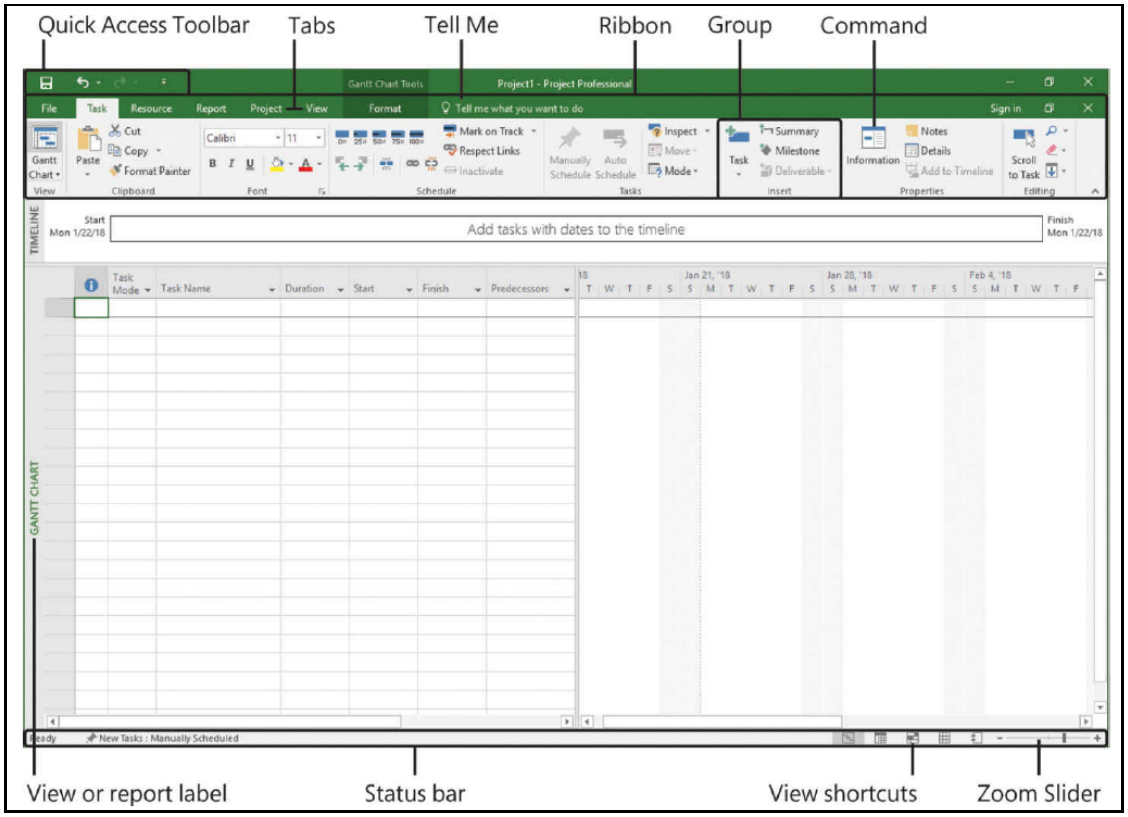
6.2.3 Getting started

Creating a project file

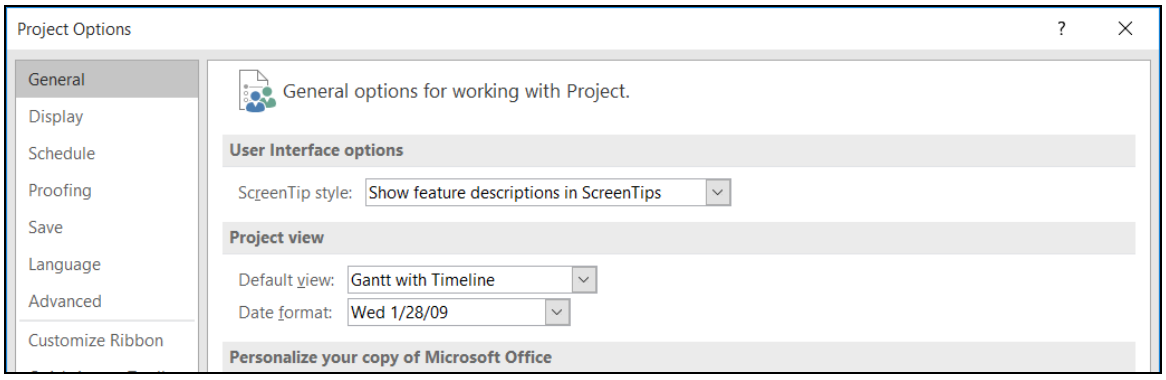
- Create a folder called Didiga SSIP anywhere you like
- Start, All programs, Microsoft Office, Microsoft Project 2106
- When you start Project, its Start screen appears



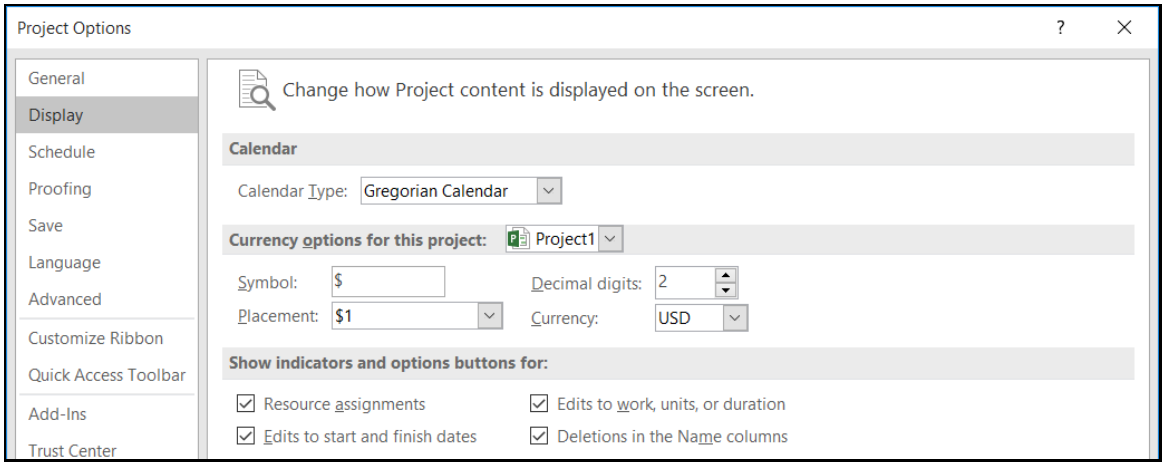
- The Project Start screen includes options for creating a new plan or opening a plan
- You create a new plan by clicking the Blank Project option on the Start screen. Doing so creates the new plan in the main Project interface



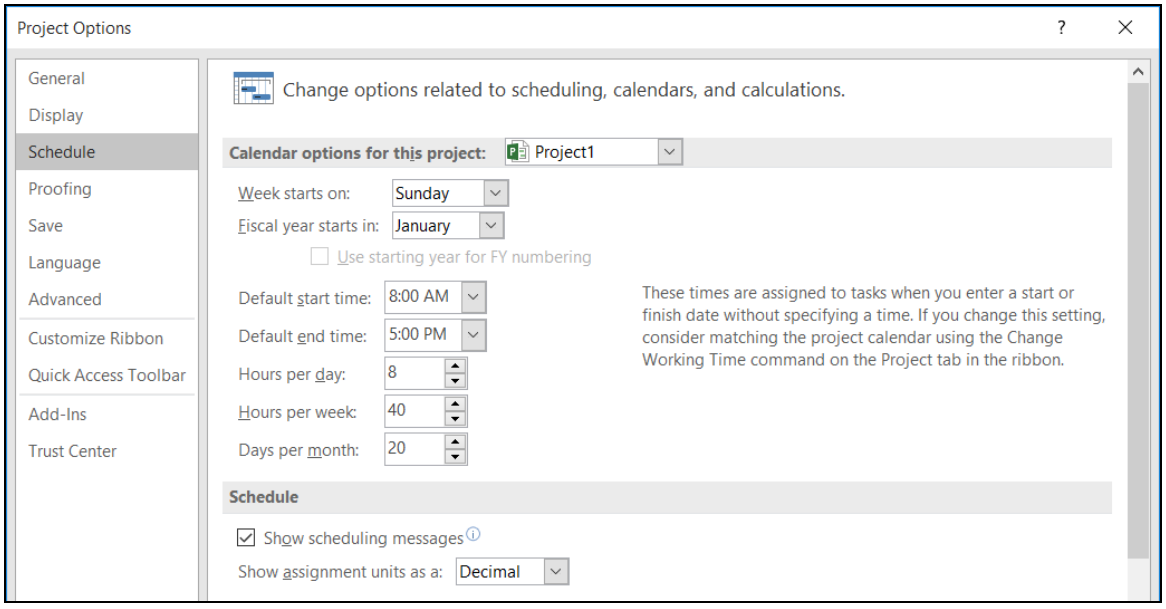
- Here are the major parts of the Project interface; note the label of the active view along the left edge
- Let's walk through the major parts of the Project interface
  - The Quick Access Toolbar is a customizable area of the interface where you can add your favorite or frequently used commands.
  - Use the Tell Me box to quickly find a Project command, or help about that command or feature
  - The ribbon contains the commands you use to perform actions in Project.
  - Groups are collections of related commands.
  - Commands are the specific features you use to perform actions in Project.
  - Zoom Slider: Simply zooms the active view in or out
- File -> Options -> General tab -> Project view -> Default view then Select "Gantt with Timeline" from the dropdown box



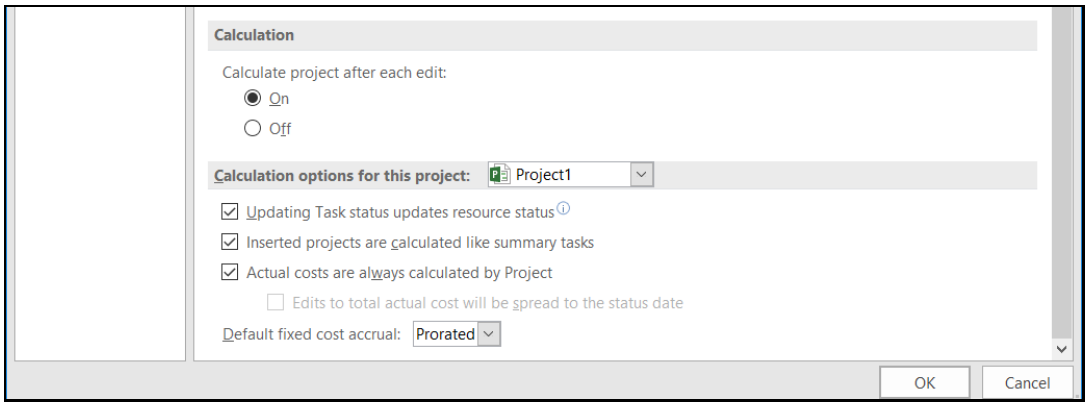
- File -> Options -> Display tab -> Show Indicators and Options Buttons for. Check all options



- File -> Options -> Schedule tab -> Schedule -> Show Assignment Units. Choose "Decimal" from the dropdown box



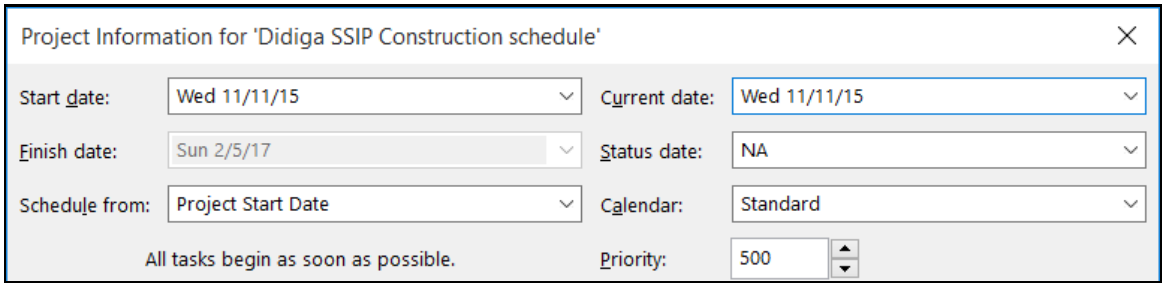
- File -> Options -> Schedule tab -> Calculation -> Calculate Project after Each Edit. Check the On button



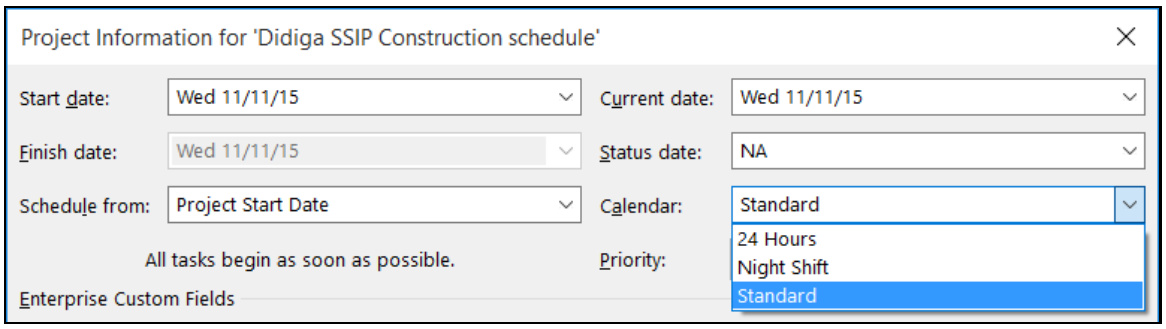
- Options -> Save tab -> Save projects -> Save Files In this format. Select Project (*.mpp). file name as Didiga SSIP Construction schedule

Start Date

- Click Project tab -> Properties Group -> Project Information.
- A dialog box appears. In the start date box, type 11/11/15, or click the down arrow to display the calendar, select November 11, 2015.
- Click OK to accept the start date.

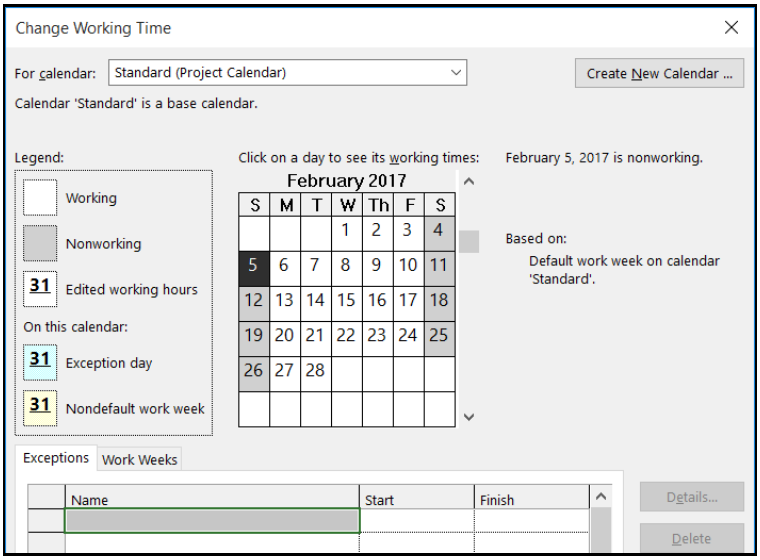


- Click Project tab -> Properties Group -> Project Information.
- Click the arrow on the Calendar dropdown box. A list appears containing three base calendars and select a Standard Calendar as your project Calendar

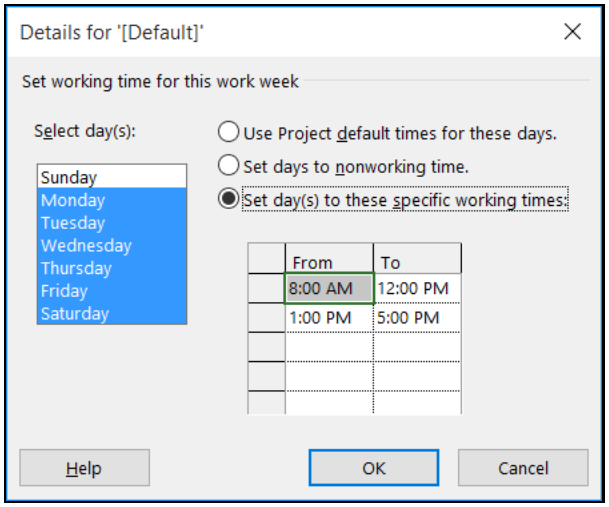


Setting Your Project Calendar

- Click Project tab -> Properties Group -> Change Working Time



- To change the working time of a particular day of each week, Select the workweeks field
- Click Details
- Select the day (Monday-Saturday) and Mark the “Set day(s) to these specific working time”
- Click Ok



- Exceptions are used to modify a Project calendar to have a non-standard workday or a non-working day.

6.2.4 Calculating duration for activities

A duration of the task is the estimated amount of time it will take to complete a task. As a project manager you can estimate a task duration using expert judgment, historical information, analogous estimates or parametric estimate. Before undertaking any work or project it is necessary to know the time it will take to accomplish, which is obtained or derived by dividing the total quantity by acceptable Norms. For example,

- Site Clearance for Camping site using four Daily Laborer
  - One Daily Laborer in 8 hr execute 10m2
  - Four crew each congaing four Daily Laborer in 8 hr. execute 160 m2
  - Total quantity for site clearance is 141 m2
  - Estimated time = 141/160 = 0.88 days
  - Therefor for total days for this activity is ~ 1 Day
- The expected duration for the rest of the activities is calculated in similar fashion. For Didiga SSIP the duration is calculated and presented in File with the name of Norms Output and Resources.xls located in **C-Excel file folder**.

6.2.5 Scheduling tasks

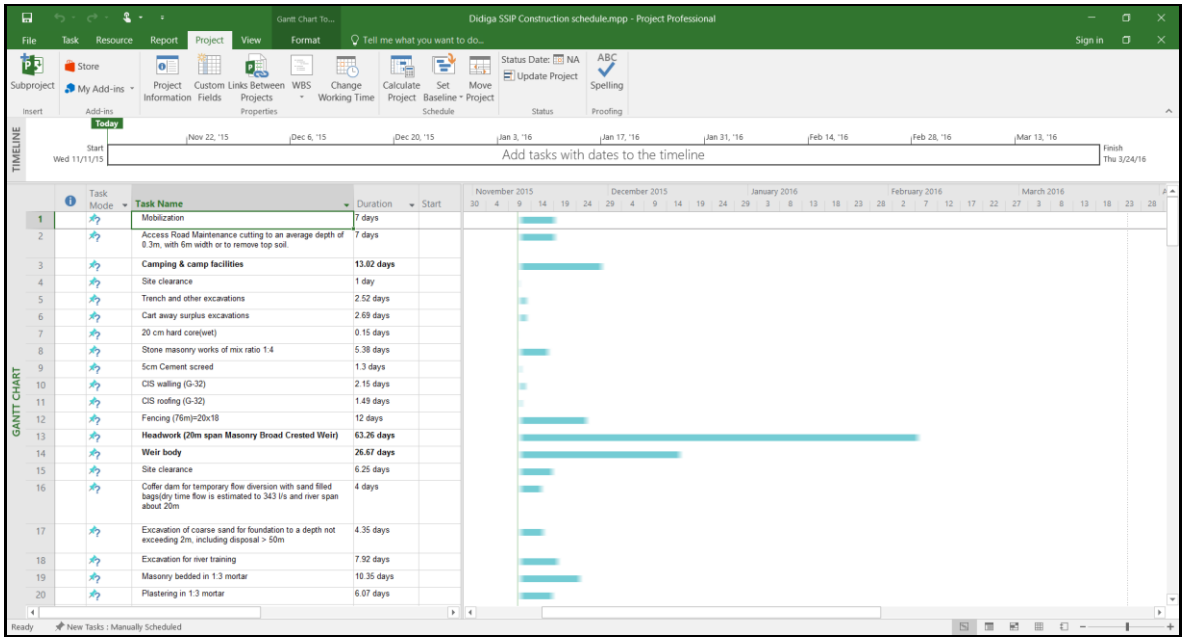
- Tips
  - Brainstorming: Enter tasks as you think of them, without regard to sequence or grouping of related tasks. You can move and organize the tasks later.
  - Sequential: Think through the project from beginning to end, and enter tasks sequentially.
  - Phases: Think of the overall phases of the project. For example,

After those phases are in place, you can add tasks and subtasks beneath them.

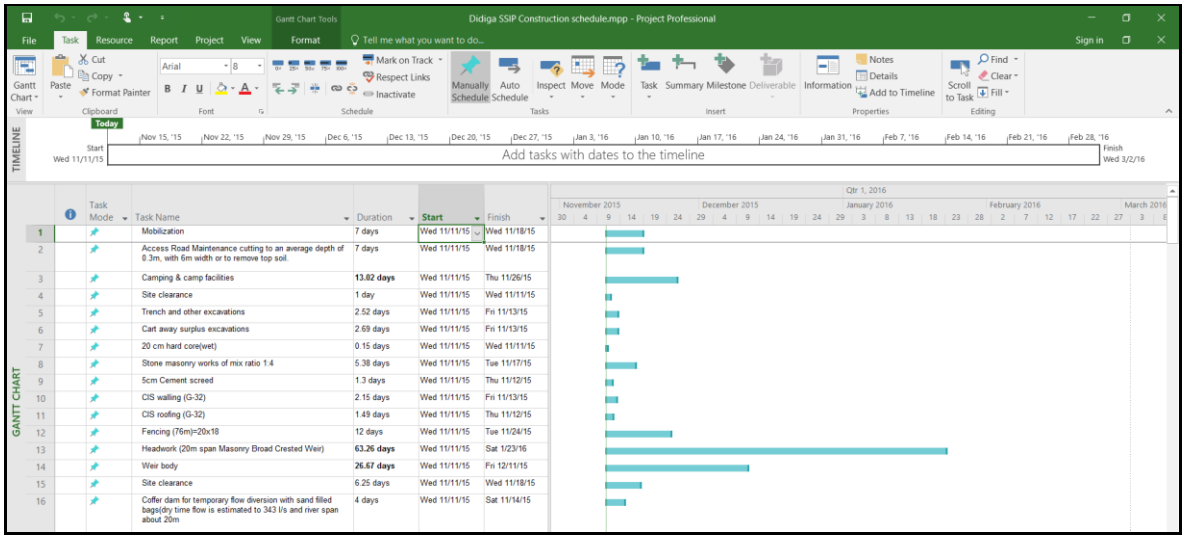
- **Milestones and deliverables**: Consider what the project is producing in terms of the mile-stones and deliverables. Enter those events as tasks and then add tasks and subtasks beneath them to flesh out the project. Your scope statement can be a valuable guide in this process

Entering Tasks

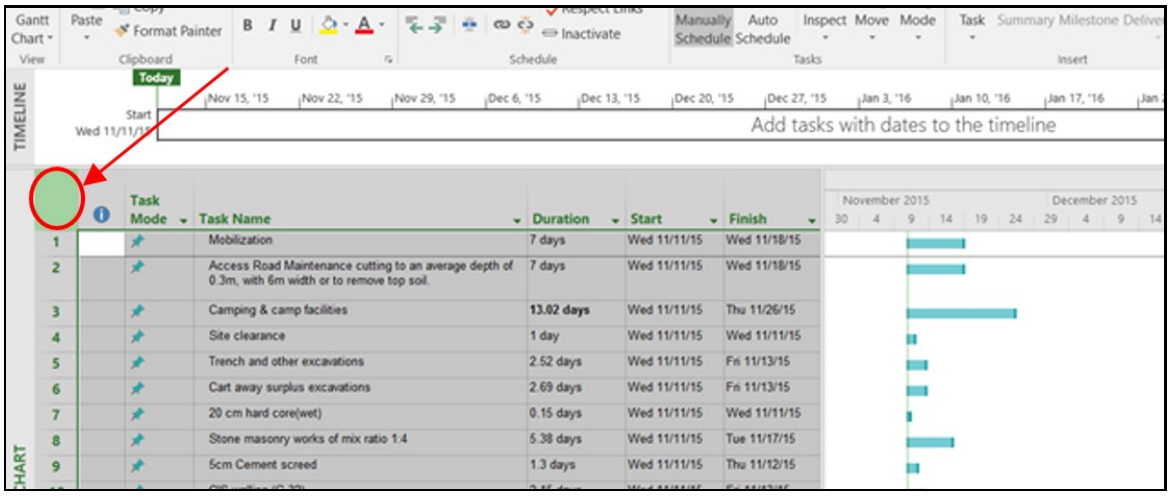
- From C-Excel file folder open Didiga Duration.xlsx file
- Copy all activities and durations
- In Gantt Chart View, just click a cell directly below the Task Name Column Paste it



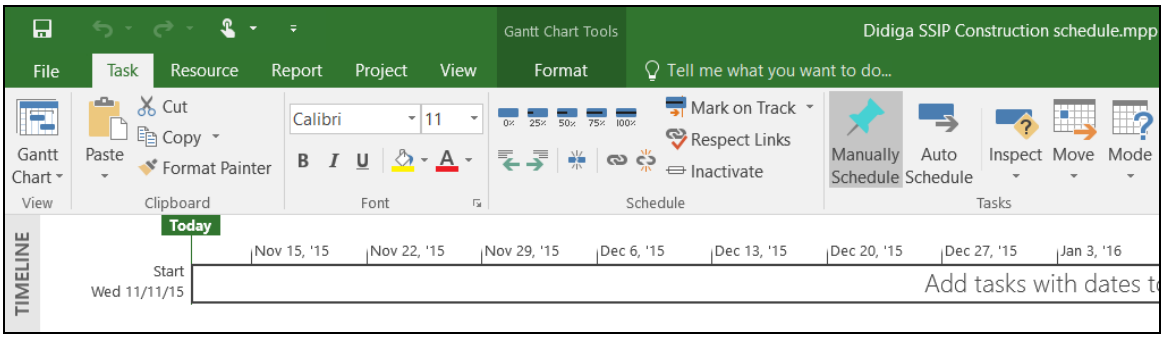
- In Gantt Chart View, just click a cell directly below the Start Column and select November 11/ 2015.
- Similarly select the same day for all activities



- Click the top left corner to select all the tasks



- Click the auto schedule tab

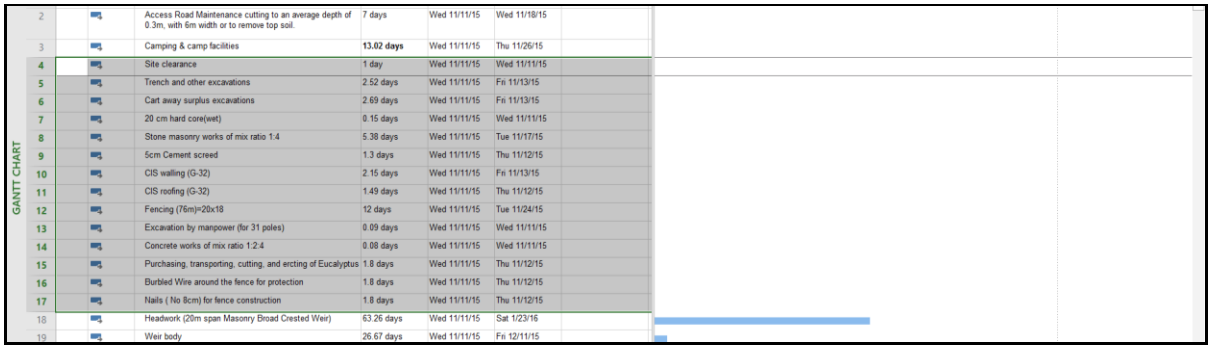


- Then the task Mode will change to auto schedule mode

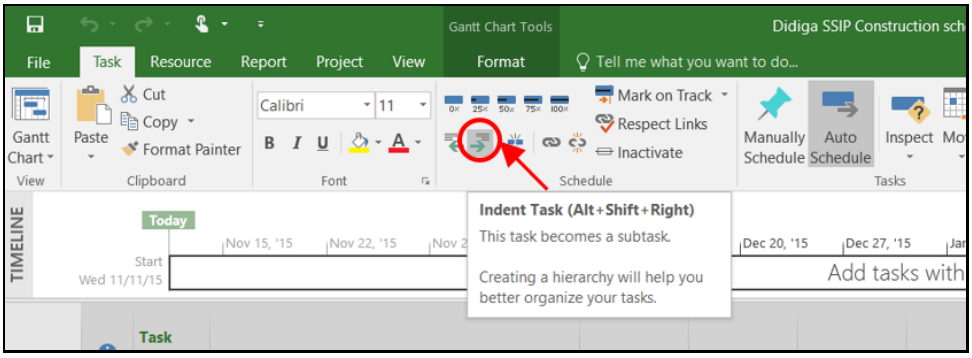
Sub Tasks

There can be a huge number of tasks in a project schedule, it is therefore a good idea to have a bunch of related tasks rolled up into a hierarchical chart view to help you organize the plan in a better way. It helps you organize your plan into phases. In MS Project, you can have several number of sub-tasks under any higher level task.

- Mobilization and Access roads don't have subtasks so leave them as it is
- But Camping and camping facilities have number of sub task that needs to be rolled up to do so select task from 3.1 to 3.9.5 (refer the Norm,output and resources excel file)



- Click Indent tab



- Again there are sub tasks of Fencing i.e. from 3.9.1 to 3.9.5 and likewise by clicking indent tab create the sub tasks
- The created task hierarchy looks like this

GANTT CHART

1		Mobilization	7 days	Wed 11/11/15	Wed 11/18/15
2		Access Road Maintenance cutting to an average depth of 0.3m, with 6m width or to remove top soil.	7 days	Wed 11/11/15	Wed 11/18/15
3		**Camping & camp facilities**	**5.38 days**	**Wed 11/11/15**	**Tue 11/17/15**
4		Site clearance	1 day	Wed 11/11/15	Wed 11/11/15
5		Trench and other excavations	2.52 days	Wed 11/11/15	Fri 11/13/15
6		Cart away surplus excavations	2.69 days	Wed 11/11/15	Fri 11/13/15
7		20 cm hard core(wet)	0.15 days	Wed 11/11/15	Wed 11/11/15
8		Stone masonry works of mix ratio 1:4	5.38 days	Wed 11/11/15	Tue 11/17/15
9		5cm Cement screed	1.3 days	Wed 11/11/15	Thu 11/12/15
10		CIS walling (G-32)	2.15 days	Wed 11/11/15	Fri 11/13/15
11		CIS roofing (G-32)	1.49 days	Wed 11/11/15	Thu 11/12/15
12		**Fencing (76m)=20x18**	**1.8 days**	**Wed 11/11/15**	**Thu 11/12/15**
13		Excavation by manpower (for 31 poles)	0.09 days	Wed 11/11/15	Wed 11/11/15
14		Concrete works of mix ratio 1:2:4	0.08 days	Wed 11/11/15	Wed 11/11/15
15		Purchasing, transporting, cutting, and erecting of Eucal	1.8 days	Wed 11/11/15	Thu 11/12/15
16		Burbled Wire around the fence for protection	1.8 days	Wed 11/11/15	Thu 11/12/15
17		Nails (No 8cm) for fence construction	1.8 days	Wed 11/11/15	Thu 11/12/15
18		Headwork (20m span Masonry Broad Crested Weir)	63.26 days	Wed 11/11/15	Sat 1/23/16

Creating Relationships between Tasks

Once you have a list of tasks ready to accomplish your project objectives, you need to link them with their task relationships called dependencies. For example, Task “Access road” can start once Task “Mobilization” has finished. These dependencies are called Links.

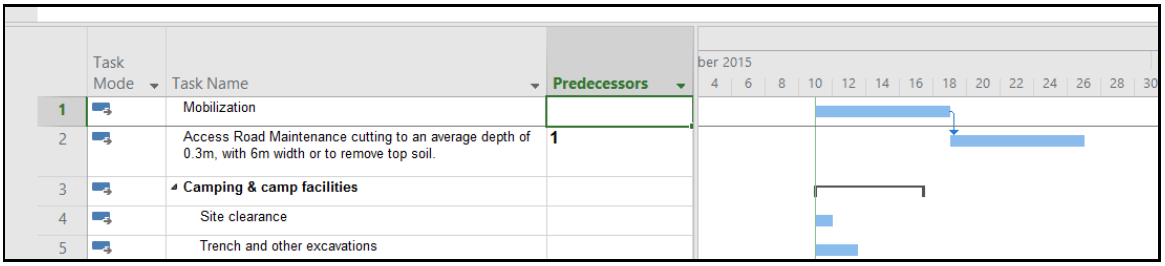
In MS Project, the first task is called a **predecessor** because it precedes tasks that depend on it. The following task is called the **successor** because it succeeds, or follows tasks on which it is dependent. Any task can be a predecessor for one or more successor tasks. Likewise, any task can be a successor to one or more predecessor tasks.

There are only four types of task dependencies; here we present them with examples.

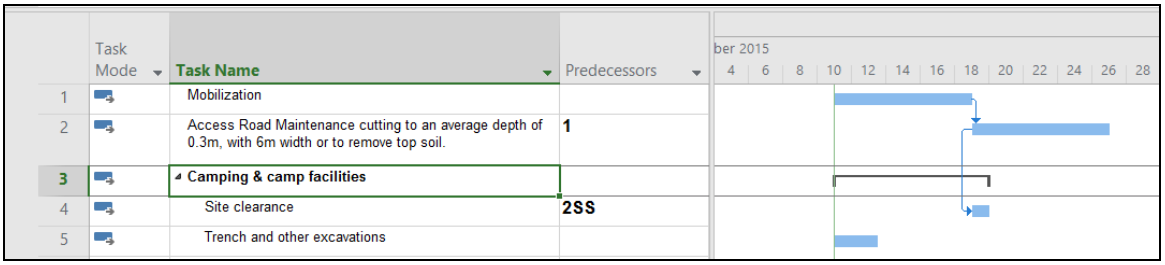
- **Finish to Start (FS):** The finish date of the predecessor task determines the start date of the successor task.
- **Finish to Finish (FF):** The finish date of the predecessor task determines the finish date of the successor task.
- **Start To Start (SS):** The Start date of the predecessor task determines the start date of the successor task.
- **Start to Finish (SF):** The Start date of the predecessor task determines the finish date of the successor task.

Link Task

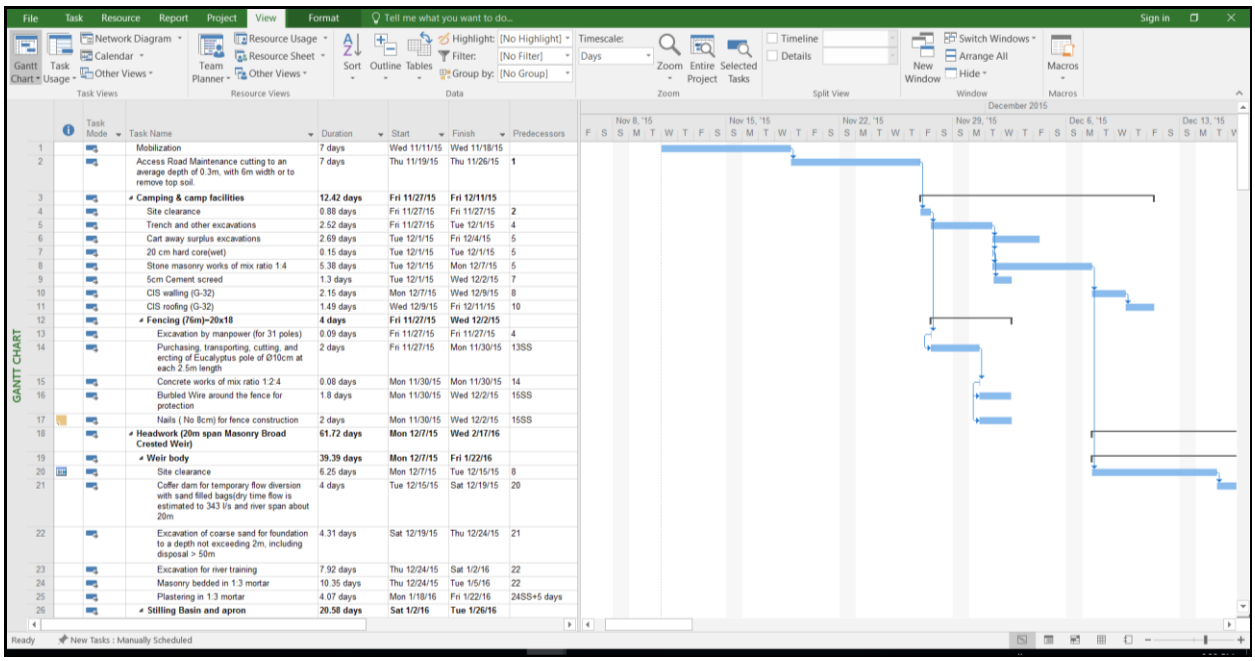
- In order to organize the tasks in specific order you have to understand the tasks relationships. Start with mobilization->Camping and facilities->Head work->Main canal…
- In the predecessor tab of “access road” enter “1” (which is ID no. of Mobilization indicating that it comes after mobilization completed)



- Under Camping and camping facilities the sub task “site clearance” can be started at the same time as “access road” activity starts hence enter “2SS”



- The rest of the task linkage is self-explanatory
- The final task schedule (Partially) will look like this

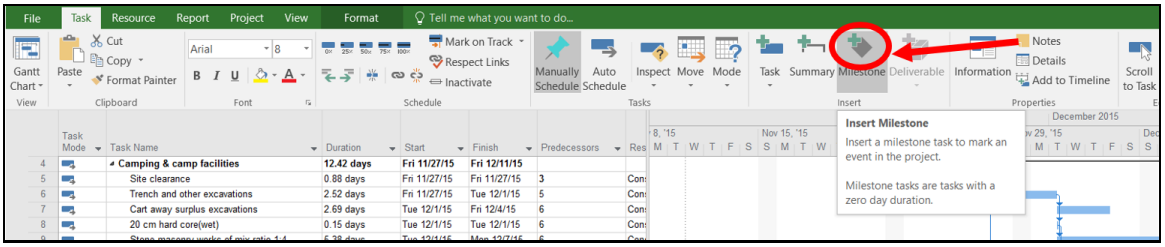


6.2.6 *Create milestones*

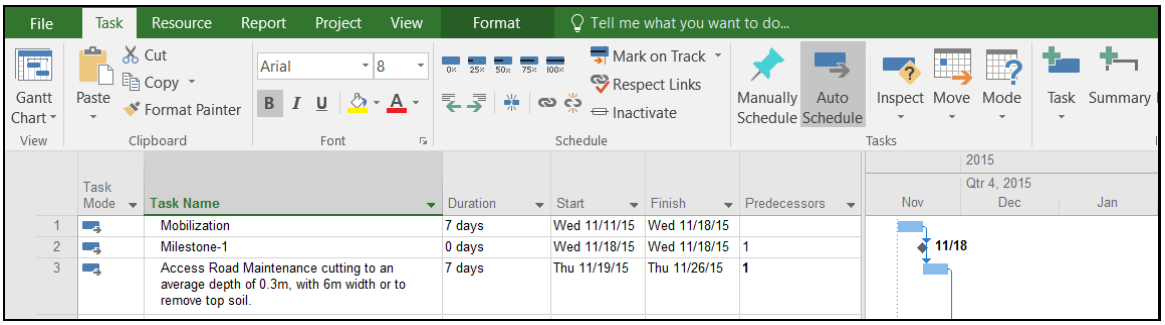
In Project Management, Milestones are specific points in a project timeline. They are used as major progress points to manage project success and stakeholder expectations. They are primarily used for review, inputs and budgets

Inserting a Milestone

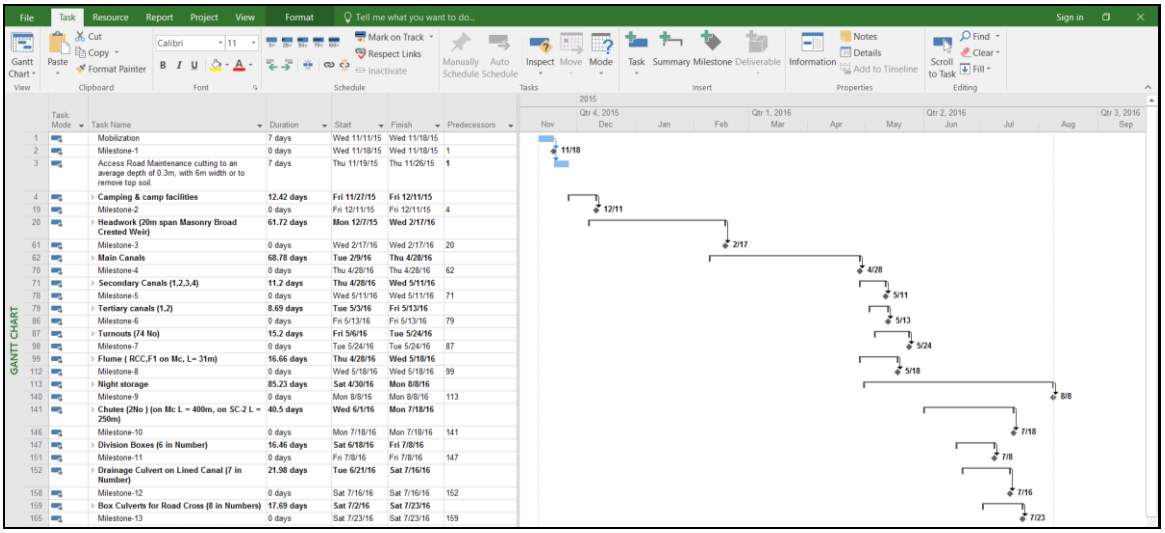
- Click Task name below mobilization
- Click Task tab -> Insert group -> Click Milestone



- MS Project names the new task as <New Milestone> with zero-day duration
- Click on <New Milestone> to change its name to Milestone-1
- Link it with “Mobilization” by entering “1” at the predecessor column of Mile stone
- You can see the milestone appear with a rhombus symbol in the Gantt Chart View on the right.



- Repeat the same procedures for all major tasks



6.2.7 Setting up resources in the project

In project management terminology, resources are required to carry out the project tasks. They can be people, equipment, facilities or funding required for the completion of a project task.

Optimum resource scheduling is the key to successful project management.

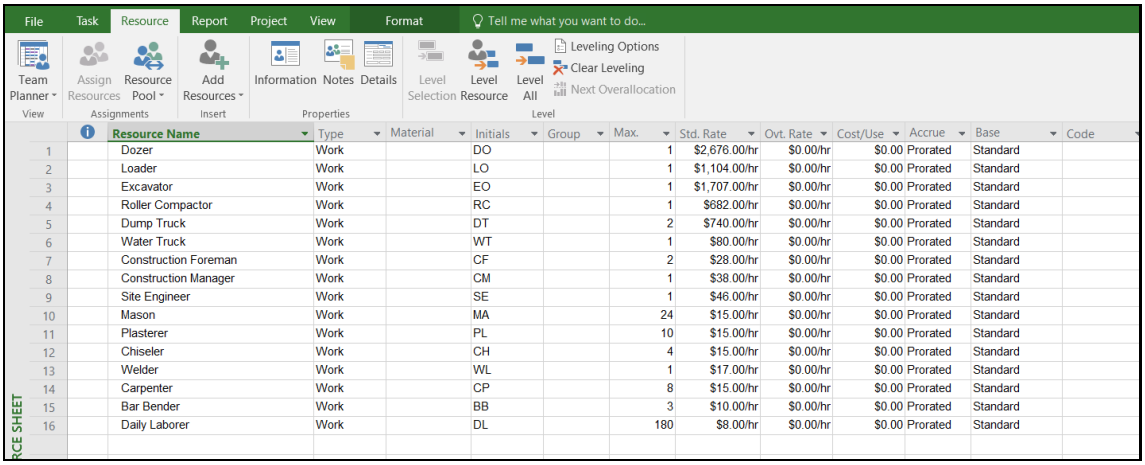
Resource types

- **Work resources**: People and equipment to complete the tasks.
- **Cost resources:** Financial cost associated with a task.
- **Material resources:** Consumables used as project proceeds.

Adding resource names manually

To add resources to your project by simple data entry, follow these steps:

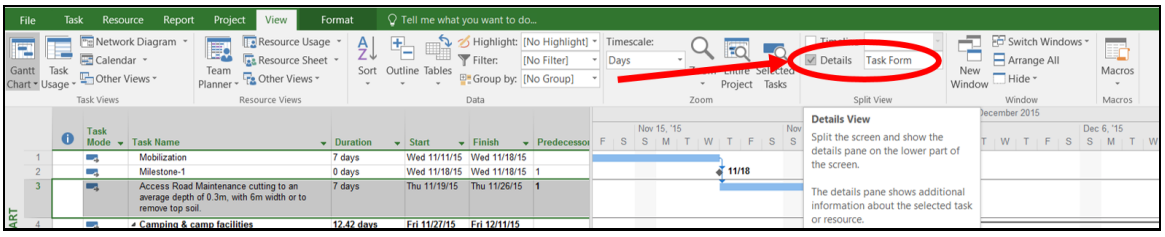
- Click View, Resource Sheet to switch to the Resource Sheet view
- Make sure the Entry table is applied. Click View, Table, Entry
- In the first Resource Name field, type the name of a resource and then press Enter
- Enter the names of other resources in the same way
- If a piece of equipment will be integral to the successful completion of a task, enter its name as a work resource, just as you would a human resource
- On the Initials column enter the abbreviation against each resources
- On the Max column enter the number of resources to be utilized
- On the standard rate column enter the hourly cost against each resources



	Resource Name	Type	Material	Initials	Group	Max.	Std. Rate	Ovt. Rate	Cost/Use	Accrue	Base	Code
1	Dozer	Work		DO		1	$2,676.00/hr	$0.00/hr	$0.00	Prorated	Standard	
2	Loader	Work		LO		1	$1,104.00/hr	$0.00/hr	$0.00	Prorated	Standard	
3	Excavator	Work		EO		1	$1,707.00/hr	$0.00/hr	$0.00	Prorated	Standard	
4	Roller Compactor	Work		RC		1	$682.00/hr	$0.00/hr	$0.00	Prorated	Standard	
5	Dump Truck	Work		DT		2	$740.00/hr	$0.00/hr	$0.00	Prorated	Standard	
6	Water Truck	Work		WT		1	$80.00/hr	$0.00/hr	$0.00	Prorated	Standard	
7	Construction Foreman	Work		CF		2	$28.00/hr	$0.00/hr	$0.00	Prorated	Standard	
8	Construction Manager	Work		CM		1	$38.00/hr	$0.00/hr	$0.00	Prorated	Standard	
9	Site Engineer	Work		SE		1	$46.00/hr	$0.00/hr	$0.00	Prorated	Standard	
10	Mason	Work		MA		24	$15.00/hr	$0.00/hr	$0.00	Prorated	Standard	
11	Plasterer	Work		PL		10	$15.00/hr	$0.00/hr	$0.00	Prorated	Standard	
12	Chiseler	Work		CH		4	$15.00/hr	$0.00/hr	$0.00	Prorated	Standard	
13	Welder	Work		WL		1	$17.00/hr	$0.00/hr	$0.00	Prorated	Standard	
14	Carpenter	Work		CP		8	$15.00/hr	$0.00/hr	$0.00	Prorated	Standard	
15	Bar Bender	Work		BB		3	$10.00/hr	$0.00/hr	$0.00	Prorated	Standard	
16	Daily Laborer	Work		DL		180	$8.00/hr	$0.00/hr	$0.00	Prorated	Standard	

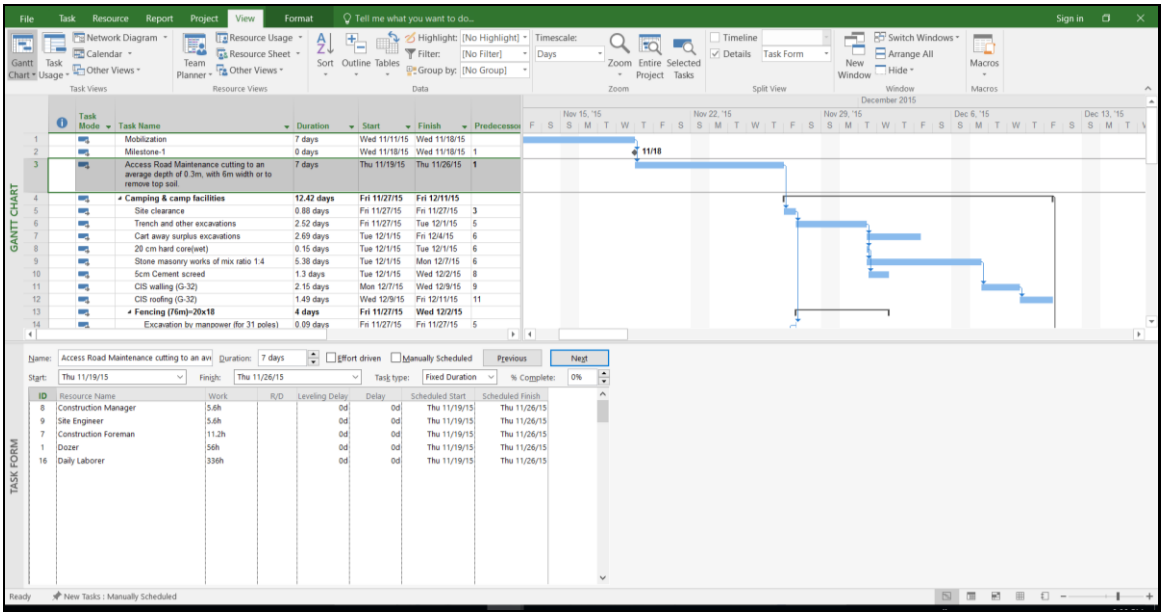
Assigning resources to tasks

- Click View Tab -> Split View group -> Details -> Task Form.

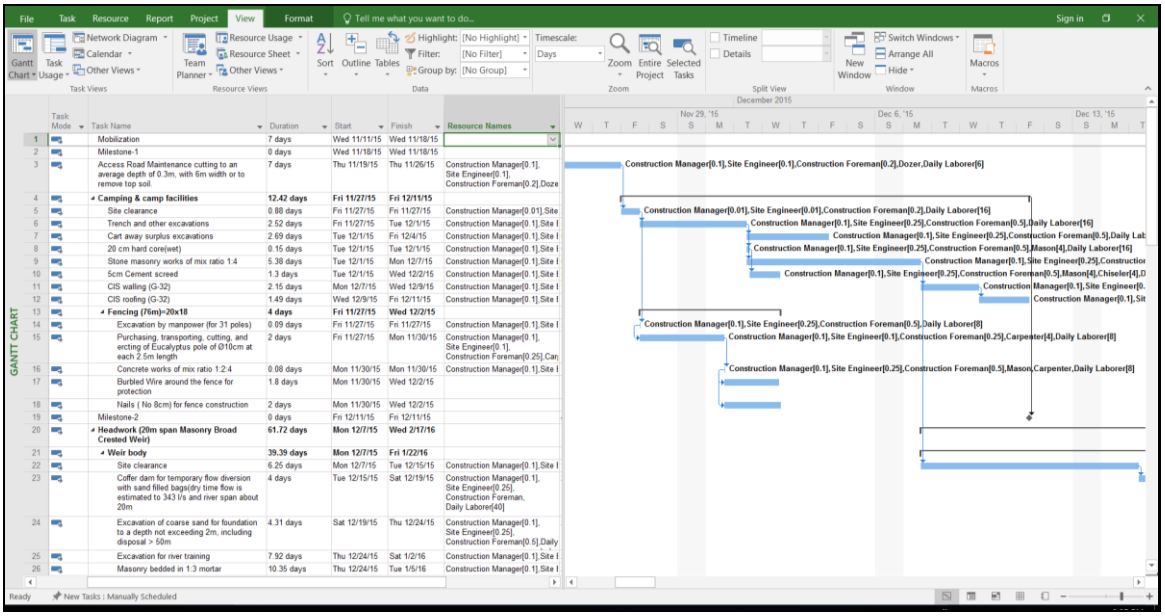


	Task Mode	Task Name	Duration	Start	Finish	Predecessor
1		Mobilization	7 days	Wed 11/11/15	Wed 11/18/15	
2		Milestone-1	0 days	Wed 11/18/15	Wed 11/18/15	1
3		Access Road Maintenance cutting to an average depth of 0.3m, with 6m width or to remove top soil.	7 days	Thu 11/19/15	Thu 11/26/15	1
4		Camping & camp facilities	12.42 days	Fri 11/27/15	Fri 12/11/15	

- The window is split in two, Gantt Chart view and Task Form view below it.
- In the Task Form view, click under the Resource Name column and select the resource.
- Click the cell below the Resource Name column.
- Select the resource from the dropdown list.
- On the unit's tab enter the expected input for that specific task.



- Repeat the same procedure for each task
- During the process of assigning the resources will appear at the Gant chart and "Resources name" column



View critical path

Critical Path is the succession of connected tasks that will take the longest to complete. The word "critical" does not mean that the tasks are complex or important or need to be closely monitored, but the focus is on terms schedule that will affect the project finish date.

So, if you want to shorten the duration of a project, you should first start with activities/tasks on the critical path. Critical path can be a single sequence of tasks (a single critical path) or there can be more than 1 critical paths for a single project. While schedule changes are made, it is also likely that the critical path will change from time to time.

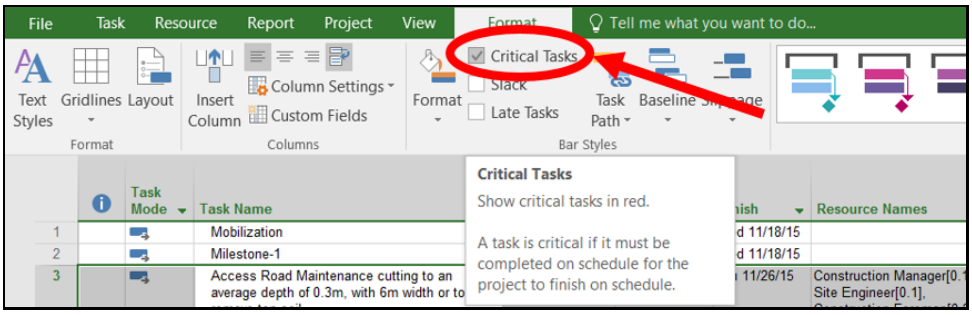
One needs to always focus on the Critical Path first, when one wants to apply fast-tracking or crashing to shorten the project duration.

Slack or Float are key to understanding Critical path. There are two types of Float:

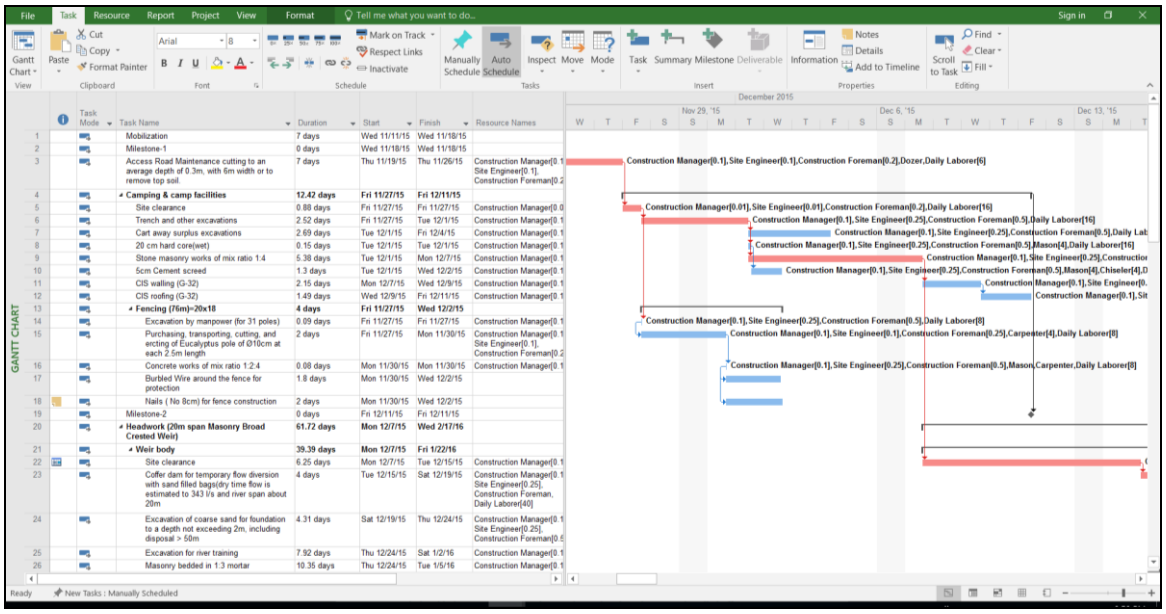
- **Free Float:** It is the amount of time a task can be delayed without delaying another task.
- **Total Float:** It is the amount of time a task can be delayed without delaying the completion of the project.

To View Critical path

- In Gantt Chart view -> Format Tab -> Bar Styles Group -> Check the Critical Tasks box ON



- All task bars in the critical path, in the Gantt Chart View on the right, will turn Red in color.



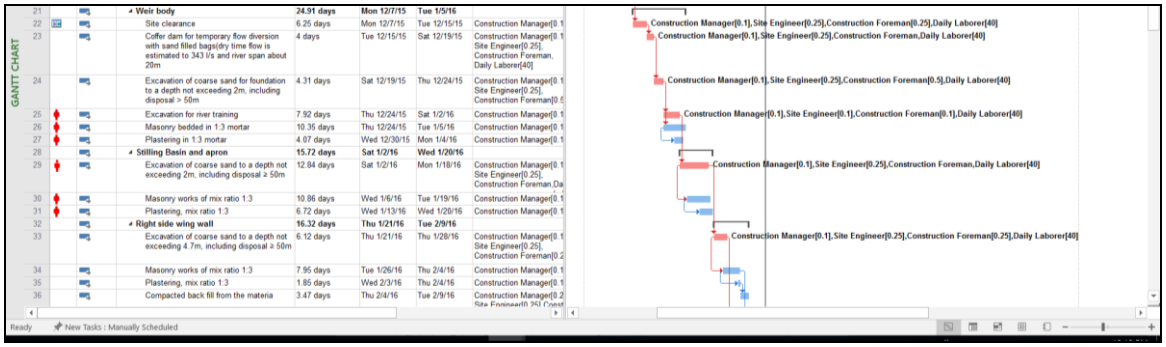
Check resource allocations

Relationship between a resource's capacity and task assignments is called **allocation**. This can be defined by 3 states:

- **Under allocated**: A skilled worker who works for 40 hours a week, has work assigned for only 20 hours.
- **Fully allocated**: A skilled worker who works for 40 hours a week, is assigned 40 hours of work in that week.
- **Over allocated**: A skilled worker is assigned 65 hours of work, when he only has a 40-hour workweek.

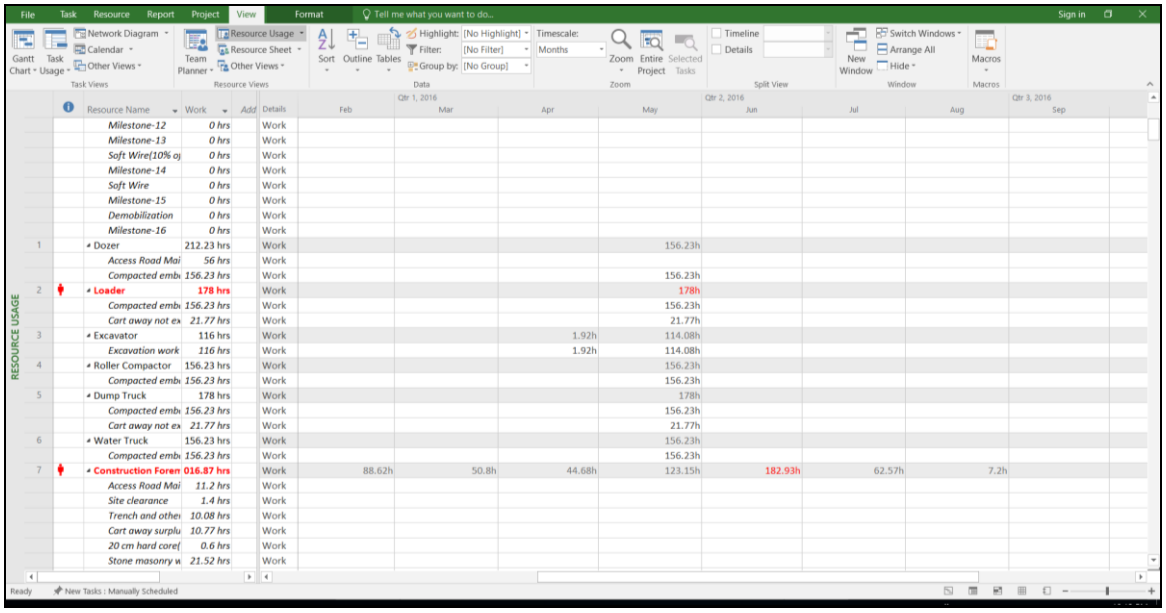
- Click View Tab -> Task Views group -> Gantt Chart view.

Gantt Chart View displays some limited resource information, as shown in the following screenshot. It summarizes whether there may be a problem by the red over allocated icon in the indicator column.



The Resource Usage view displays resources and all tasks assigned to them underneath the Resource Name. The left-hand side of the screen lists the Resources and the Task Names together with columns of total information for the resource or assignment. The right-hand side shows a time-phased view.

- Click View Tab -> Resource Views group -> Resource Usage view.



Resolve Resource over Allocation

One would need to either change the scope (reduce the amount of work), assign more resources, or accept a longer schedule to resolve over-allocation.

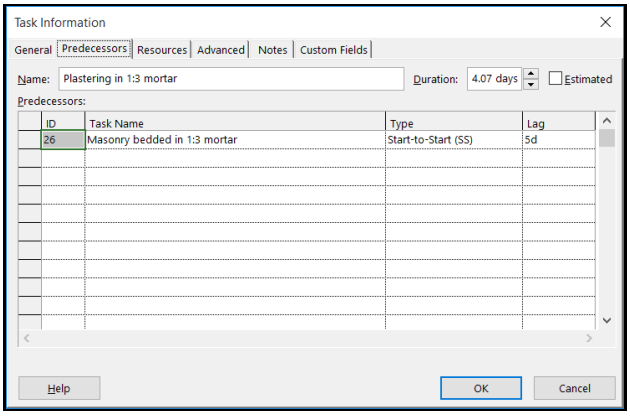
This can be achieved by using some of the following techniques:

I. Adjust Schedule

By changing its lead or lag time when the resource has more tasks assigned than can be completed during a given time period. If you add delay that is less than or equal to the amount of slack on the task, you will not affect the finish date of the project.

By default, when you link tasks, they are assigned a “Finish to Start” relationship. In this relationship,

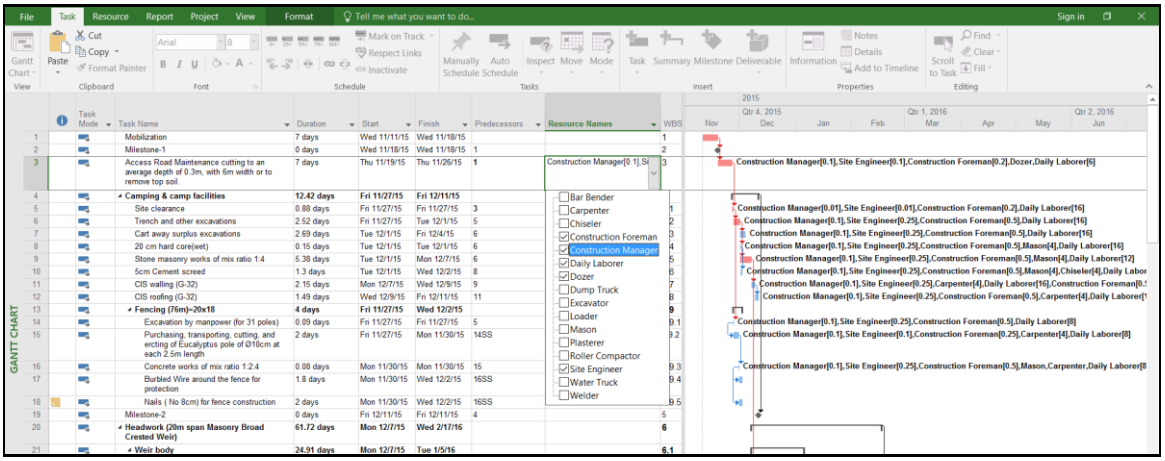
- **Lead**: Lead time causes successor task to begin before its predecessor tasks ends.
- **Lag**: Lag time causes successor task to start after its predecessor task ends.
- Click Task Tab -> double-click the required Task under Task Name column -> Task Information dialog box opens -> Predecessors Tab
- Under Lag heading column, enter the lag in terms of hours, days, weeks, or years.



II. Substitute resources or add additional resources

You can manually allot some other resource to the task.

- Click View Tab -> Gantt Chart View -> Resource Name column.
- Click the box below the Resource Name column for the task you need the resource to be assigned.



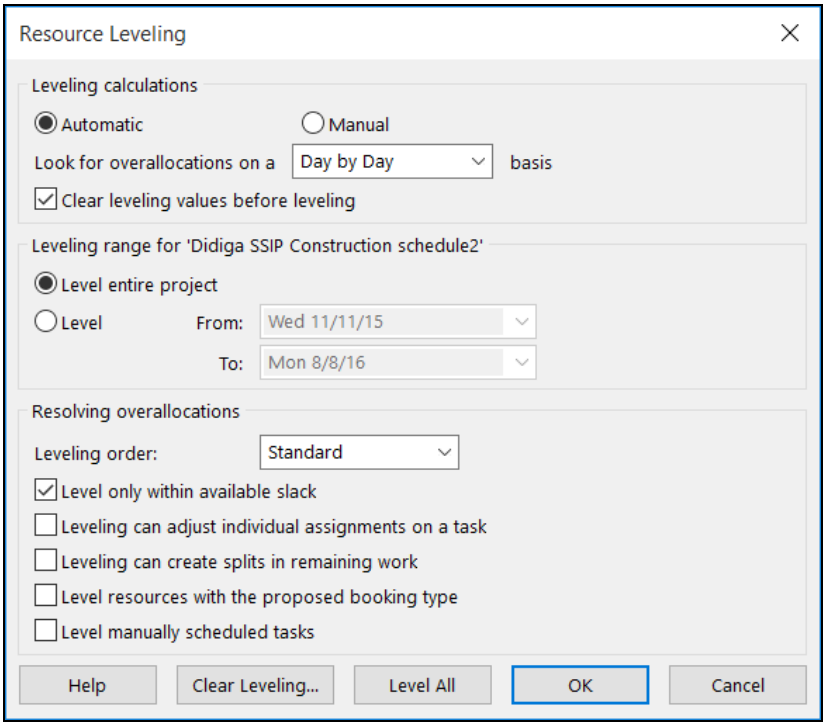
Level Over-Allocated Resources

If resources are over-allocated you can use resource-leveling feature in MS Project 2016. It works by either splitting tasks or by adding delay to tasks to ensure the resource is not overloaded. Leveling can delay the individual task finish dates and even the project finish date. Project does not change who is assigned to each task, total work, or assignment unit values.

Leveling

Steps in the Leveling process are only a few, but it is important to understand what each option does. The steps are as follows:

- Click Resource tab -> Level group -> Leveling Options.



In Resource Leveling dialog box, under Resolving over allocations, leveling order dropdown box you can choose Standard. You have 3 options here:

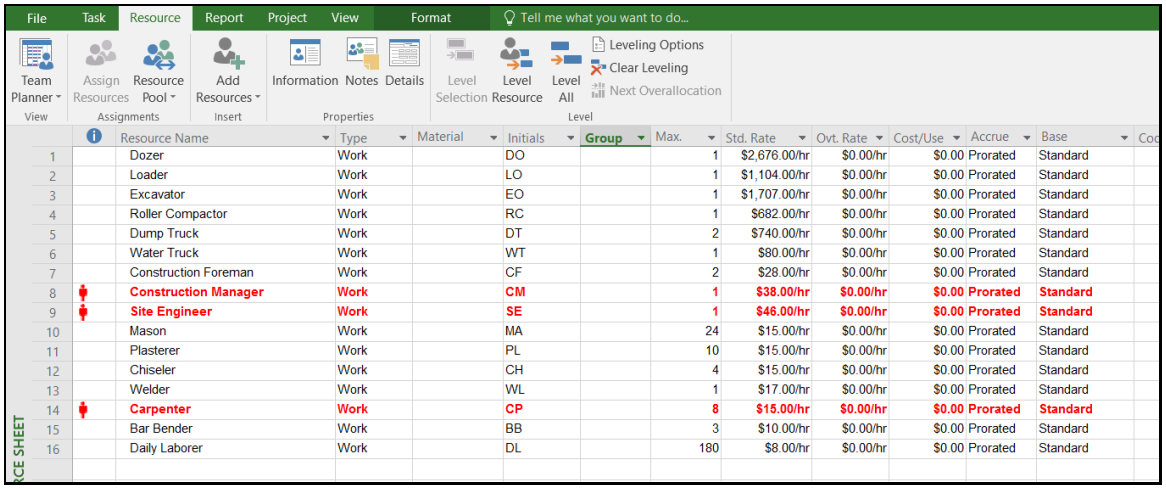
- **ID only** option delays tasks only according to their ID numbers. Numerically higher ID numbers (for example, 10) will be delayed before numerically lower ID numbers. You might want to use this option when your plan has no task relationships or constraints.
- **Standard option** delays tasks according to predecessor relationships, start dates, task constraints, slack, priority, and IDs.
- **Priority, standard option** looks at the task priority value before the other standard criteria (Task priority is a numeric ranking between 0 and 1000).

In Resource Leveling dialog box, under Resolving over allocations, you have several options that you can select. These are explained as follows:

- **Level only within available slack**. Selecting this checkbox would prevent Project from extending the plan's finish date. MS Project will use only the free slack within the existing schedule, which could mean that resource over allocations might not be fully resolved.
- **Leveling can adjust individual assignments**. Selecting this checkbox allows Project to add a leveling delay (or split work on assignments if Leveling Can Create Splits in Remaining Work is also selected) independently of any other resources assigned to the same task. This might cause resources to start and finish work on a task at different times.
- **Leveling can create splits in remaining work checkbox**. This allows Project to split work on a task (or on an assignment if Leveling Can Adjust Individual Assignments on a Task is also selected) as a way of resolving over allocation.
- **Level manually scheduled tasks**. Selecting this allows Project to level a manually scheduled task just as it would an automatically scheduled task.

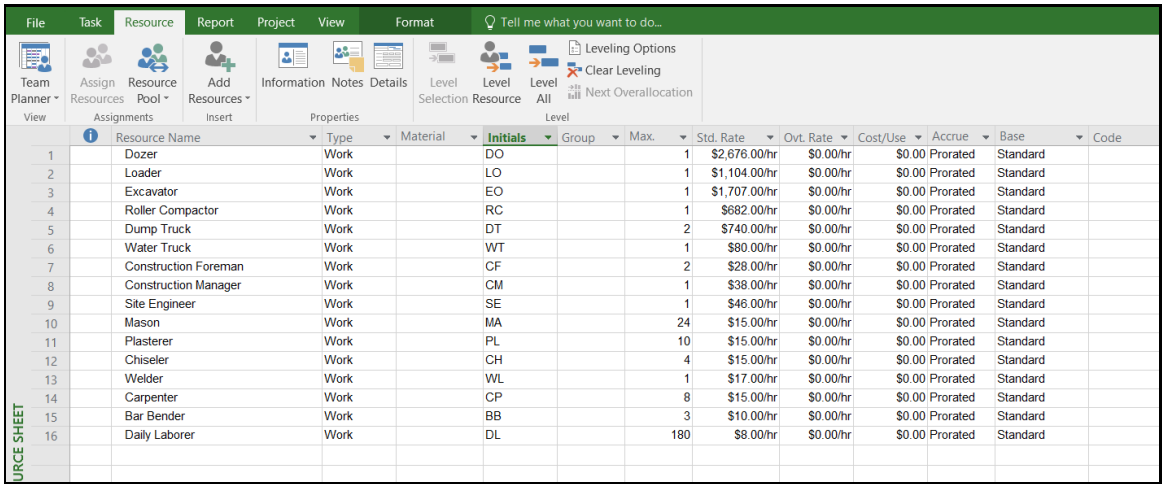
- After the desirable adjustment click level all
- Leveling will remove entire over-allocation

➢ Resource before Leveling



	Resource Name	Type	Material	Initials	Group	Max.	Std. Rate	Ovt. Rate	Cost/Use	Accrue	Base
1	Dozer	Work		DO		1	$2,676.00/hr	$0.00/hr	$0.00	Prorated	Standard
2	Loader	Work		LO		1	$1,104.00/hr	$0.00/hr	$0.00	Prorated	Standard
3	Excavator	Work		EO		1	$1,707.00/hr	$0.00/hr	$0.00	Prorated	Standard
4	Roller Compactor	Work		RC		1	$682.00/hr	$0.00/hr	$0.00	Prorated	Standard
5	Dump Truck	Work		DT		2	$740.00/hr	$0.00/hr	$0.00	Prorated	Standard
6	Water Truck	Work		WT		1	$80.00/hr	$0.00/hr	$0.00	Prorated	Standard
7	Construction Foreman	Work		CF		2	$28.00/hr	$0.00/hr	$0.00	Prorated	Standard
8	**Construction Manager**	**Work**		**CM**		**1**	**$38.00/hr**	**$0.00/hr**	**$0.00**	**Prorated**	**Standard**
9	**Site Engineer**	**Work**		**SE**		**1**	**$46.00/hr**	**$0.00/hr**	**$0.00**	**Prorated**	**Standard**
10	Mason	Work		MA		24	$15.00/hr	$0.00/hr	$0.00	Prorated	Standard
11	Plasterer	Work		PL		10	$15.00/hr	$0.00/hr	$0.00	Prorated	Standard
12	Chiseler	Work		CH		4	$15.00/hr	$0.00/hr	$0.00	Prorated	Standard
13	Welder	Work		WL		1	$17.00/hr	$0.00/hr	$0.00	Prorated	Standard
14	**Carpenter**	**Work**		**CP**		**8**	**$15.00/hr**	**$0.00/hr**	**$0.00**	**Prorated**	**Standard**
15	Bar Bender	Work		BB		3	$10.00/hr	$0.00/hr	$0.00	Prorated	Standard
16	Daily Laborer	Work		DL		180	$8.00/hr	$0.00/hr	$0.00	Prorated	Standard

➢ Resource after Leveling



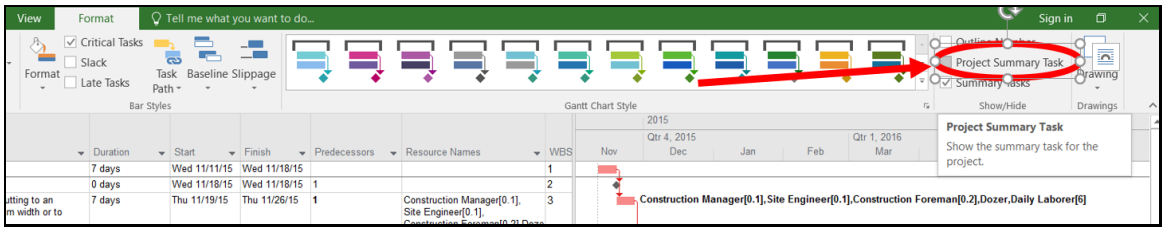
	Resource Name	Type	Material	Initials	Group	Max.	Std. Rate	Ovt. Rate	Cost/Use	Accrue	Base	Code
1	Dozer	Work		DO		1	$2,676.00/hr	$0.00/hr	$0.00	Prorated	Standard	
2	Loader	Work		LO		1	$1,104.00/hr	$0.00/hr	$0.00	Prorated	Standard	
3	Excavator	Work		EO		1	$1,707.00/hr	$0.00/hr	$0.00	Prorated	Standard	
4	Roller Compactor	Work		RC		1	$682.00/hr	$0.00/hr	$0.00	Prorated	Standard	
5	Dump Truck	Work		DT		2	$740.00/hr	$0.00/hr	$0.00	Prorated	Standard	
6	Water Truck	Work		WT		1	$80.00/hr	$0.00/hr	$0.00	Prorated	Standard	
7	Construction Foreman	Work		CF		2	$28.00/hr	$0.00/hr	$0.00	Prorated	Standard	
8	Construction Manager	Work		CM		1	$38.00/hr	$0.00/hr	$0.00	Prorated	Standard	
9	Site Engineer	Work		SE		1	$46.00/hr	$0.00/hr	$0.00	Prorated	Standard	
10	Mason	Work		MA		24	$15.00/hr	$0.00/hr	$0.00	Prorated	Standard	
11	Plasterer	Work		PL		10	$15.00/hr	$0.00/hr	$0.00	Prorated	Standard	
12	Chiseler	Work		CH		4	$15.00/hr	$0.00/hr	$0.00	Prorated	Standard	
13	Welder	Work		WL		1	$17.00/hr	$0.00/hr	$0.00	Prorated	Standard	
14	Carpenter	Work		CP		8	$15.00/hr	$0.00/hr	$0.00	Prorated	Standard	
15	Bar Bender	Work		BB		3	$10.00/hr	$0.00/hr	$0.00	Prorated	Standard	
16	Daily Laborer	Work		DL		180	$8.00/hr	$0.00/hr	$0.00	Prorated	Standard	

Project Summary Task

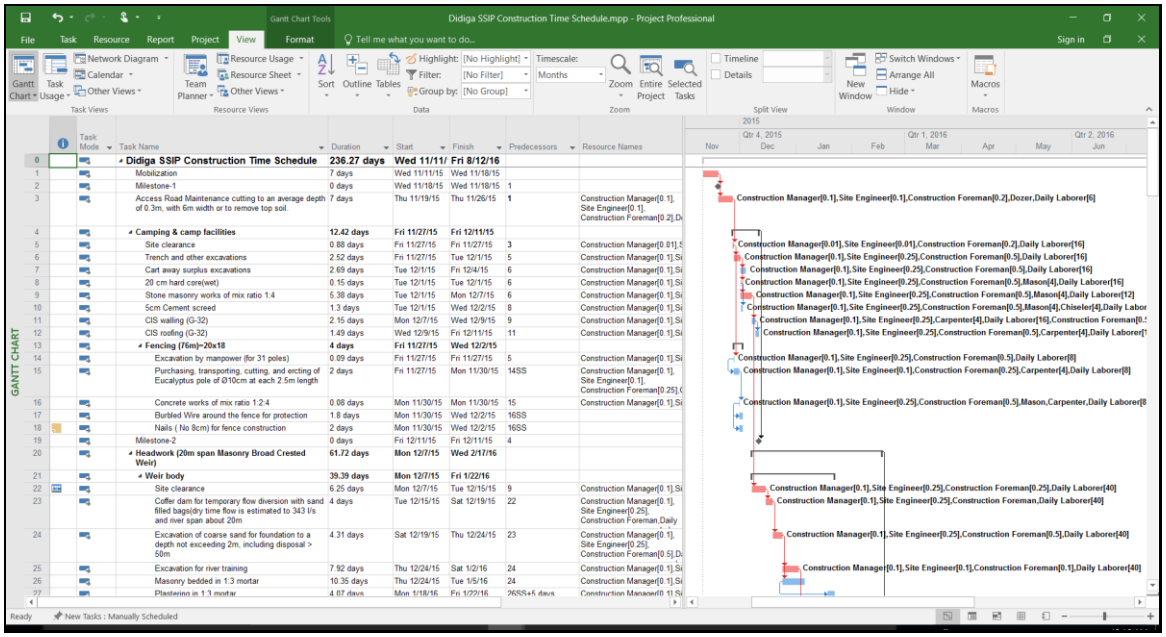
Project summary task is at the highest level of the plan's outline; it includes rolled-up details from all subtasks. It also represents the full duration of the plan, so it's a handy way of seeing some essential details, such as the plan's overall duration. Project automatically generates the project summary task but does not display it by default.

To display the project summary task

- Click anywhere in a Gantt chart view. When the focus is on a Gantt chart view, the label of the Format tab is Gantt Chart Tools.
- On the Format tab, select the Project Summary Task check box



Project displays the project summary task at the top of the Gantt Chart view with an ID of 0.

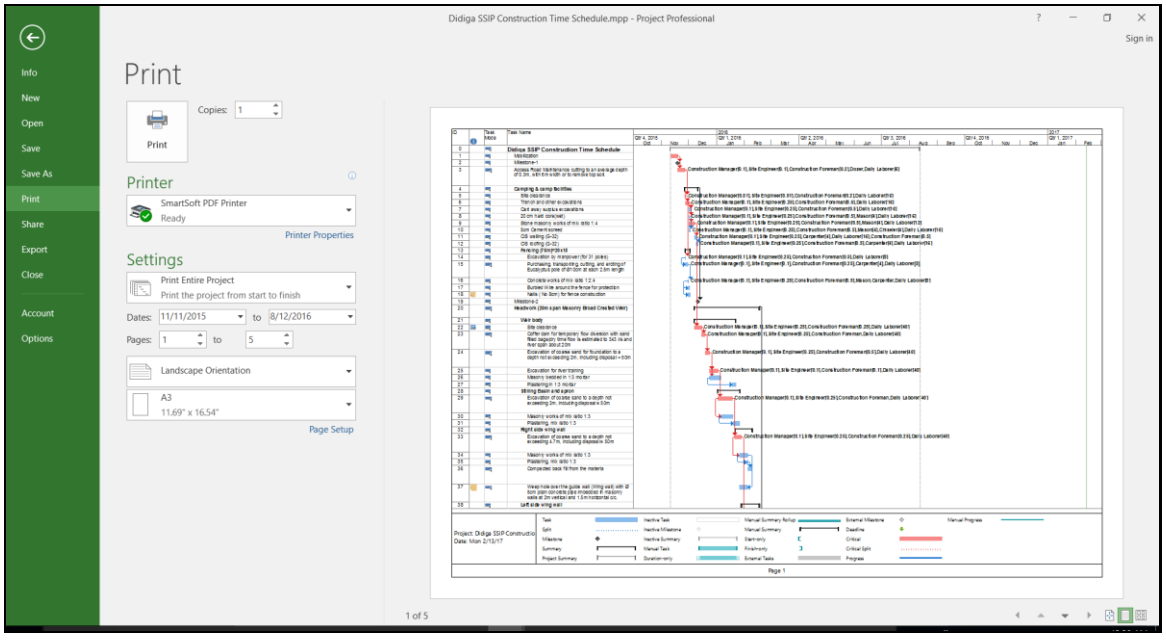


6.3 REPORTING PROJECT INFORMATION

6.3.1 *Setting up and printing views*

To set up and print a view, follow these steps:

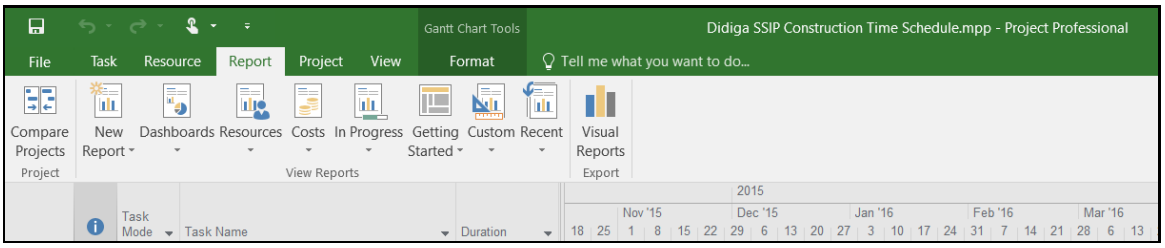
- Open the view and arrange the data as you want it to appear when printed.
- Click File, Page Setup to display the Page Setup dialog box.
- Specify the options you want for the printed view using controls on the different tabs of this dialog box. You can adjust the view orientation, page scaling, margins, header and footer, and so on. When finished, click OK.
- On the Standard toolbar, click Print Preview. A picture of the view as printed appears, reflecting your Page Setup options.



6.3.2 Reporting project information

Generating reports:
To see the list of available built-in reports:

- Click Reports, Report. The Reports dialog box appears, showing the following categories.

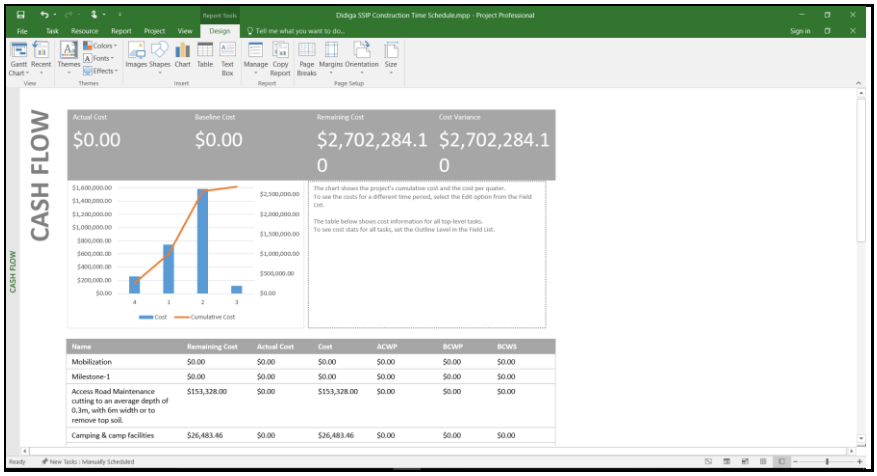


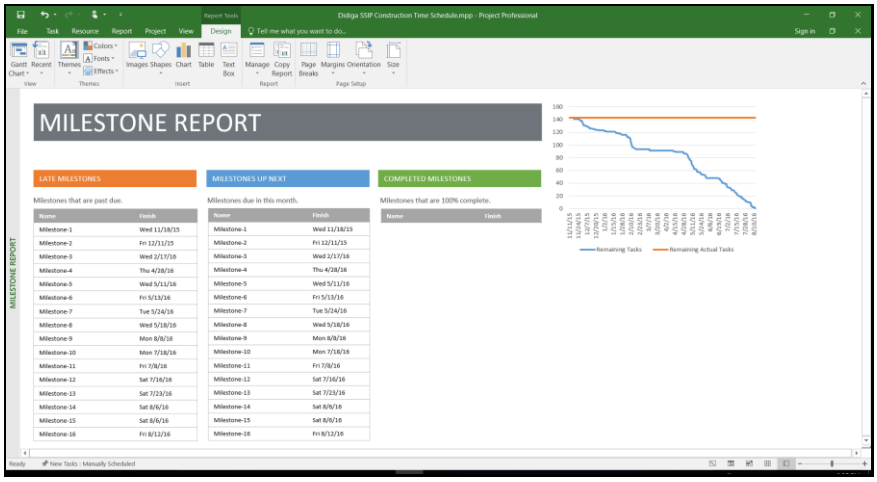
The report categories are as follows:

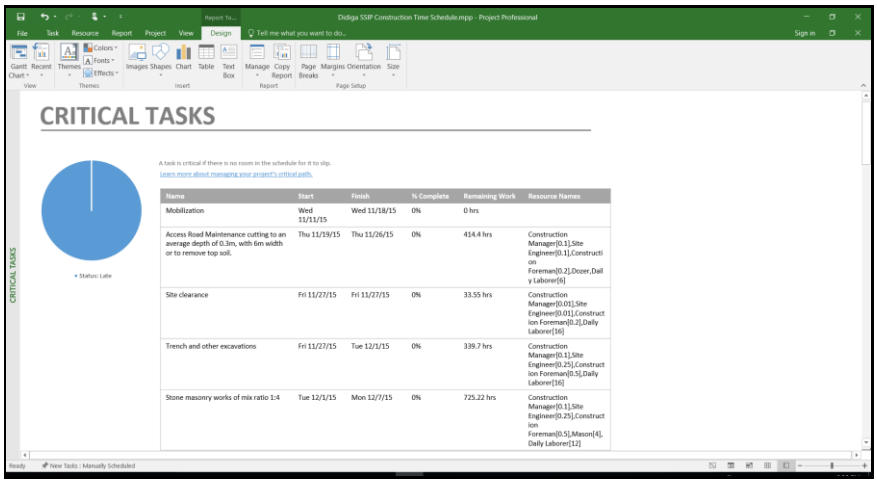
- New Reports
- Dashboards
- Resources
- Costs
- In progress
- Custom….

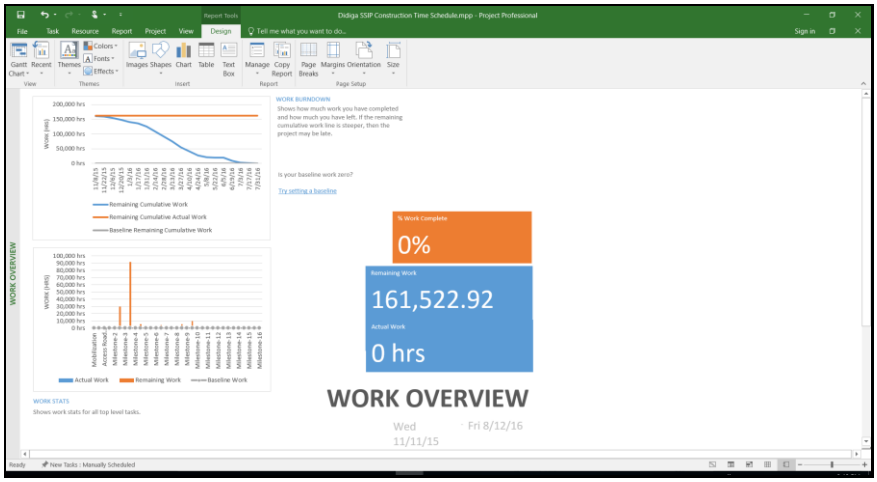
To select and print a report, follow these steps:

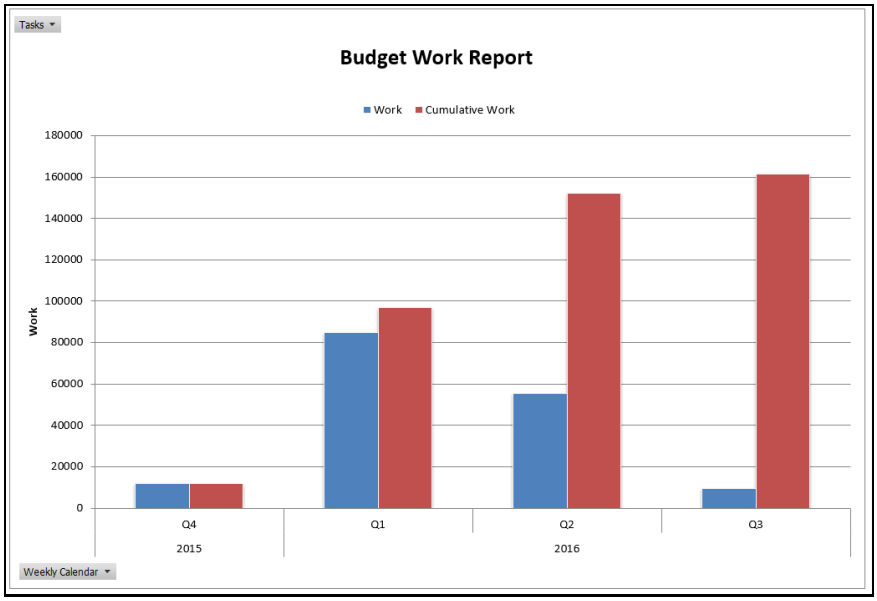
- Click View, Reports.
- In the Reports dialog box, double-click the category you want.
- In the dialog box that appears, double-click the report you want.
- If a dialog box prompts you for more information, such as a date range, enter it and then click OK.
- The report appears in a Print Preview window
- When ready to print the report, click Print on the Print Preview toolbar.
- In the Print dialog box that appears, select the page range and number of copies you want to print and then click OK.
- Here are some of report examples




MILESTONE REPORT
LATE MILESTONES
MILESTONES UP NEXT
COMPLETED MILESTONES


CRITICAL TASKS


WORK OVERVIEW
0%
161,522.92
0 hrs


Tasks
Budget Work Report
Work
Cumulative Work
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
Work
Q4
Q1
Q2
Q3
2015
2016
Weekly Calendar

You are Done!!!

REFERENCE

- Eagle Point 2007, User Manual
- Hec-Ras River Analysis System, User Manual
- Hec-Ras River Analysis System, Hydraulic Reference Manual
- Hec-Ras River Analysis System, Application Guide
- Zprofile, User Manual
- ICT, WAPCOS Irrigation canal long section VB.net program
- Shimburit Micro Earth Dam Irrigation Project Headwork Feasibility Study Document
- GeoStudio 2007 documentation
- Slope Stability: US Army Corps of Engineers, ENGINEERING AND DESIGN
- DESIGN OF SMALL DAMS; USBR
- General Design and Construction Considerations for Earth and Rock-Fill Dams; US Army Corps of Engineers
- Earth Dams and Reservoirs; U.S. Department of Agriculture Soil Conservation Service Engineering Division
- Ms-Project 2016 User Manual

APPENDICES

APPENDIX I: Worked Example & Model (Soft copy)

APPENDIX II: Softwares (Soft copy)

Prepared by

GIRDC