

Optimum Bridge Site Selection using Network Analysis Tool (Al Muwaffaqiyah Bridge in Iraq as A case Study)

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Abstract

The main objective of this research is to select the best site for the establishment of a new bridge on the Al Gharraf river within the limits of the Al Muwaffaqiyah region . Al Muwaffaqiyah region is located in Wasit province in Iraq. The study area is divided into multiple zones . Three alternatives are proposed to construct the bridge site. The best one is selected using network analyst tool of ArcGIS software depending on the largest number of routes passing between zones. The route link between both sides of Al Gharraf river in Al Muwaffaqiyah region is one of the important projects in the city. The project will provide a new crossing point on Al Gharraf river . The proposed route will contribute to reduce traffic congestion depending on the foundations of planning and traffic so that gives the desired result of this project in terms of the location and importance of economic feasibility.

Keywords: Network Analyst , Site Selection , Traffic Congestion , Route location, Travel Time .

الخلاصة

الهدف الرئيسي من البحث هو اختيار الموقع الامثل لأتشاء جسر جديد على نهر الغراف ضمن حدود منطقة الموقية التي تقع في محافظة واسط بالعراق ، وقسمت منطقة الدراسة الى عدد من النطاقات وتم اقتراح ثلاثة بدائل لأتشاء موقع الجسر و أختير أفضل البدائل بأستخدام أداة تحليل الشبكة لحقيقية البرمجيات (ArcGIS Software) وبالأعتقاد على أكثر عدد من المسارات المارة مابين المناطق . ويعتبر ربط المسار بين جانبي نهر الغراف في منطقة الموقية من المشاريع المهمة في المدينة ، حيث سيوفر المشروع عبور جديدة على نهر الغراف ، وان المسار المقترح سيساهم في تقليل الاختناقات المرورية بالأعتقاد على اسس تخطيطية ومرورية بحيث يعطي النتيجة المتوخاة من المشروع من ناحية الموقع والاهمية والجدوى الاقتصادية.

الكلمات المفتاحية : تحليل الشبكة ، اختيار الموقع ، الاختناق المروري ، موقع المسار ، زمن الرحلة .

Introduction

Wasit province in Iraq is seeking to develop the basic services offered to its citizens . These basic services is to improve the transport networks on the mind of the biggest problems of maintaining services . The improvement of the transportation networks is a natural consequence of the growth of the province and the breadth of its architecture and the emergence of new growth areas as well as increase the number of population and the increase of vehicles . The purpose of the study is the choice of the construction site of a bridge on Al Gharraf river in Al Muwaffaqiyah region in Wasit province.

An alternative performance measure is travel time, useful for indicating when high-speed service (such as limited-stop or express service) should be considered between two locations. Since travel time varies with the size of a community and the amount of traffic congestion (for transit modes operating in mixed traffic) , travel time is not suitable as a service measure without defining different categories of city sizes (HCM, 2000).

Urban planners have always aimed at optimizing the road network design to meet transportation cost, safety, land use, aesthetic and environmental considerations. With the rapid growth in traffic patterns and space utilization, there is a growing need for a tool to design and evaluate urban road networks (Nagar and Tawfik, 2007).

Geographic Information System (GIS) can quickly analyze and display a route from a station location to the emergency call. This route (depending on the

sophistication of the street file) may be the shortest path (distance) or the quickest path (depending on time of day and traffic patterns) (ESRI, 2006).

A GIS can be a useful tool for determining emergency vehicle response routing, and the application of dynamic variables like historical traffic count data can help emergency response vehicles to avoid traffic congestion and improve response times (Michael, 2014).

Objective

- The optimum site selection for a new bridge in Al Muwaffaqiyah region is the principle objective of this study . The route is proposed using network analyst tool of ArcGIS software.
- The study is focused on the traffic coming from the eastern side of Al Gharraf river to the west side and vice versa. The factors affecting the traffic and transport inventory components are determined in order to minimize the traffic congestion within the region.
- The nature and degree of transportation system is linked to the concept of easy access. The more improved accessibility increases trips breed. It can add that the flights affected by breed comfort, safety and convenience offered by the road network and transportation systems and that its arguments. The citizens exercise their activities in areas where easy access is achieved.

Study Area and Landuses

The study area is Al Muwaffaqiyah region . Al Muwaffaqiyah region is located in Wasit province in south region of Iraq . The study area is about four square kilometers. It is divided by the length of Al Gharraf river approximately (1.35 km) and the basin area of nearly (158000 square meters) . The west side is the oldest than the eastern side of the area where most of the east side buildings were created after 2003. The boundary of study area is illustrated in Figure (1) .

Al Muwaffaqiyah region is the most important areas in Wasit province. It has a densely populated and dense transport networks as a result of its privileged position and the diversity of the nature of land use . The region containing multiple uses as shown in Figure (2) . The multiplicity of land uses will generate different types of trips. There are four main entrances of the study as shown in Figure (2) . These are as follows :

- Route of Al Muwaffaqiyah – Kut , which is located north of Al Muwaffaqiyah region in the western side of Al Gharraf river.
- Outgoing way towards Kut – Nasiriyah , which is located east of Al Muwaffaqiyah region in the eastern side of Al Gharraf river.
- Route of Al Muwaffaqiyah – Diwaniyah , which is located west of Al Muwaffaqiyah region in the western side of Al Gharraf river.
- Route of Al Muwaffaqiyah – Al-Hay , which is located south of Al Muwaffaqiyah region in the western side of Al Gharraf river.



Figure 1. Study Area in Al Muwaffaqiyah.



Figure 2 . Landuses and Entrances in Al Muwaffaqiyah Region.

Methodology for Bridge Site Determination

The location of bridge site is determined using network analyst tool of ArcGIS software . Figure (3) shows the basis map of Al Muwaffaqiyah region which has been prepared by ArcGIS ArcMap program. Three alternatives are proposed to construct the bridge site .

The best motion paths for transmission between parts of the study area are selected relative to the alternatives of the bridge site . The study area of Al Muwaffaqiyah is divided into eleven zones . The origin and destination of zones determine the lengths of routes to move . The time required for transmission is calculated depending on the speed of movement rate . The best path is found by comparing the times over to move for each route (at least for so) . The selected path ensures faster transmission and less expensive with fuel exchange and pollution . Figure (4) shows the zones of study area .

The main road network of the Al Muwaffaqiyah region is drawn according to the information available from the competent authorities of roads office in Kut in Iraq and the basic map of the city . The speed of each path is determined from the information provided by roads office in Kut . The speed rates are ranged between 40 km per hour for the paths that pass through the city center and 65 km per hour for paths that do not pass through the center . The route networks in Al Muwaffaqiyah region are displayed in ArcGIS ArcMap program as illustrated in Figure (5) .

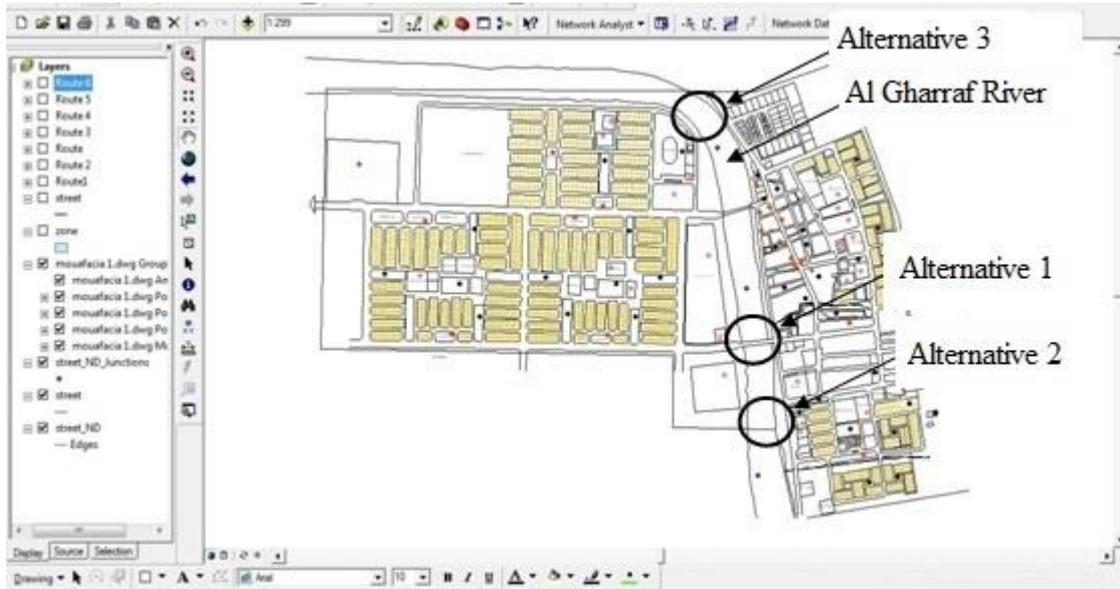


Figure 3 Base Map and Proposed Alternatives in ArcGIS Software

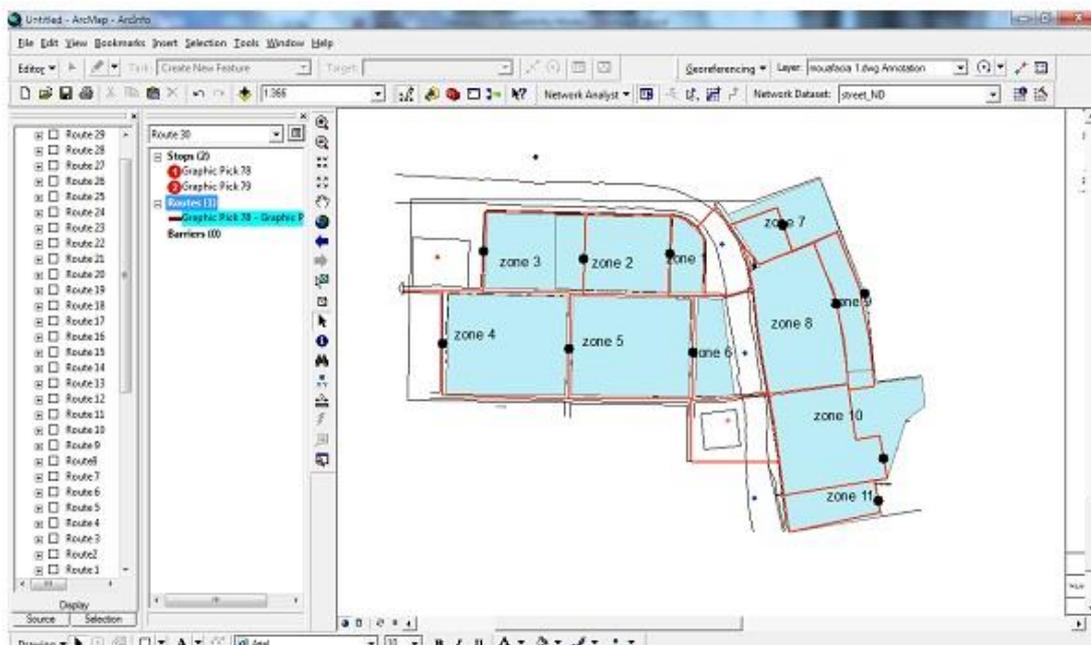
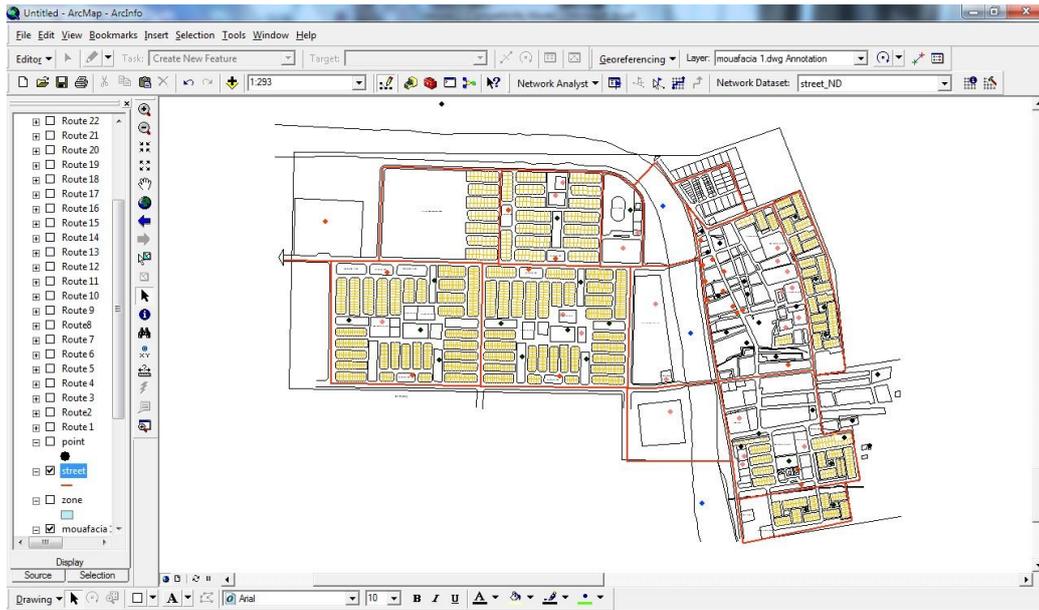


Figure 4 Al Muwaffaqiyah Zones



Thirty routes passes through zones are selected as illustrated in Figures 6 through 35.

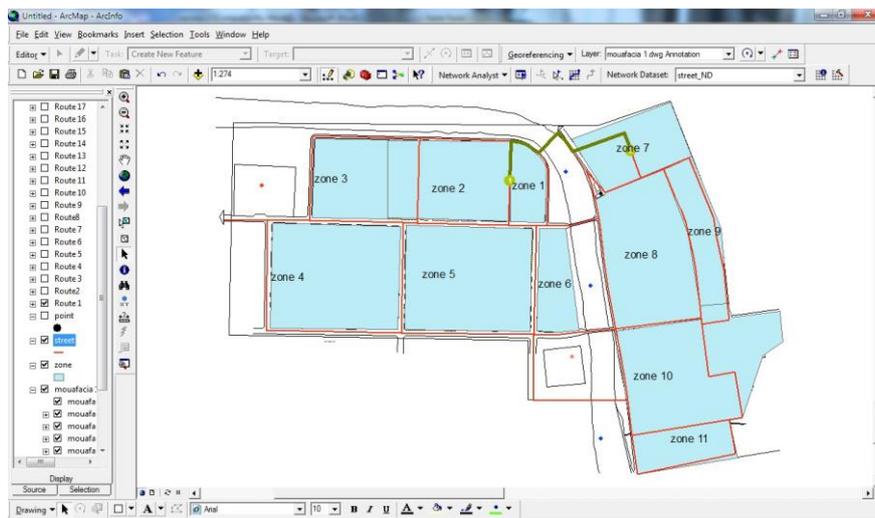


Figure 6 Route Number 1 From Zone 1 to Zone 7

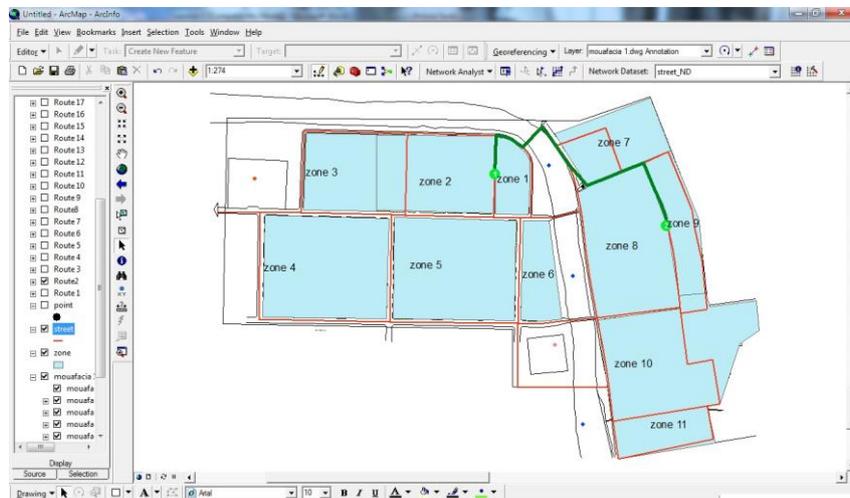


Figure 7 Route Number 2 From Zone 1 to Zone 8

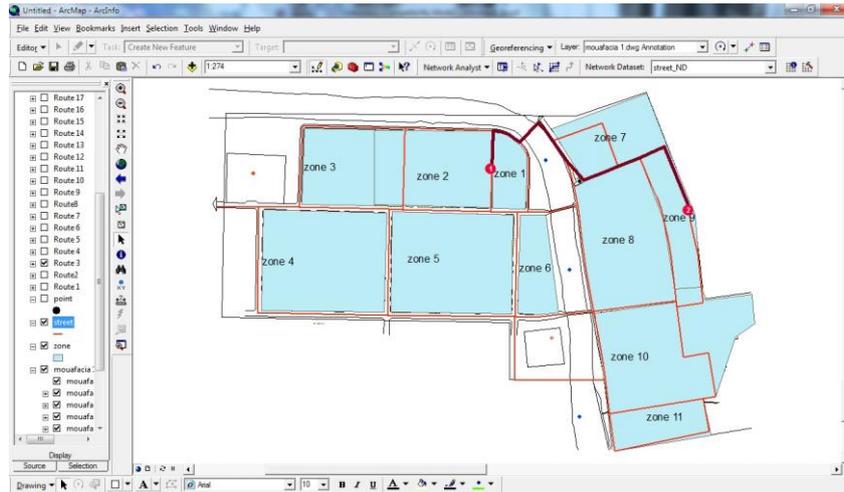


Figure 8 Route Number 3 From Zone 1 to Zone 9

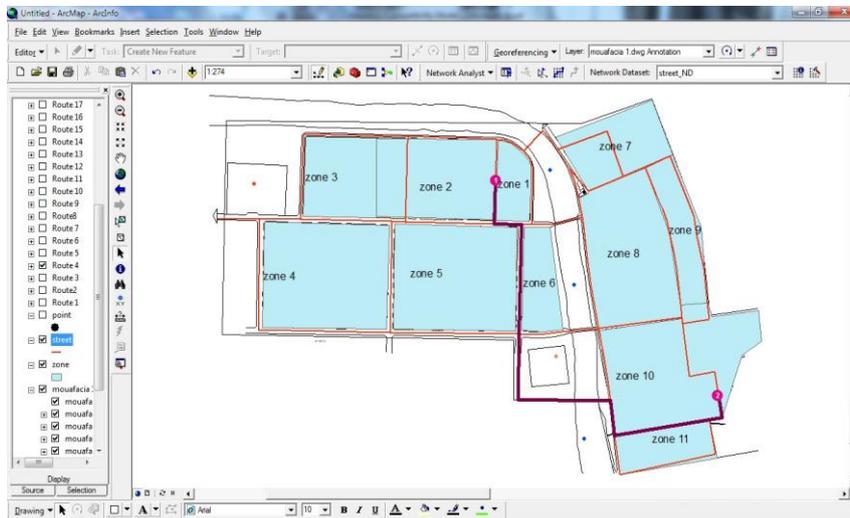


Figure 9 Route Number 4 From Zone 1 to Zone 10

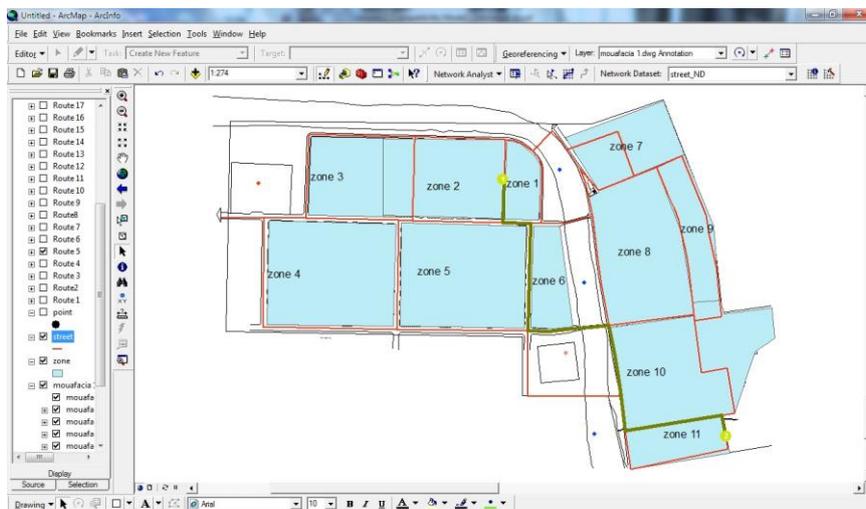


Figure 10 Route Number 5 From Zone 1 to Zone 11

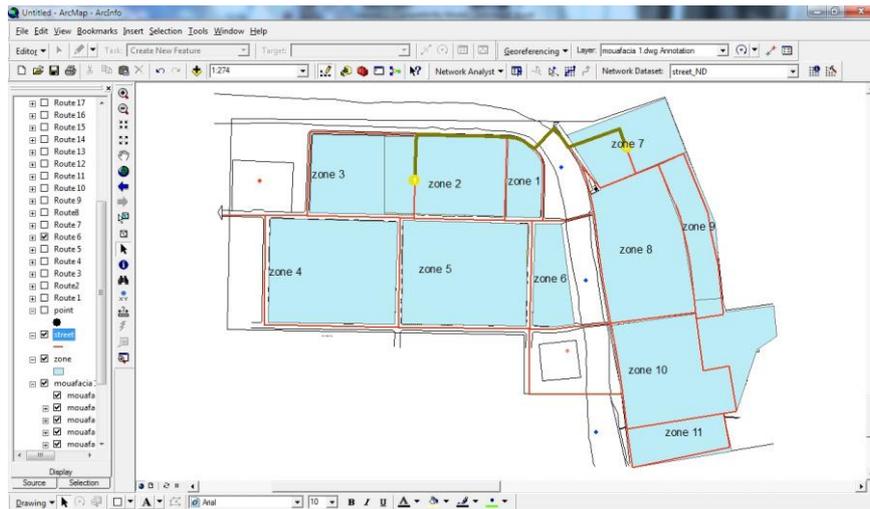


Figure 11 Route Number 6 From Zone 2 to Zone 7

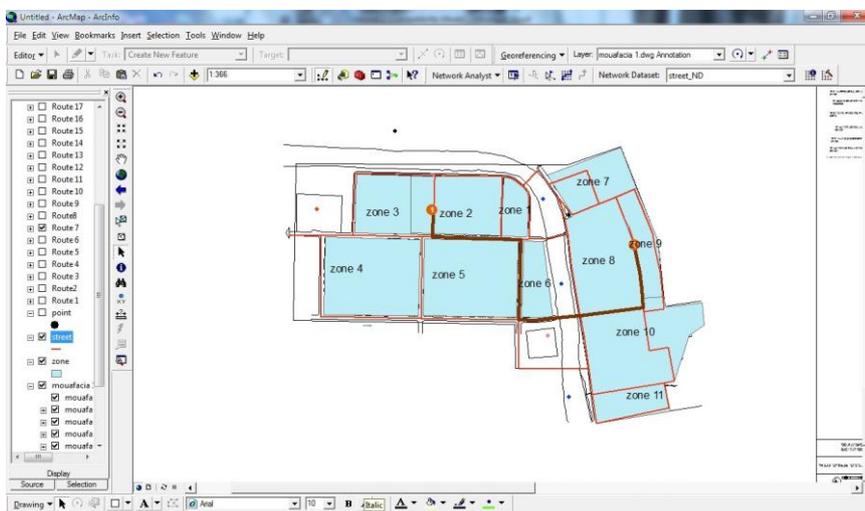


Figure 12 Route Number 7 From Zone 2 to Zone 8.

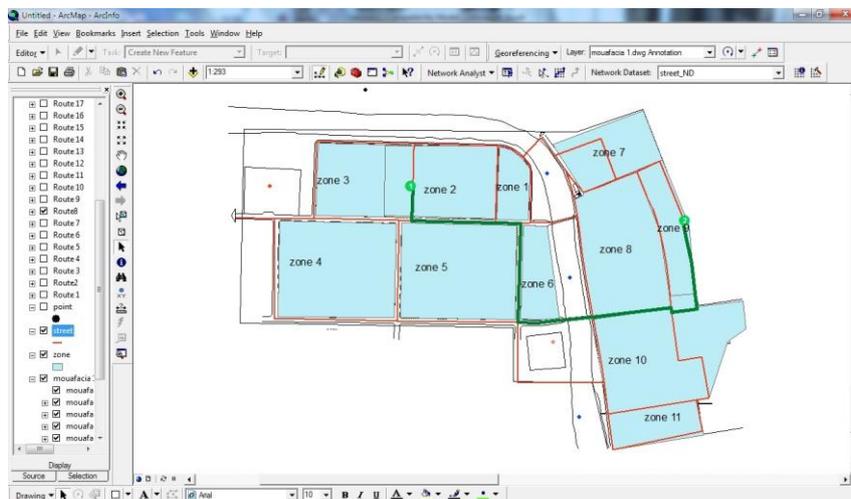


Figure 13 Route Number 8 From Zone 2 to Zone 9.

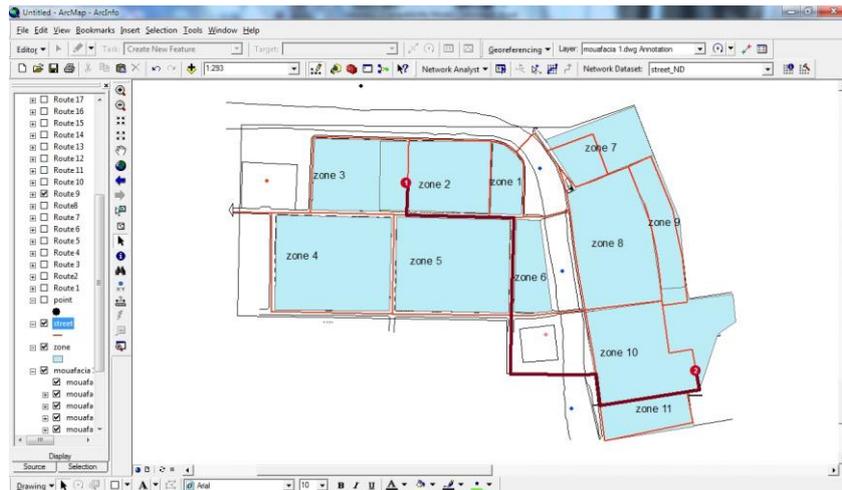


Figure 14 Route Number 9 From Zone 2 to Zone 10.

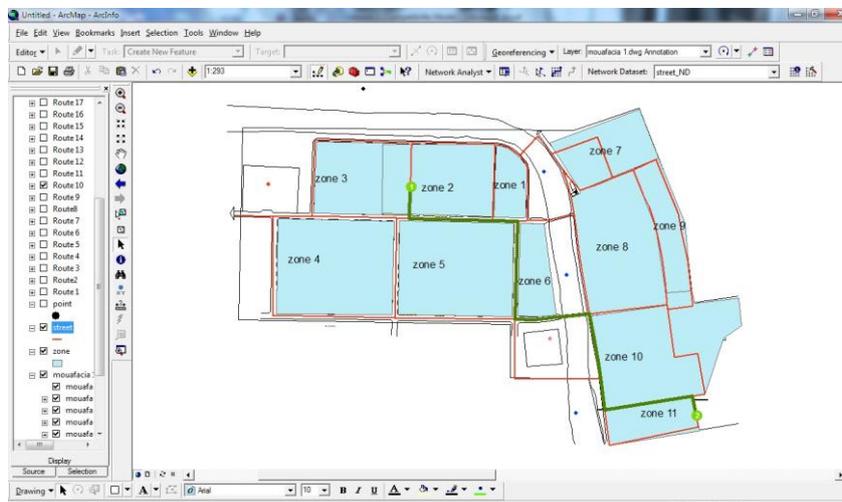


Figure 15 Route Number 10 From Zone 2 to Zone 11.

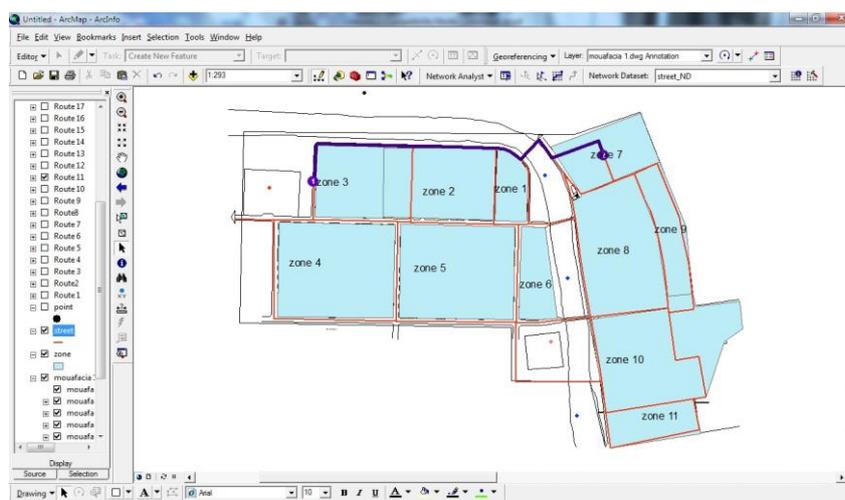


Figure 16 Route Number 11 From Zone 3 to Zone 7.

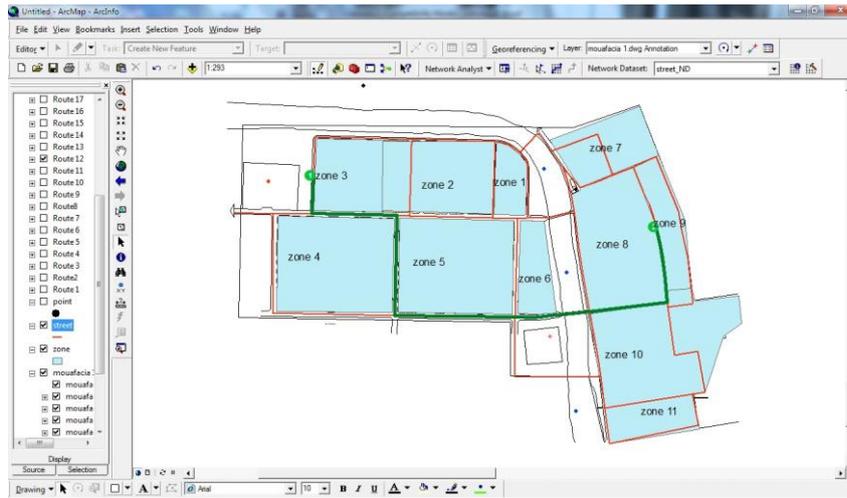


Figure 17 Route Number 12 From Zone 3 to Zone 8.

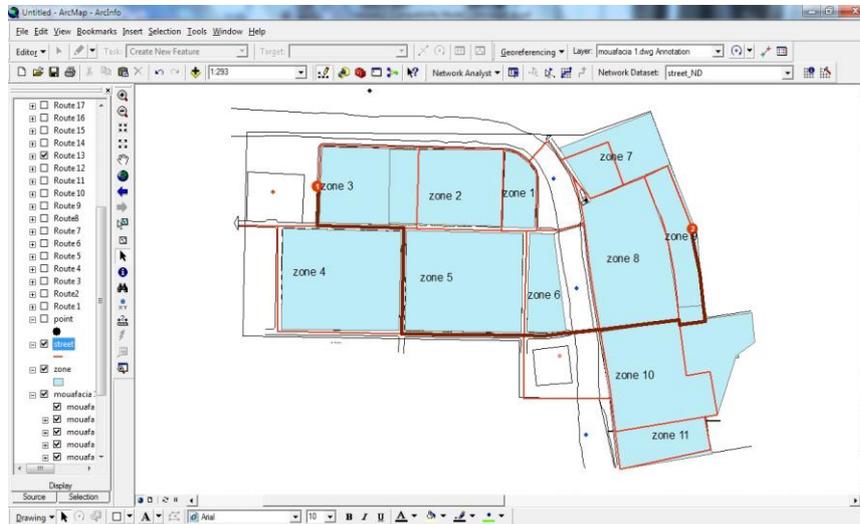


Figure 18 Route Number 13 From Zone 3 to Zone 9.

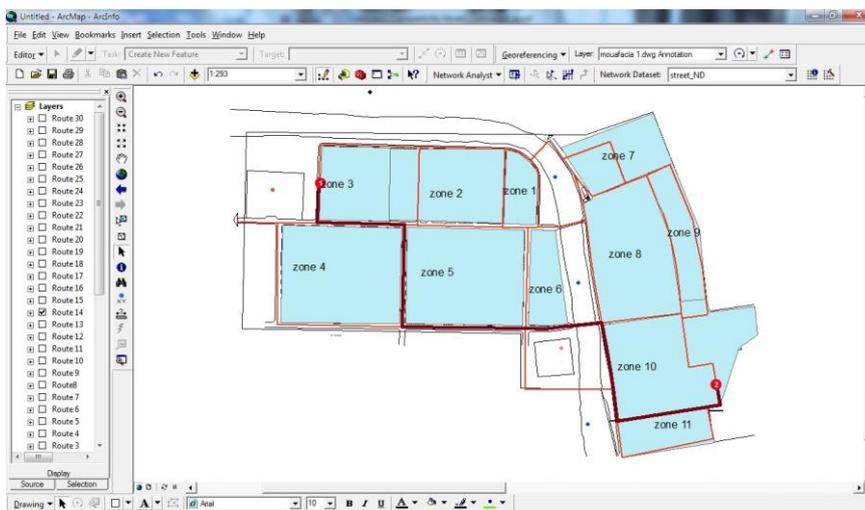


Figure 19 Route Number 14 From Zone 3 to Zone 10.

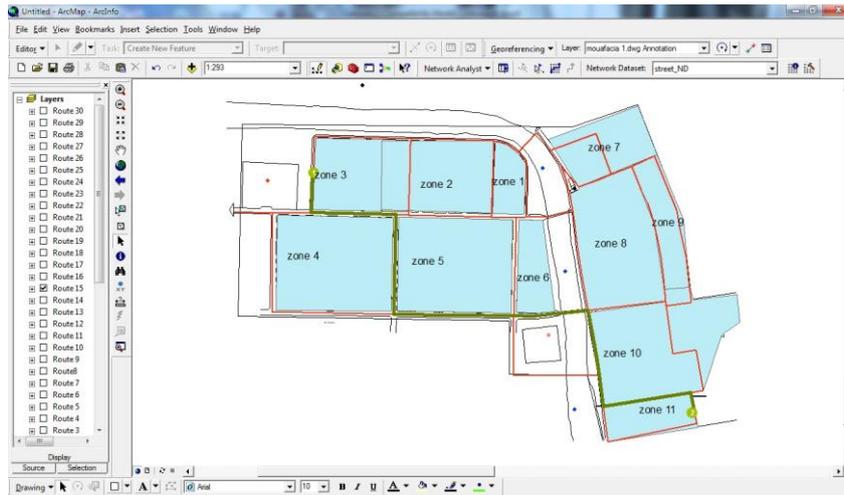


Figure 20 Route Number 15 From Zone 3 to Zone 11.

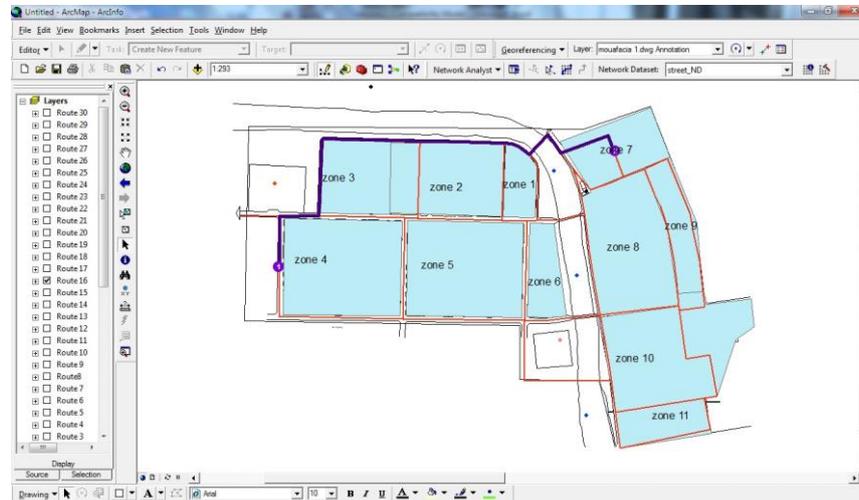


Figure 21 Route Number 16 From Zone 4 to Zone 7.

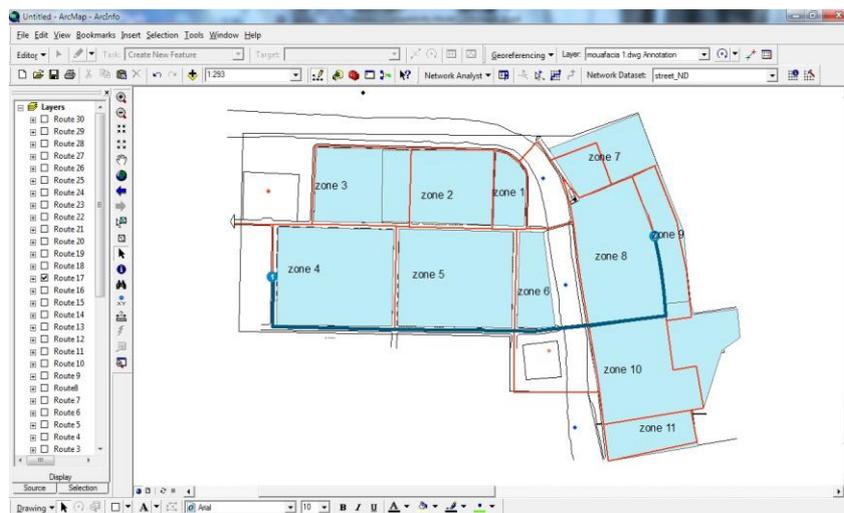


Figure 22 Route Number 17 From Zone 4 to Zone 8.

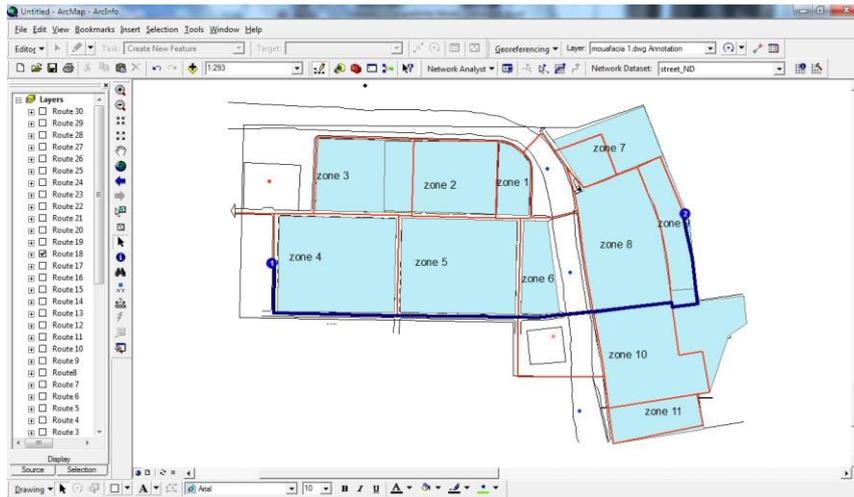


Figure 23 Route Number 18 From Zone 4 to Zone 9.

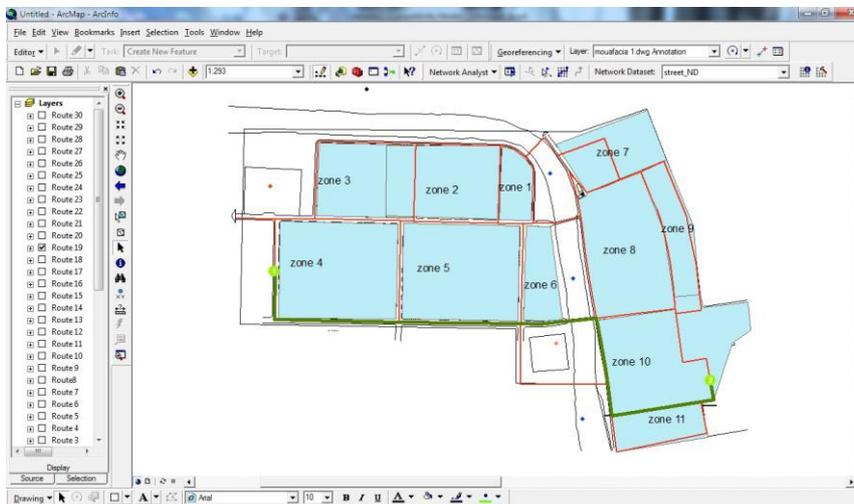


Figure 24 Route Number 19 From Zone 4 to Zone 10.

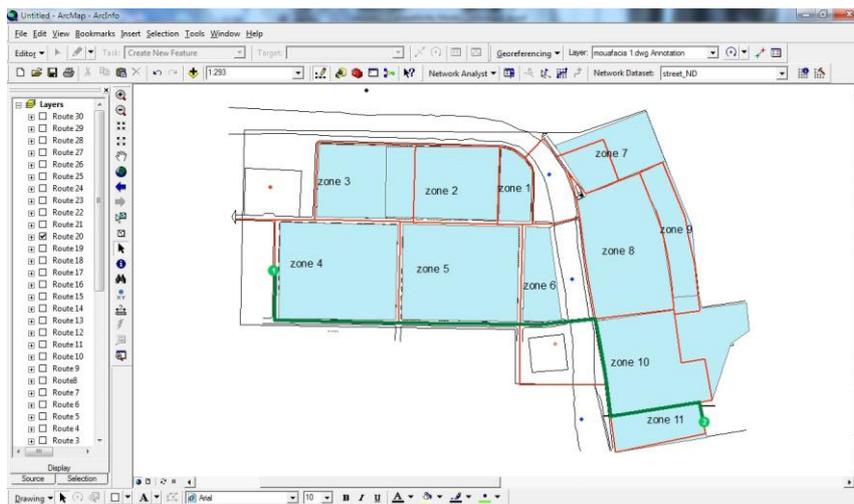


Figure 25 Route Number 20 From Zone 4 to Zone 11.

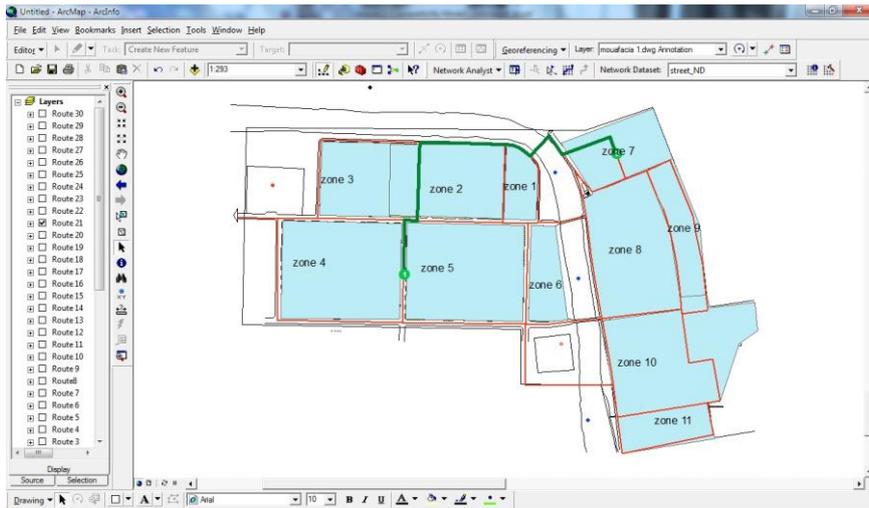


Figure 26 Route Number 21 From Zone 5 to Zone 7.

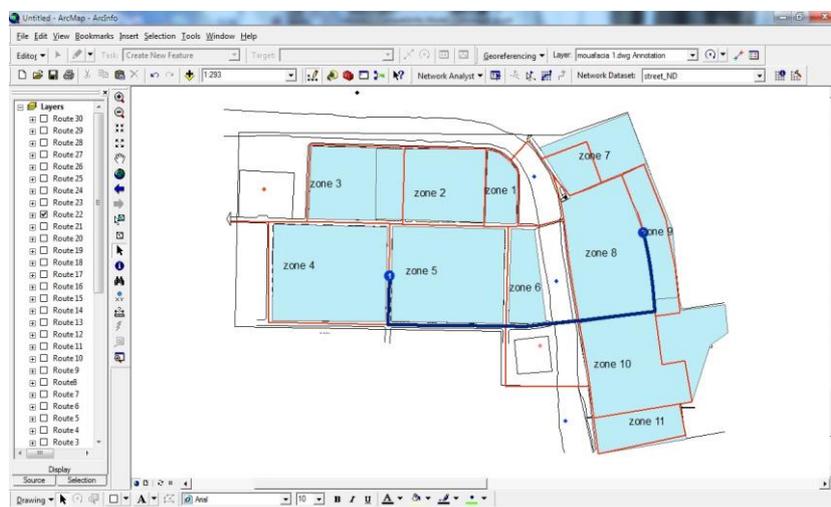


Figure 27 Route Number 22 From Zone 5 to Zone 8.

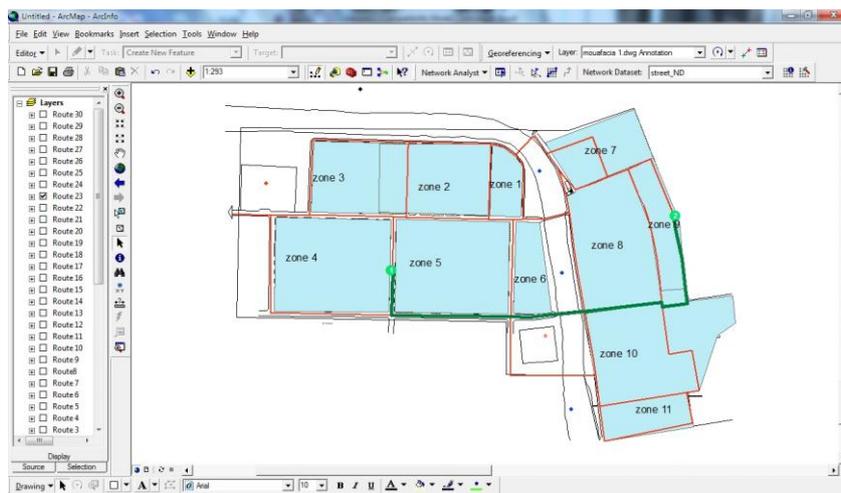


Figure 28 Route Number 23 From Zone 5 to Zone 9.

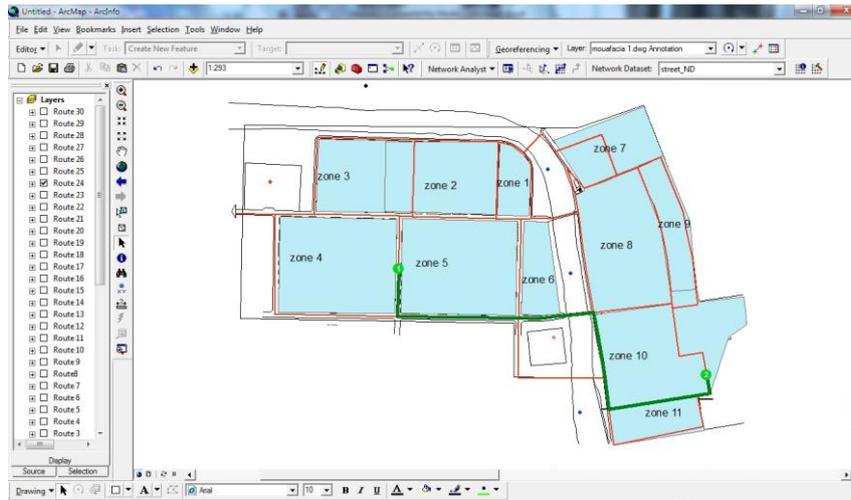


Figure 29 Route Number 24 From Zone 5 to Zone 10.

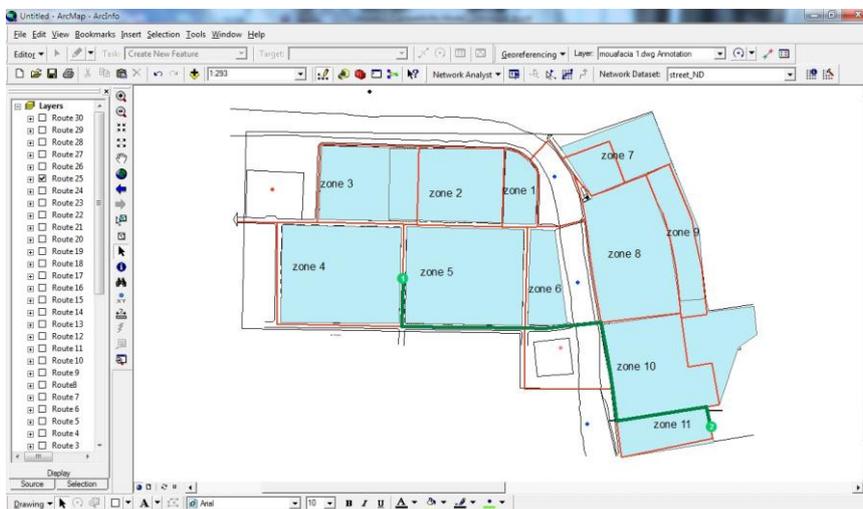


Figure 30 Route Number 25 From Zone 5 to Zone 11.

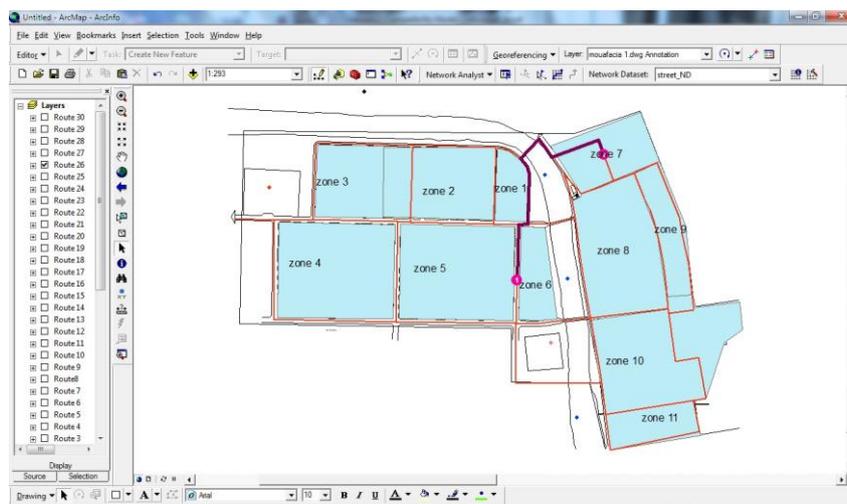


Figure 31 Route Number 26 From Zone 6 to Zone 7.

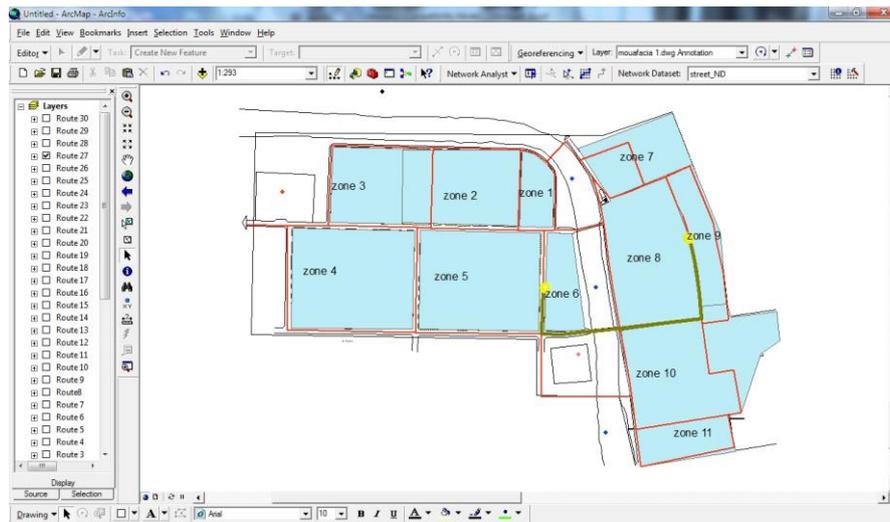


Figure 32 Route Number 27 From Zone 6 to Zone 8.

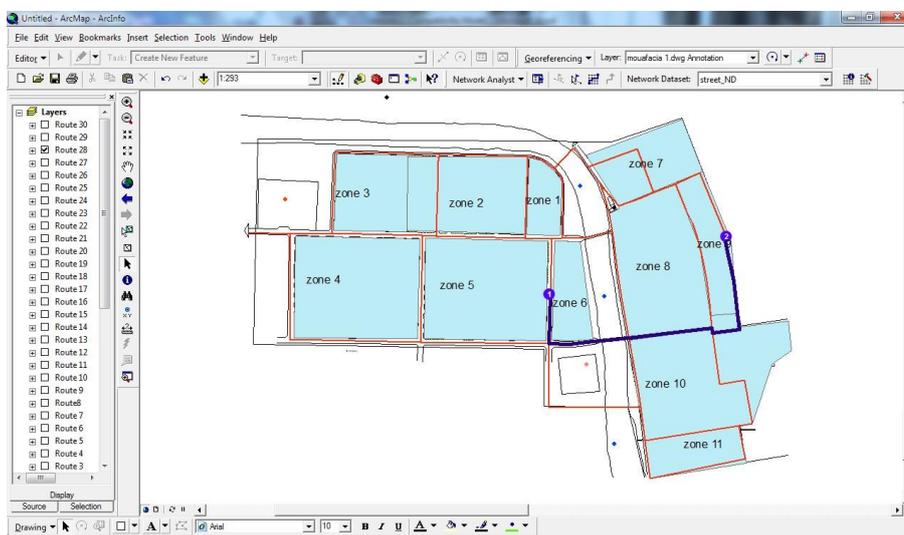


Figure 33 Route Number 28 From Zone 6 to Zone 9.

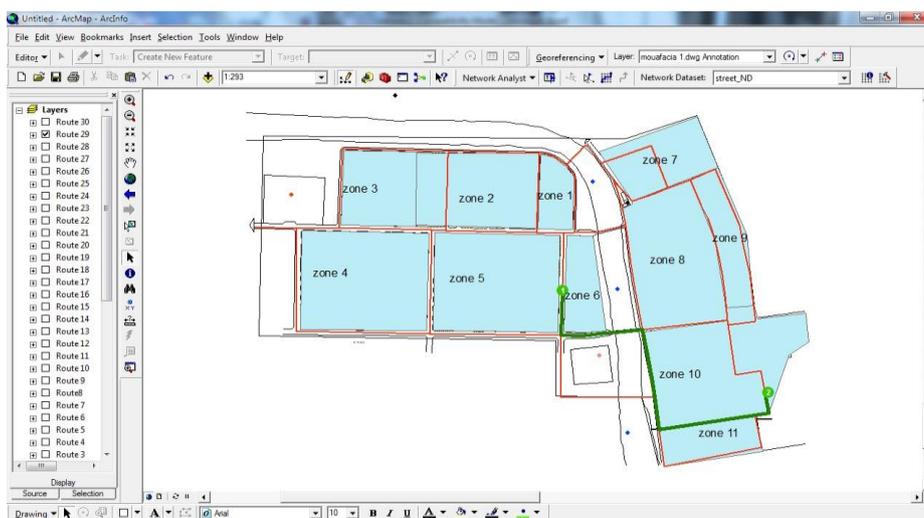


Figure 34 Route Number 29 From Zone 6 to Zone 10.

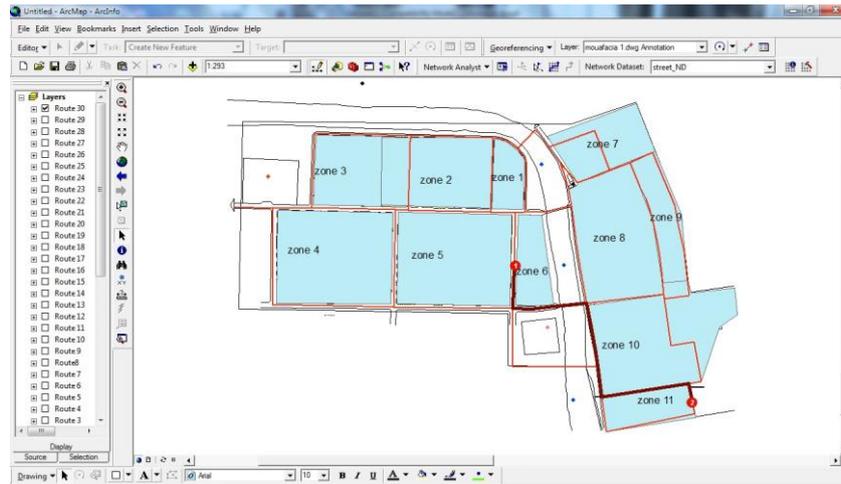


Figure 35 Route Number 30 From Zone 6 to Zone 11.

Results Analysis

The travel time between zones is determined by ArcGIS software ver.9.3. Table (1) shows the routes which are chosen by network analyst tool of ArcGIS software during the passage of the proposed alternatives . These routes are used to count the number of times tracks passing through one alternative as shown in the Table (2) . Table (2) shows that the alternative number one is the best because it has the largest number of routes passing through it.

Table 1 Travel Time to Pass from Zone to Zone

From zone	To zone	proposal	Program Time (seconds)*	Factored time (minutes)**
1	7	3	109	9.083333
	8	3	181	15.08333
	9	3	191	15.91667
	10	2	176	14.66667
	11	1	173	14.41667
2	7	3	143	11.91667
	8	1	212	17.66667
	9	1	222	18.5
	10	2	203	16.91667
	11	1	200	16.66667
3	7	3	176	14.66667
	8	1	243	20.25
	9	1	253	21.08333
	10	1	240	20
	11	1	234	19.5
4	7	3	222	18.5
	8	1	222	18.5
	9	1	233	19.41667
	10	1	216	18
	11	1	211	17.58333
5	7	3	178	14.83333
	8	1	179	14.91667

	9	1	189	15.75
	10	1	173	14.41667
	11	1	167	13.91667
6	7	3	144	12
	8	1	135	11.25
	9	1	145	12.08333
	10	1	130	10.83333
	11	1	124	10.33333

* Time given by ArcGIS software and it is calculated from the origin point to the destination point without any interruption or delay.

** Time required to move between zones after the addition of stops and delays.

Table 2 Number of Routes Passanger in the Proposed Alternatives

Alternatives for Brigde Location	Routes Passanger from Alternatives
1	20
2	2
3	8

Conclutions

From this study we can conclude the following:

- Network analyst of ArcGIS software is a powerful tool for brigde site determination .
- The construction of new bridge will contribute to reduce traffic congestion .
- The bridge location links both sides of Al Gharraf river in Al Muwaffaqiyah region which provides faster transmission and lest cost.
- The use of geographic information system facilitates the analysis of routes between different origions and destinations .
- ArcGIS software addresses these route automatically and gives the criteria for the best alternative according to times and distances . It has the ability to deal with multiple plans and maps .

References

- ESRI , 2006, GIS Technology and Applications for the Fire Service , An ESRI White Paper, Redlands , New York , USA , March.
- Highway Capacity Manual, 2000 , Transportation Research Board , National Research Council , National Academy of Sciences , United States of America , HCM .
- Michael , T. Winn , January 2014, “ A Road Network Shortest Path Analysis : Applying Time-Varying Travel-Time Costs For Emergency Response Vehicle Routing , Davis Country , Utah ” , Thesis , Department of Humanities and Social Sciences in Candidacy , Master of Science , Northwest Missouri State University , United States of America.
- Nagar , Atulya & Tawfik , Hissam , 2007, “ A Multi-Criteria Based Approach to Prototyping Urban Road Networks ”, Issues in Informing Science and Information Technology , Volume 4.