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PHYSICAL PROPERTIES OF THE BOTTOM SEDIMENTS OF THE EUPHRATES RIVER IN THE CITY OF NASIRIYAH, SOUTHERN IRAQ

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Abstract

The research aimed to study the physical characteristics of the bottom sediments, a part of a course of Euphrates River in AL-Nasiriyah city, with a length of 7.5 km. Ten cross-sections were identified that were used as stations for sampling the bottom sediments. One cross-section was divided into three sections, including (the two banks and the middle of the river). Three samples were mixed for each section to obtain one homogeneous sample for each cross-section. After analyzing these samples in the laboratory, it was concluded:There is a difference in the granular size of the bottom sediments according to the locations of cross-sections, as they are affected by each of the facilities built on the river, such as bridges. The values of d50* ranged between (0.088 - 0.15 mm), while the values of d90* ranged between (0.3 - 0.67 mm). The results also indicated that the bottom sediments in the course of the Euphrates River have a sandy gradient, as the percentage of sand ranges between (53.1- 68.6%), and the percentage of silt was (14.3 - 31.7%), while the percentage of clay ranged between (11.3 -19.8%), at the level of all samples of the studied cross-sections.

1-Introduction

Rivers are the main source of water supply for various purposes, as settlement centers were linked and civilizations flourished in river basins and along their courses, so this vital resource and its associated activities and various processes and the resulting landforms attracted the attention of researchers in the field of hydrology and geomorphology alike. The study of river load is one of the fields of research in the behavior of rivers, and their effectiveness in erosion, transport, and sedimentation processes, which provides a database in engineering and agricultural planning such as the construction of ports, dams, and reservoirs, as well as irrigation projects, as well as the transported materials affect the flow system in rivers and the quality of their water.The river load is the total sum of materials collected from the river basin and carried by the river in a specific part of the water body of its course to be transported during the flow towards the downstream area [1].

(*) d50: Diameter of bed material when 50% of the material is finer.
(*) d90: Diameter of bed material when 90% of the material is finer.

The materials transported in the watercourse vary according to the type and size of the materials and their location in the river section. The nature of the flow in it, as the carried materials that move with the water stream in a suspended manner, are classified as a suspended load and move due to the effect of the flow disturbance and the size of the particles,and these materials consist of organic materials, granules Sand, Clay, and Silt [2].Moreover, moving materials on the bottom surface are called Bed loads, Figure (1).

The movement of this type of material is less fast than the first type because of the large size of the Benthic sediment and its friction with the bottom surface during its downstream movement.

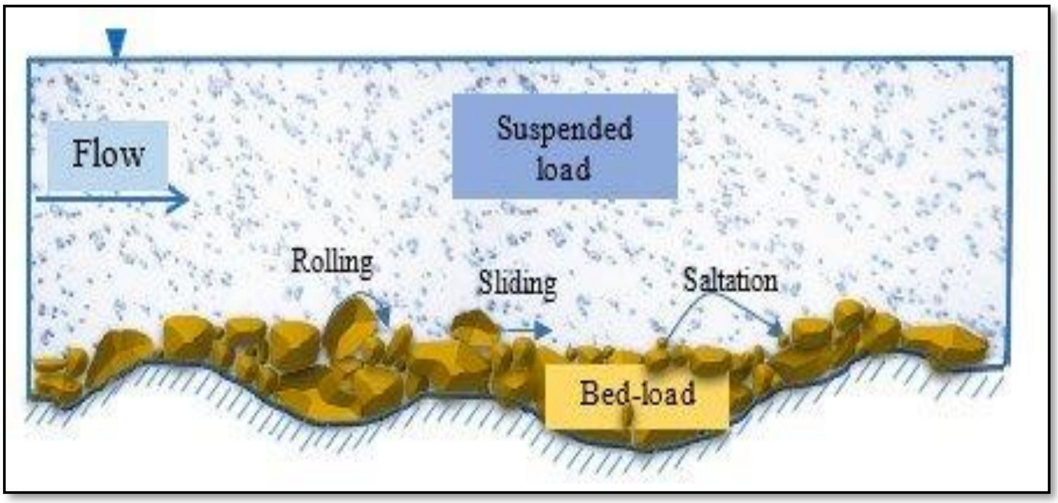


Figure (1): Type of sediment and the nature of its movement in the watercourse.
https://www.google.com/search?q=river%20sediment&tbm

Previously referred to the interest of researchers in studying this subject due to its importance and environmental impacts, and reference will be made to part of the studies that dealt with the benthic load being the subject of our study, including the study (Safaa Al-Asadi, 2012) [3] studying the river load of the Shatt Al-Arab and its environmental effects, as the load was estimated Benthic and physical properties of bottom sediments in the Shatt al-Arab. (Study by Ibrahim Anwar Ibrahim and Mahmoud Shukr Hamrawi, 2013) [4].They studied the concentration of suspended sediments and the bottom load of the measuring station (Eski Kalek) on the Great Zab River for the period from August 2009 to April 2010, where the bottom load was estimated based on 10% of the suspended load, while the bottom material was analyzed using the sieve sorting method and the hydrometer. The results showed that the bottom sediment ranged from coarse gravel to silt with a value of (d_{50} = 0.16mm), and the specific gravity of the bottom material was (2.67 gm/cm3). Study of (Maytham Abd al-Ridha Abd al-Hussein, 2008) [5] as he conducted a study of the physical and chemical properties of the marsh sediments in Dhi Qar Governorate and conducted a mechanical analysis of the surface sedimentary materials from them at a depth of 30 cm, as well as measuring the percentage of organic matter in them as well as the positive and negative elements.Study of (Essam Issa Omran, Mohsen Jassim Nasser, and Amir Hashem Hussein, 2016) [6] They completed a study of sediment movement in the irrigation channels branching from the mainstream of Shatt al-Hilla, as the study found when analyzing the sediment texture, that the bottom sediments are coarser at the beginning of the flow and less the coarseness of the sediment towards the downstream, as the proportion of silt increases in those areas.

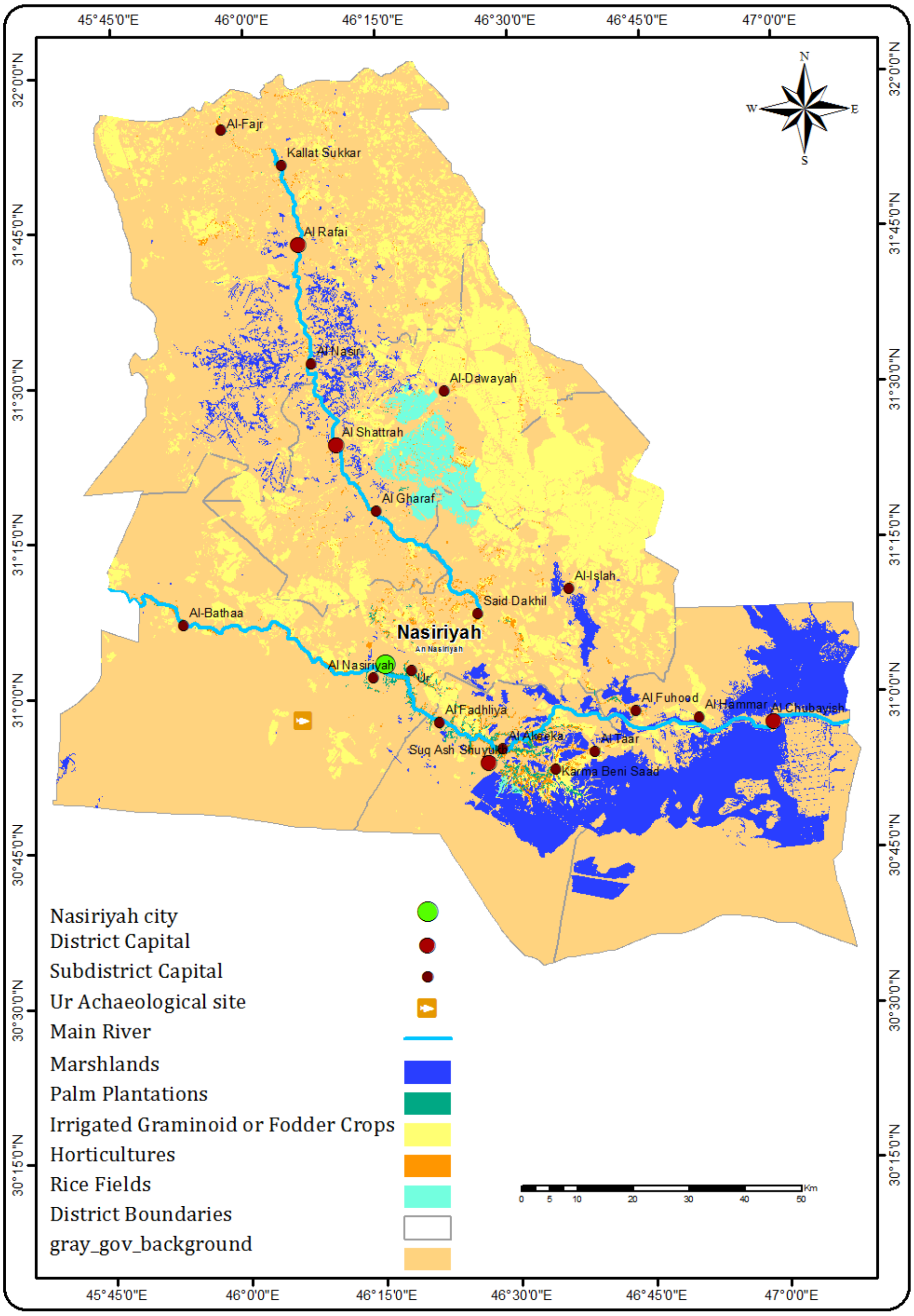
In this study, selected samples of benthic sediments of the Euphrates River within the city of Nasiriyah in southern Iraq will be analyzed after defining the cross-sections of the areas from which samples will be taken in the river, to obtain information about the granular gradation of the sedimentary materials at the bottom of the Euphrates River.

2-Description of the study area:

The headwaters of the Euphrates River are located in south-eastern Turkey within the southern Taurus Mountains. It consists of the confluence of two main tributaries, the Euphrates Su and Murad Su. Its basin area is 378,000 km2. It is a common river between Turkey, Syria, and Iraq as the length of the river in Turkey is 1000 km, it contributes 89% of the water revenue, and its basin area is 125,000 km2. Three tributaries flow into Syria: Al-Sajur, Al-Balikh, and Al-Khabour. The river length is 680 km, and the basin area is 76 km 2. Syria contributes 11% of the water revenue of the Euphrates River. The eastern region is within the Iraqi sedimentary plain to enter the city of Nasiriyah from the north-west side at the Al-Batha district and continues to flow in the center of the city of Nasiriyah in the southeast direction branch after leaving the city into six branches, all of which flow into the Al-Hammar Marsh, then continues to flow south after leaving the Al-Hammar Marsh to meet the Tigris River In the city of Qurna within the province of Basrah.

The city of Nasiriyah is located within the sedimentary plain in southern Iraq, whose surface is characterized by flatness, as it gradually descends between the contour lines (32 m) to (9 m) from north to south, and the maximum height of the city's surface is (3.5 m). The geographical location of the city of Nasiriyah is within latitude (31) to the north and an arc of longitude (46) to the east. It is the center of Dhi Qar Governorate, see map (1). The area of the city is (269.63) km2, divided into (45) residential neighborhoods. The climate of the study area is classified as desert, as its exposure to solar radiation increases at a rate of (8.3) hours, the average annual temperature is (33 ° C), and the annual total rainfall does not exceed (128 mm), while the wind speed reaches an annual average of (3.2 m/s), and the rates of dust storms rise, reaching an annual rate of (30 / day) [7].

Map (1) shows the study area.



Source: Researcher based on a programArcGis 10.3.

3- Hydrology of the Euphrates River within the city of Nasiriyah:

The Euphrates River enters the city of Nasiriyah, as mentioned previously in Paragraph (2), from the north-west side at the Al-Batha sub-district and continues to flow in the center of the city of Nasiriyah in the south-eastern direction, to branch after leaving the city into six branches, all of which flow into the Al-Hammar Marsh, and then continues

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to flow south after its exit from Marsh Al-Hammar to meet the Tigris River in the city of Qurna within the province of Basra. The average annual revenue of the Euphrates River for the period (1939-1973) is (30.3) billion cubic meters as recorded at the Hit station; after that, it decreased to (16.5) billion cubic meters during the period (2009-2012) [8]. Its revenue decreased to (2.4) billion cubic meters during the period (2008-2015) in the city of Nasiriyah and continued to decline until it reached (0.924) billion cubic meters during the period (2010-2021) in the Nasiriyah station [9].

The reasons for this decrease in revenues are due to several factors, including natural changes represented by climate changes and the accompanying high rates of temperatures, high evaporation rates and low annual precipitation amounts, and other reasons related to human factors represented by water investments that were built on the river basin in both Turkey and Syria. These water projects built on the Euphrates River led to a decrease in the water revenue of the river in Iraq in general, especially in the city of Nasiriyah, as the water discharge of the river decreased to (29.3 m3/sec), during the period (2010-2021) after the rate of water discharge reached to (457 m3/sec), during the period (1950-1978), as shown in Table (1).About the water levels recorded at the Nasiriyah station, they decreased to (2.01) meters for the period (2015-2021) compared to the period (1971-1980), when the annual level of the Euphrates River reached (4.3) meters. The highest monthly level for the period (2015-2021) was in June when it reached (2.1) meters, and the lowest level was recorded in July, when it reached (1.84) meters, compared to the period (1971-1980), when the highest level in June reached (5.1) meters, while it was recorded The lowest level was in November and February, when it reached (4) and (4) meters, respectively, as shown in Table (2).

Table (1): Annual and monthly discharge rate (m^3/sec, billion m^3/year) to the Euphrates River at Nasiriyah station

Month / Period	October	November	December	January	February	March	April	May	June	July	August	September	Annual rate m^3/sec	Annual revenue billion m3
1950-1978	215	225	280	388	430	529	761	997	896	373	192	192	457	14.4
2010-2021	36	26	28	35	31	27	29	33	25	22	29	31	29.3	0.924

Sources:

- Ministry of Irrigation, General Authority for Dams and Reservoirs, National Center for Water Resources Management in Iraq, Rivers Drainage Records.
- Ministry of Water Resources, Directorate of Water Resources in Dhi Qar Governorate, Department of Water Distributions and Water Significance, unpublished data for the period (2021).

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Table (2): Water levels of the Euphrates River at the city of Nasiriyah (m)

Month / Period	October	November	December	January	February	March	April	May	June	July	August	September	Annual rate
1971-1980	4.3	4	4.4	4.1	4	4.3	4.1	4.8	5.1	4.7	4.3	4.3	4.3
2015-2021	1.94	1.87	1.98	2.02	2.01	2.2	2.5	1.87	2.1	1.84	1.92	1.97	2.01

Sources:

- Ministry of Irrigation, General Authority for Dams and Reservoirs, Department of Water Significance, River Drainage Records, published data (1971-1980).
- Ministry of Water Resources, Directorate of Water Resources in Dhi- Qar Governorate, Department of Water Distribution and Water Significance, unpublished data for the period (2015-2022).

4. Study methodology:

The study included several stages, starting with the first stage, which included reviewing previous studies that serve the research subject and collecting data and information from relevant institutions. Then the second stage, which is the field study stage, included identifying cross-sections, their coordinates, and their distribution along the study area and then collecting data and samples. The third stage included laboratory work for analyzing samples and obtaining results.

4.1- Determine the cross-sections of the study area:

The dimensions of the study area were determined using the Arc Gis program (10.3), where the length of the study area was about (7.5) km, which starts from point No. (1) represents (Nasiriya Highway Bridge) to point No. (2), which represents (Nasiriyah Thermal Power Station), as shown in Figure (3). After that, ten cross-sections were identified and distributed along the course of the Euphrates River in the study area. The river those sections were adopted as stations for sampling bottom sediments and revealing their physical characteristics.

The location of each cross-section was determined by fixing a metal rod at each bank of the river, and the geographical coordinates of each cross-section were taken by a GPS device, as shown in Table (3), which shows the coordinates of the cross-sections distributed along the study area and the distance between them, as well as in Figure (4).

Table (3): Coordinates of the cross sections and the distance between them

The distance between the points	CS No.	Left bank		Right bank	
		East (m)	North (m)	East (m)	North (m)
0 km	**1**	620623.61	3434259.40	620741.18	3434473.51
1 km	**2**	619716.95	3434647.62	619808.60	3434868.90
1 km	**3**	618790.20	3435033.22	618835.93	3435139.95

1 km	**4**	618019.00	3435689.00	618122.91	3435771.61
400m	**5**	617761.00	3435829.00	617712.15	3435917.79
500m	**6**	617551.00	3435410.00	617498.00	3435471.00
1 km	**7**	616588.33	3435059.61	616559.00	3435189.00
1 km	**8**	615674.38	3434715.86	615618.78	3435808.76
1 km	**9**	614775.72	3434465.06	614801.88	3434548.61
650m	**10**	614183.30	3434657.74	614178.18	3434771.21

Source: A field study on 10.28.2022.

Figure 3: An illustration of the length of the selected study area
Source: Google Earth.

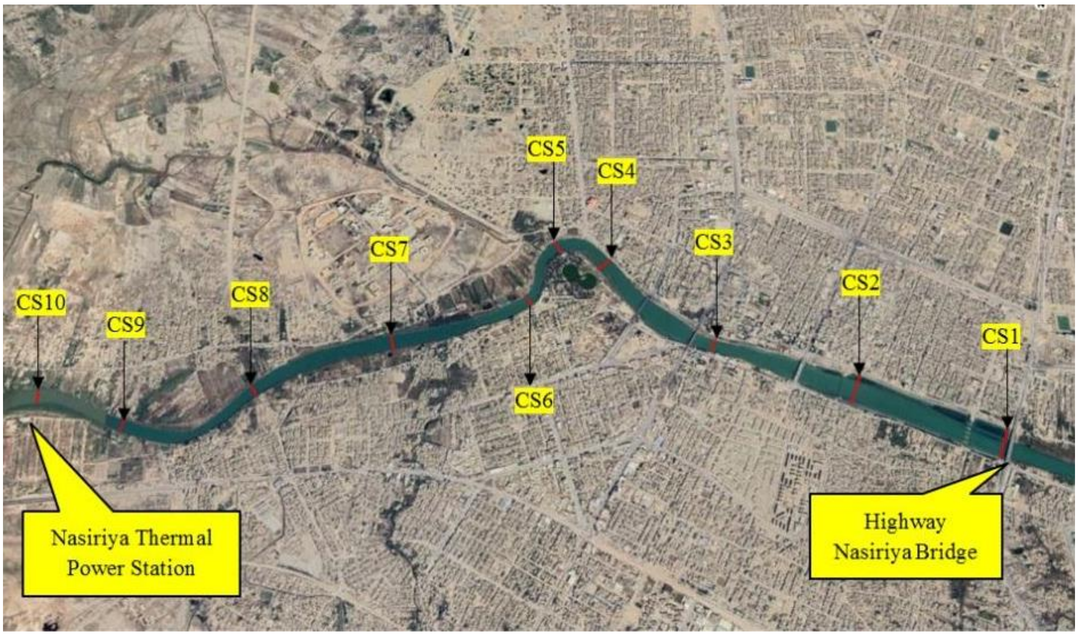

Figure (4): Distribution of cross-sections along the study area
Source: Google Earth.

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4.1- Data collection:

The Van VeenGrab Sampler, shown in Figures (5) and (6), was used to collect bottom material samples. This tool is widely used in the study of river sediments, as the device consists of two jaws opened and closed by two arms. The currency mechanism is summarized as follows:

The jaws are opened at the water's surface to be lowered at the specific point from which the sample will be taken. It is lowered quietly until the jaws are closed when it touches the bottom of the river. After that, it is raised to the surface of the water again to collect the sample obtained from it And kept in a bag coded and numbered according to the point, cross-section, and the date the sample was taken.

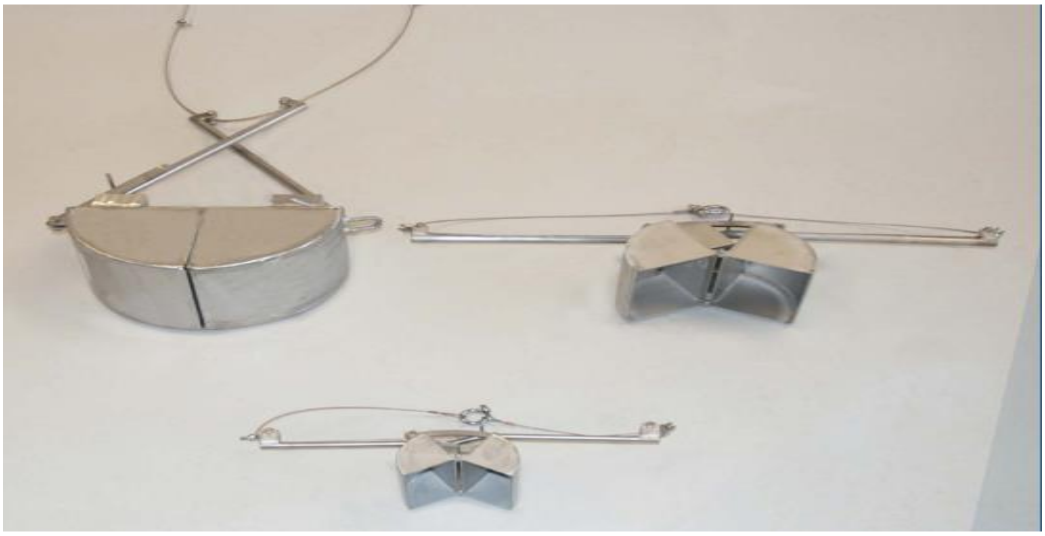

Figure 5: The Van Veen Grab Sampler

Eijkelkamp soil & water, Nijverheidsstraat 30, Giesbeek, the Netherlands, 2018

Picture (6) shows the collection of samples in the study area

Source: Fieldwork on 11.18.2022

The data relating to the bottom material samples of the Euphrates River were collected at cross-sections distributed along the course of the river in the study area, and this was

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done by dividing each cross-section into three areas at (1/4, 1/2, 4/3) of the cross-section width. Bringing the total number of samples to 3 for each cross-section, as shown in Figure (5). Then, these three samples are mixed to obtain one homogeneous sample representing the cross-section, to be analyzed in the laboratory.

Picture (7) shows the collection of samples in the study area
Source: Fieldwork on 11.18.2022

4.3. Laboratory work:

The laboratory work is very necessary to obtain the basic information related to the river bed samples for the study area, including obtaining the grain gradient curve of the Euphrates river bed samples according to the nature of our work. This curve describes the relationship between the size and diameter of the particles in mm versus the passing percentage as a percentage (%). The grain gradient curve consists of two parts of the curves: the first part results from the sieve analysis of samples whose grain diameter exceeds sieve No. 200 mm or 0.075 mm, which describes particles that represent gravel and sand, and the second part results from hydrometer examination of particles passing through sieve No. 200 or 0.075 mm which describes the particles representing clay and silt.After that, all the two curves are connected to obtain one curve representing the selected sample, the granular gradient curve. In this research, a group of sieves was used to conduct the sieve analysis of samples, which are graded from largest to smallest, and the number of nine sieves are: (4, 2, 0.85, 0.6, 0.425, 0.3, 0.25, 0.21, 0.15, and 0.075) mm, according to Specification (ASTM, D-422) [13].

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5. Results and Discussion:

After collecting samples from the cross-sections in paragraphs (4.4 and 1.2) and conducting laboratory analyses, the grain gradient curves were obtained for the bottom samples included in Figures (6-15). Table (4) shows the summary of the analysis of each cross-section as the percentages of sand, clay, and silt were obtained in addition to the values (d50, (d90) for each cross-section.

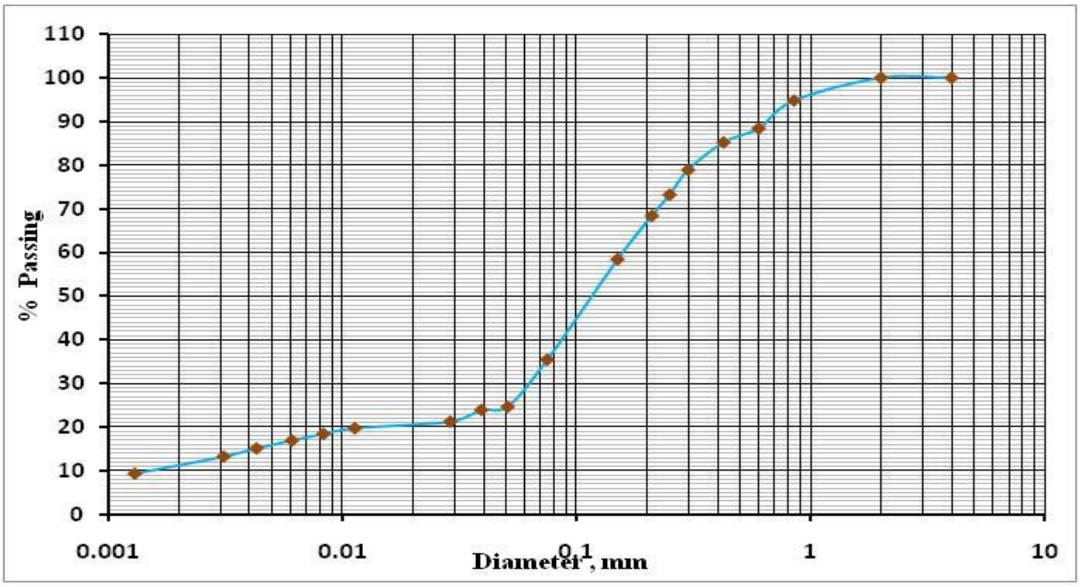

Figure (8): Curved the granular gradient of cross-section No.(1) .

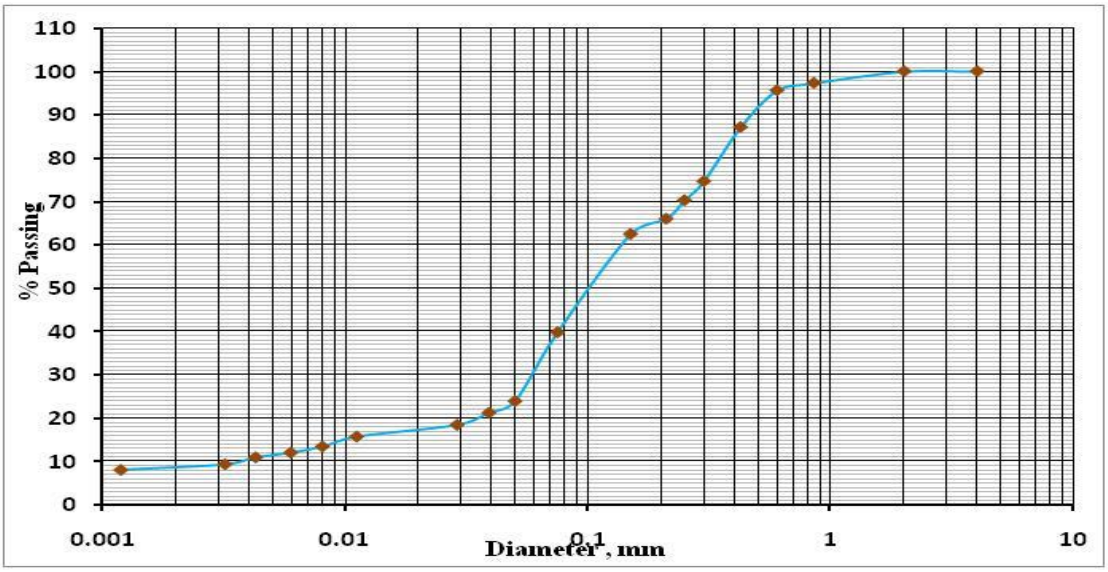

Figure (9): Curved the granular gradient of cross-section No.(2) .

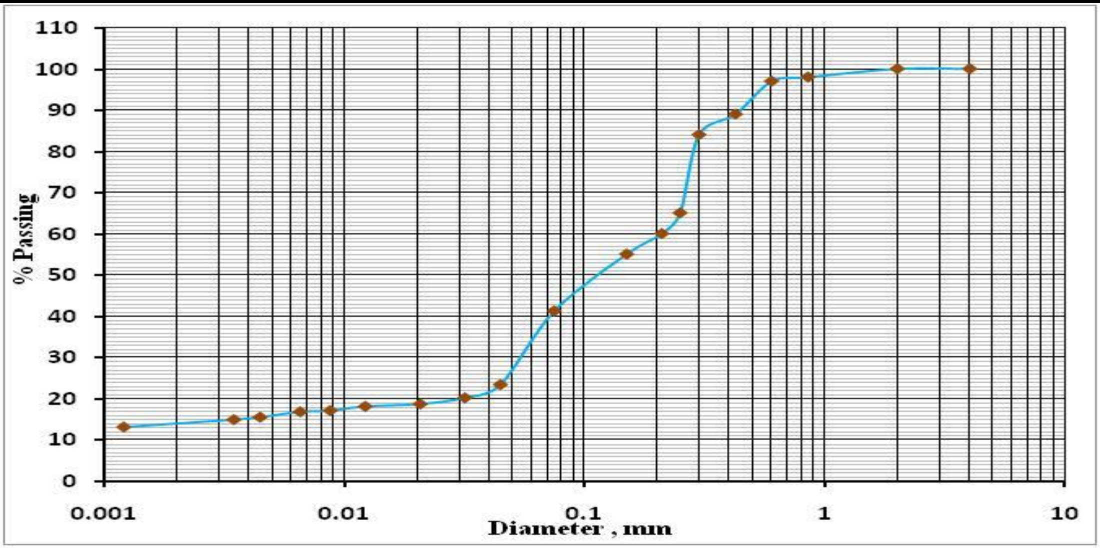

Figure (10): Curved the granular gradient of cross-section No.(3) .

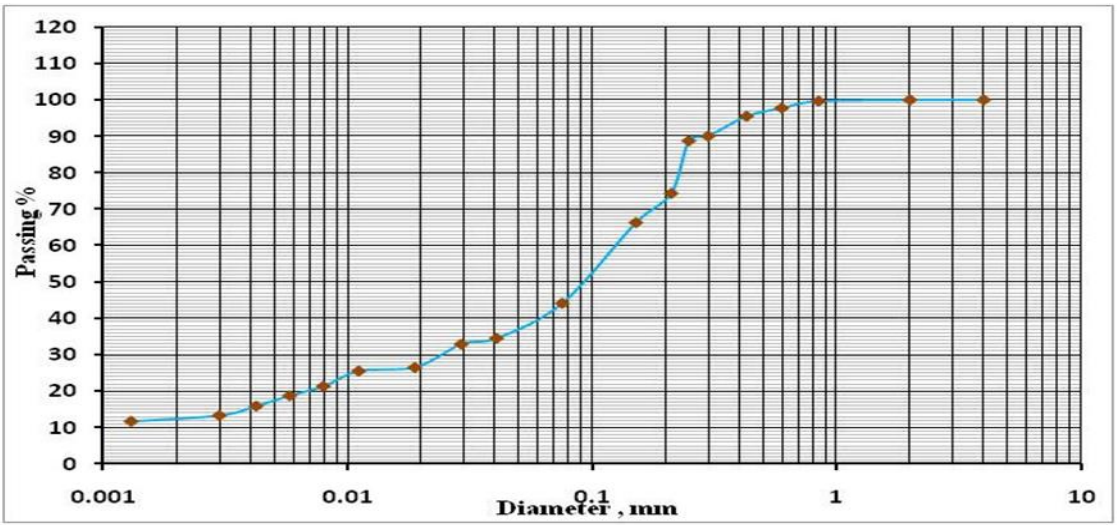

Figure (11): Curved the granular gradient of cross-section No.(4) .

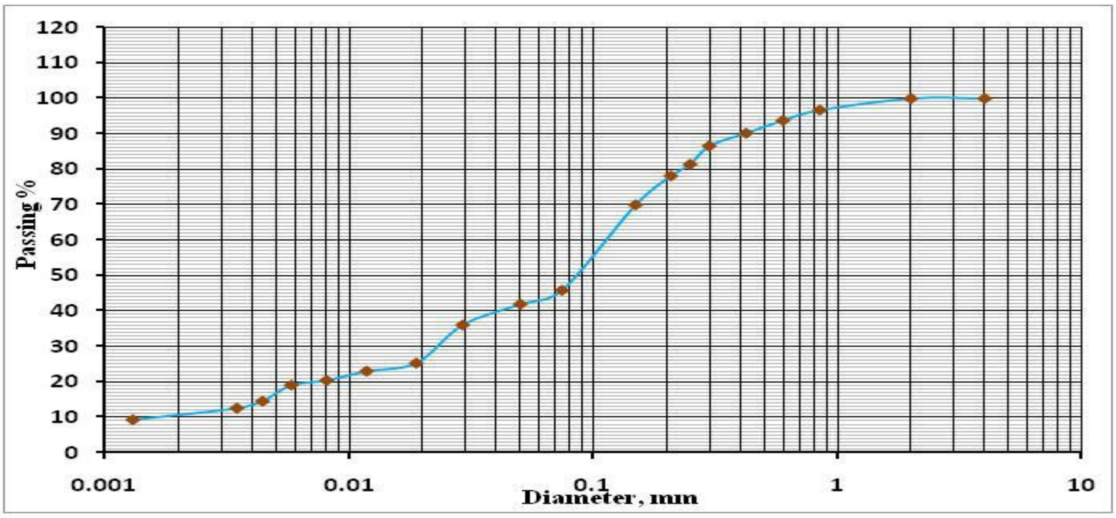

Figure (12): Curved the granular gradient of cross-section No.(5) .

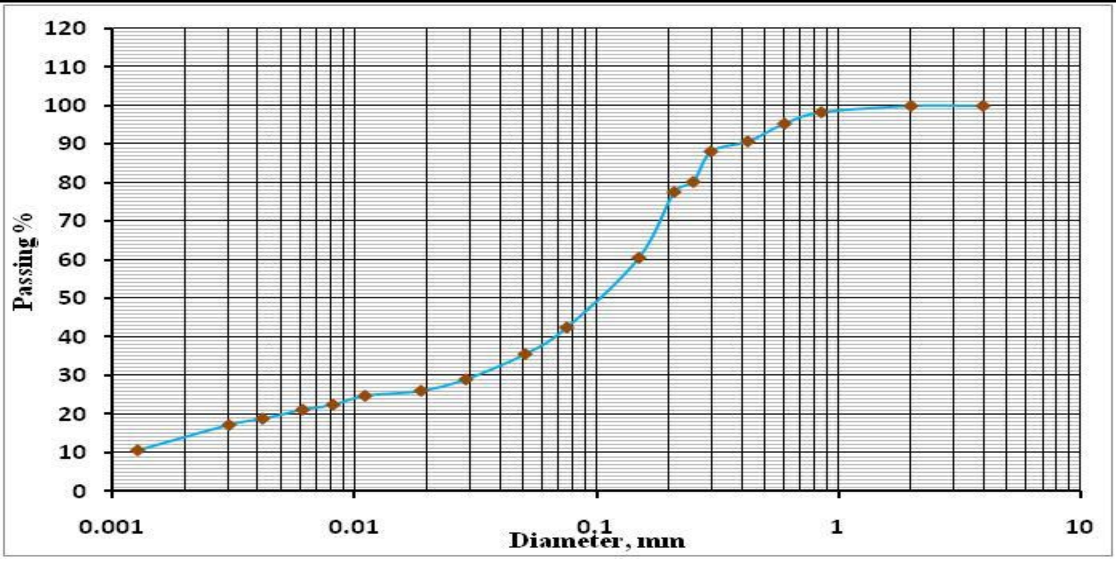

Figure (13): Curved the granular gradient of cross-section No.(6) .

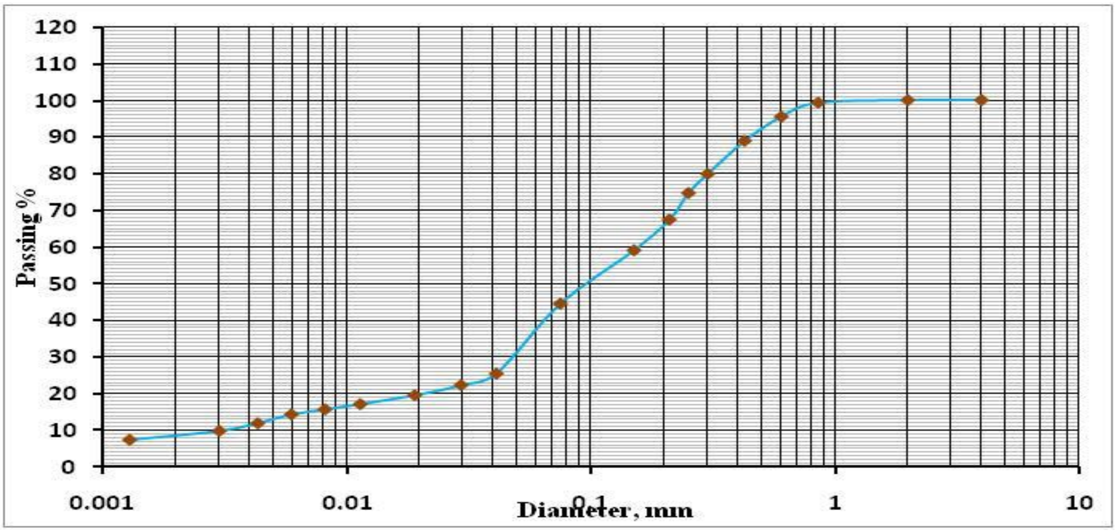

Figure (14): Curved the granular gradient of cross-section No.(7) .

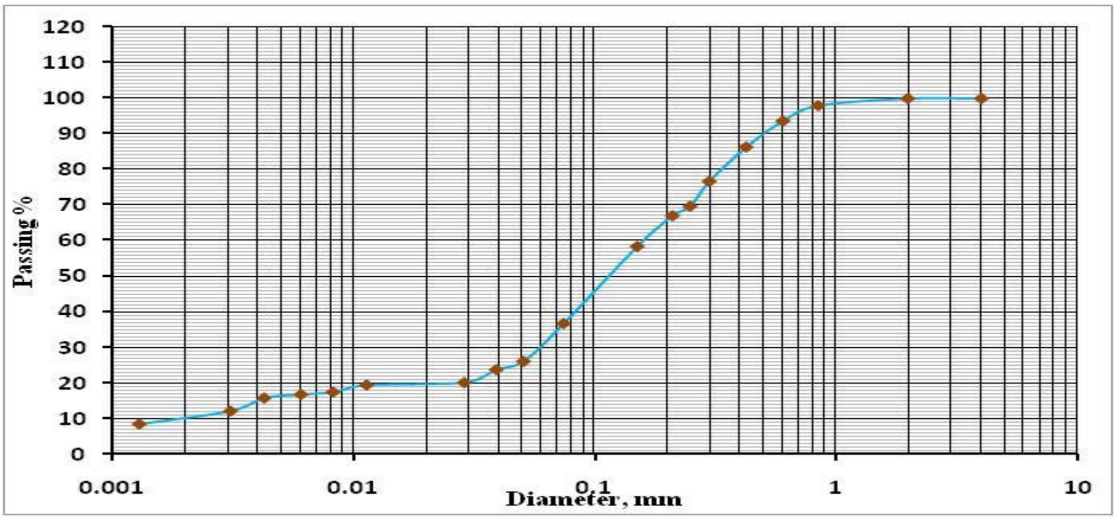

Figure (15): Curved the granular gradient of cross-section No.(8) .

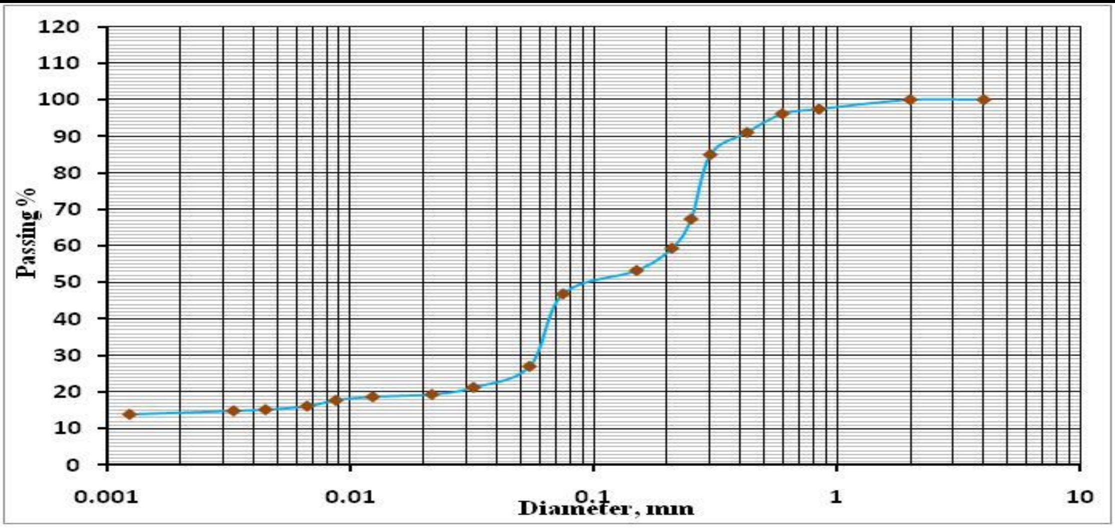

Figure (16): Curved the granular gradient of cross-section No.(9) .

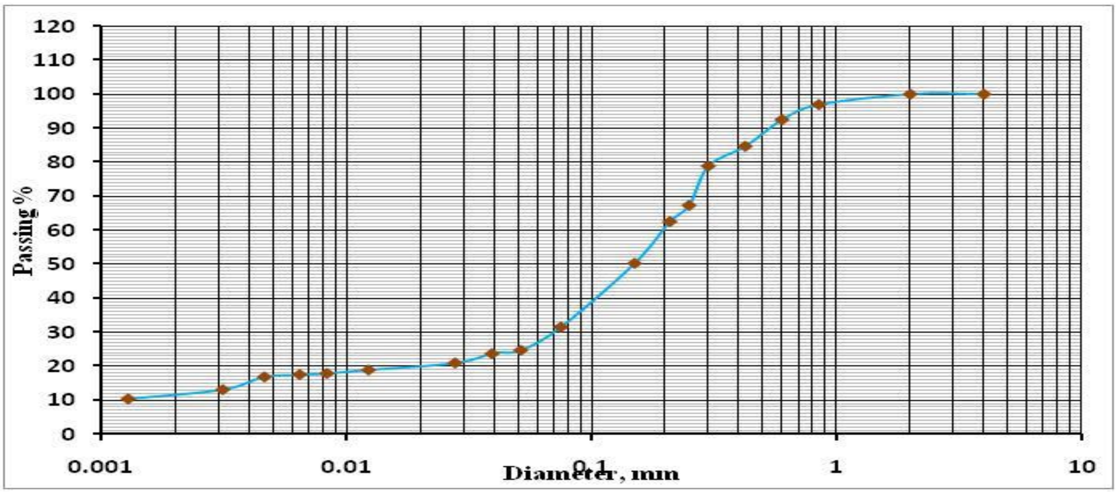

Figure (17): Curved the granular gradient of cross-section No.(10) .

Table (4): Characteristics of sedimentation of the Euphrates River bottom along the study area

Section No.	Clay %	Silt %	Sand %	d_{50} (mm)	d_{90} (mm)
1	15.8	19.6	64.6	0.12	0.67
2	11.3	28.4	60.3	0.1	0.48
3	16.0	25.2	58.8	0.11	0.43
4	17.5	26.7	55.8	0.093	0.3
5	16.5	29.3	54.2	0.088	0.42
6	19.8	22.5	57.7	0.105	0.41
7	13.0	31.7	55.3	0.095	0.45
8	16.4	20.2	63.4	0.125	0.5
9	15.5	31.4	53.1	0.093	0.39
10	17.1	14.3	68.6	0.15	0.54

Through laboratory analysis of bottom samples in the cross-sections chosen for the study area, it is noted through the obtained values that the d50 values range between (0.15 - 0.088 mm), while the d90 values range from (0.67 - 0.3 mm), the difference in

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particle size The bottom sediments came as a result of several factors, including the effect of bridges built on the river like sedimentation, especially in the cross-section (5), and the effect of river torsion that works to reduce the flow velocity and the accumulation of materials in the river bed, especially the soft ones, so the cross-section (5) recorded the lowest value d50, which amounted to 0.088 mm, as is the case for the cross-section (4), also the value of d50 (0.093 mm). As for the percentages of each of sand, clay, and silt in the studied samples, the results of the laboratory sorting indicated that the bottom sediments in the Euphrates River within the city of Nasiriyah have a sandy gradient, as the sand percentages range between (68.6 - 53.1%), and the silt percentages recorded gradations ranging between (31.7 - 14.3%, while the proportions of clay ranged between (19.8 - 11.3%).

Many reasons lead to the spatial change in the distribution and gradations of bottom grains, including the variation in the topography of the Euphrates River and the nature of its formation. Therefore, the cross-sections, their locations, and the factors affecting the spatial distribution of the Euphrates River bottom samples in cross-sections will be described as follows:

Cross section No. (1): This section is located near the highway bridge in the city of Nasiriyah and is bordered from the top by another newly constructed bridge, so these bridges had a significant impact on the flow, and therefore we note that the value of d90 was high in this section, as it reached the highest values (0.67 mm). As well, the value of d50 was relatively high as it reached (0.12 mm) as well as the percentage of sand was high compared to the rest of the sections, where it reached (64.6%) perhaps the reason is due to the decrease in the flow velocity as a result of the effect of the bridges supports, it was also noted that the sedimentation is very high in the right bank of this section as shown in Figure (16).

Figure (16): Shows the location of cross-section No. (1) and the effect of bridges on sedimentation conditions

Cross Section No. (2): This cross-section is located at the bottom of a small pedestrian bridge at a close distance. The approaches to this bridge caused an accumulation of sediment on both sides of the cross-section, as in Figure (17).

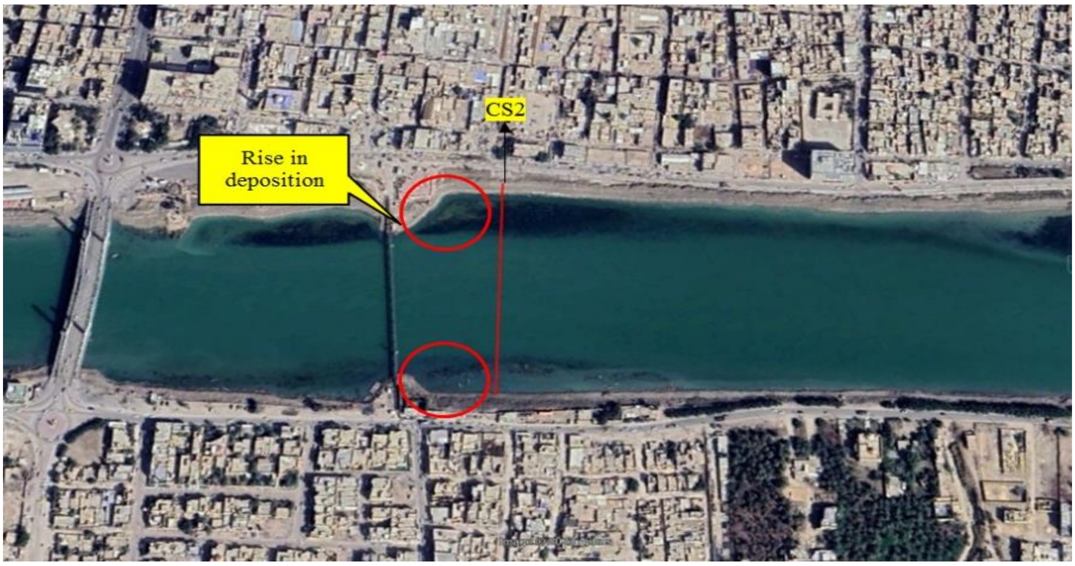

Figure (17): Shows the location of cross-section No. (2) and the effect of bridges on sedimentation conditions

Cross Section No. (3): This section is characterized by somewhat high sedimentation on its right side, and the particles of sediment materials are more sandy than the rest of the particles, reaching (58.8%).

Cross section No. (4): This section, its left side, contains a relatively large island, which caused a decrease in the flow velocity on this side, as shown in Figure (18), which allowed the sedimentation of fine particles, as the value of d50 (0.093 mm) and the value of d90 (0.3mm).

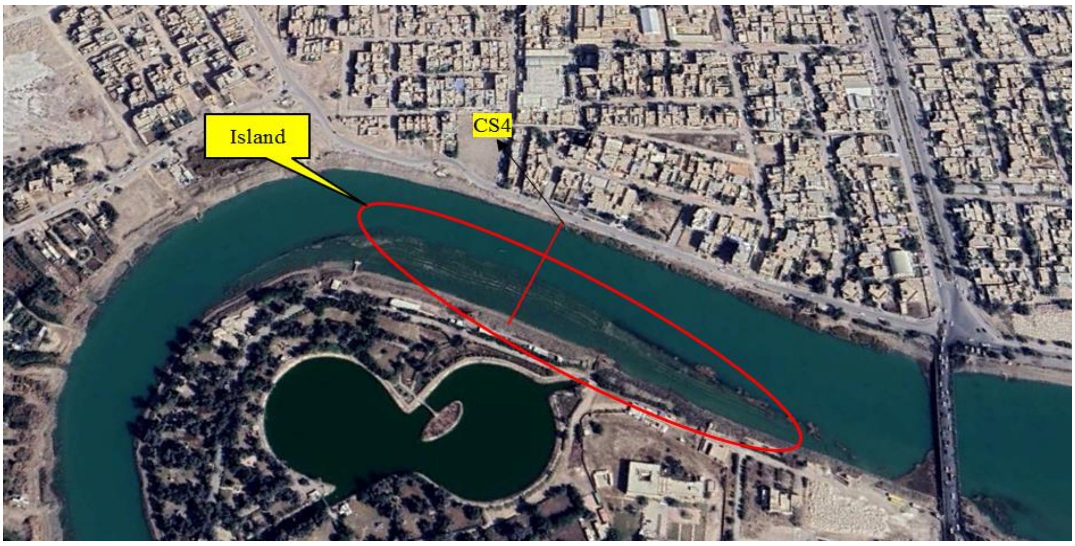

Figure (18): Shows the location of cross-section No. (4) and the effect of the island on sedimentation conditions

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Cross Section No. (5): This section is located in a very sharp zigzag, which caused the sedimentation of fine particles as a result of a decrease in the flow velocity on both sides of the cross-section, while the flow velocity was higher at the center of the section, as it reached a value of d50 (0.088 mm).

Cross Section No. (6): This section is also located in a zigzag but is not sharp either. It is characterized by precipitation on its right bank more than on the left bank.

Transverse Sections No. (9, 8, 7, and 10): The conditions of these sections were similar, as no difference in sedimentation was observed on the two banks of the sections, and they were not located near bridges or any other facilities built on the river, and also, no islands or sharp zigzags were observed in specific locations.

6. Conclusions: The study reached some results, as follows:

1. The water projects in Turkey and Syria built on the Euphrates River basin have led to a significant decrease in the river's discharge and levels in Iraq in general, and the city of Nasiriyah and other cities in southern Iraq in particular, compared to previous periods, and this requires treatments and solutions by the relevant authorities.
2. Through laboratory analysis of the Euphrates River bed samples in the selected cross-sections of the study area, it is noted through the obtained values that the d50 values range between (0.15 - 0.088 mm), while the d90 values range between (0.67 - 0.3 mm).
3. The difference in the granular size of the bottom sediments came from several factors, including the effect of bridges built on the river-like sedimentation, especially in cross-section No. (1,2), and the effect of torsion and meanders of the river that work to reduce the flow velocity and the accumulation of materials in the river bed, especially the soft ones. As in cross-section No. (5).
4. The results of the laboratory sorting of the bottom samples indicated that the bottom sediments in the Euphrates River within the city of Nasiriyah have a sandy gradient, as the percentages of sand ranged between (68.6-53.1%), and the percentages of silt recorded gradations ranging between (31.7-14.3%), while the percentages of clay ranged between (19.8-11.3%).
5. many other reasons lead to the spatial change in the distribution and gradations of the bottom grains, including the variation in topography of the Euphrates River and the nature of its formation, as in cross-section No. (4), where its left bank contains a relatively large island, which caused a decrease in the flow velocity on this side. This allowed the sedimentation of fine particles with d50 (0.093 mm) and d90 (0.3 mm) values.

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