PRELIMINARY LANDSLIDE MODELING
for
KRAMER AVENUE LANDSLIDE
SITKA, ALASKA

Prepared for:

Andrew Friske
210 Kramer Ave.
Sitka, Alaska 99835

Prepared by:

Northern Geotechnical Engineering, Inc. *d.b.a.* Terra Firma Testing

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SEPTEMBER 2018

September 5, 2018 NGE-TFT Project # 4349-16

Andrew Friske
210 Kramer Ave
Sitka, Alaska 99835

RE: PRELIMINARY DEBRIS FLOW MODELING FOR TWO POTENTIAL LANDSLIDES NEAR KRAMER AVENUE LANDSLIDE IN SITKA, ALASKA.

Andrew,

We (Northern Geotechnical Engineering, Inc. *d.b.a.* Terra Firma Testing) have prepared this letter to present our preliminary debris flow model with a diversion structure for the aforementioned project. The preliminary debris flow modeling intended to assist in planning to decrease the risk of potential damage from future debris flows to the residential properties along Kramer Avenue without increasing the risk to the downhill Sand Dollar Subdivision.

As a part of our evaluation, the risk of a future event similar to that which occurred on August 18, 2015 needs to be determined. We have not yet addressed the risk. This will involve study of precipitation and evaluating the effects of our estimate of the volume of the debris flow on the distance travelled

A landslide occurred on August 18, 2015, which the debris flow impacted several residential lots along Kramer Avenue and resulted in the loss of three lives. Shannon and Wilson, Inc. (SWI) conducted an overview study of the landslide, which is titled *South Kramer Avenue Landslide: Jacobs Circle to Emmons Street, Sitka, Alaska*, dated February 2, 2016. It was recommended by SWI that the project site be further investigated to determine mitigations to protect the existing and future development from potential landslides in the adjacent gully. This report presents our preliminary work to develop and analyze proposed mitigation features.

Two potential landslides paths, a tributary to the north of the landslide that occurred on August 18, 2015 and a small channel to the south, were evaluated by modeling the debris flow. The model of the tributary includes a diversion structure that directs the debris path to the north of the landslide on August 18, 2015. For the diversion structure we recommend an earthen berm that is constructed from the existing debris in the area. From the preliminary landslide modeling we expect that the earthen berm will be approximately 200 feet long, 25 feet tall and 15 feet wide at the crest. Our preliminary modeling shows that the debris stops approximately 240 to 330 feet east of Emmons Street.

Additional modeling and site evaluations will be required to provide detailed recommendations for the diversion berm, the runout zones and water flow paths.

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The second model is of the small channel to the south and the model does not include any modeling of provisions to mitigate risks to the residential lots along Kramer Avenue. This model does not indicate there would be damage to the existing developed residential lots, however these analyses are not exact. In the analyses for the small channel the debris stopped approximately 180 to 200 feet east of Kramer Street. Mitigations to lower the risk of potential damage is not discussed in this report.

We greatly appreciate the opportunity to provide you with our professional service. Please contact us directly with any questions or comments you may have regarding the information that we present in this report, or if you have any other questions, comments, and/or requests.

Sincerely,
Northern Geotechnical Engineering, Inc. *d.b.a.* Terra Firma Testing

Clinton J. Banzhaf, P.E.
Senior Project Engineer

Keith F. Mobley, P.E.
President

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Table of Contents

List of Figures

List of Appendices

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1.0 INTRODUCTION

In this report, we (Northern Geotechnical Engineering, Inc. *d.b.a.* Terra Firma Testing) present the results of a preliminary debris flow analysis we conducted for potential landsides near the Kramer Avenue Landslide in Sitka, Alaska; hereafter referred to as "the project site". We provided our professional service in accordance with our service fee proposal #4349-16(2) which we submitted to you on March 23, 2018. Our proposed scope was authorized by signing our proposal on March 24, 2018.

The purpose of our service is to begin the process of complying with the recommendations presented by Shannon & Wilson, Inc (SWI) and to determine if mitigation measures could be designed to reduce the risk sufficiently to allow some or all the properties within the potential debris slide zone to be developed and occupied. You contracted us to conduct a preliminary debris flow model for the tributary channel with a diversion structure and a debris flow model for a small channel. The tributary channel model was to include a conceptual diversion structure intended to decrease the risk of potential damage from a landslide to the residential property along Kramer Avenue with no increased risk to the downhill Sand Dollar Subdivision.

In this report, we provide a summary of the preliminary modeling, as well as provide the results of the debris flow results for both the tributary and small channel debris flow paths. We also provide an approximate size of diversion structure required to divert the anticipated debris flow on the tributary landslide. At this time, we have not addressed the risk.

We have not addressed stormwater flow (from snow melt and rainfall that does not induce a debris flow), water flow that will occur past the end of the debris flow, or containment of debris in the runout zone. During our site visit this past spring, discussions included keeping the storm runoff in the existing slide channel, controlling the debris containment to maximize the useable lots on Emmons Street, and to minimize the water flow into the Sand Dollar subdivision below the project site. Our studies to date still indicate that these concepts can be achieved.

2.0 PROJECT OVERVIEW

As we detail in Figure 1 of this report, the project site is located at the south end of Kramer Avenue in Sitka, Alaska. On August 18, 2015, a landslide occurred at the project site, with the debris flow impacting several residential lots and resulting in the deaths of three people; hereafter referred to as "the original event". SWI conducted an overview study of the debris flow, which was reported in *South Kramer Avenue Landslide: Jacobs Circle to Emmons Street, Sitka, Alaska,* dated February 2, 2016. The SWI report presents a debris flow risk map, shown in Figure 2 of this report, that identifies two additional potential debris flow sources that have potential to impact the residential areas. The most concerning is a debris flow source in the high-risk category which is a tributary

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adjacent to the original event. The second potential debris flow source is a small channel to the south of the original event. The results of SWI debris flow analysis for both the original event and tributary is also shown on the flow risk map in Figure 2 of this report. The berm that is referred to on Figure 2 of this report for the SWI debris flow analyses is a berm that was stockpiled material and has since been removed.

We agree with SWI's opinion that it is not possible or practical to prevent landslides and further studies should be conducted to design mitigation measures to protect existing and future development from a potential debris flow starting in the tributary gully.

The preliminary mitigation is to direct the adjacent tributary debris path, with a diversion structure, to the north of the original event with goal of the debris flow ending before Emmons Street. As part of this diversion plan the properties to the east of Emmons Street would remain undeveloped.

3.0 DEBRIS FLOW ANALYSIS

We conducted a debris flow analysis for the tributary debris flow with a diversion berm and for the small channel to the south of the original event.

3.1 UBCDFLOW

We used UBCDFLOW, empirical-based computer program, to perform the debris flow analyses for this project. This technique allows the user to manipulate initial flow volume and predict the length of debris flow. However, because the model analysis is based on user defined debris flow directions, slopes, and widths, the results generated are only as accurate as the data that is initially input into the model. Furthermore, the average parameters for the flow path sections are used in the modeling process due to a limited amount of reached (30) that define the debris flow path. Each reach defines the path with four parameters, that are; length, width, slow angle, azimuth, flow type. These generalizations do not account for the small-scale variations (both vertical and horizontal) which occur in the topography of the project site. Therefore, results obtained from numerical models should not be viewed as absolutes, but can be used along with other site-specific data to help guide design efforts.

3.2 Model Configuration

We have included a topographic map of the project site (provided by you) in Figure 3 of this report, which details the approximate location and orientation of the profiles applied to each model as a part of our debris flow analyses. We estimated the debris flow path parameters for our analyses from the topographic map in Figure 3 of this report. The schematic plan view and cross-section views for the tributary model with a diversion structure are presented in Appendix A of this report. The tributary debris flow was only modeled with a diversion structure, as SWI completed debris flow model assuming the existing conditions. We have also included the schematic plan view and cross-section views for the small channel model in Appendix B of this report. For both the Tributary and Small Channel models, we tested four initial start volumes evenly spaced between approximately 35,000 cubic feet (1000 cubic meters) and 141,000 cubic feet (4000 cubic meters) of material. The initial start volumes selected for the models were selected to show a range between a large initial start volume and smaller start volume debris flow path results.

3.3 Results

The program UBCFLOW presents the result of the analysis in two graphs that are cumulative debris volume and change in debris volume versus the distance traveled. UBCFLOW also provides at tabulated summary of the information presented in the graphs.

3.4 Tributary Debris Flow

Of the four initial start volumes, the smallest initial volume, 35,000 cubic feet (1000 cubic meters), stopped approximately 330 feet (Reach 23) before Emmons Street. The largest initial volume, 141,000 cubic feet (4000 cubic meters) stopped prior to the residential lots and approximately 240 feet (Reach 24) before Emmons Street. The other initial volumes, 71,000 cubic feet (2000 cubic meters) and 106,000 cubic feet (3000 cubic meters) ended approximately 270 feet, (Reach 24) before Emmons Street. The results of the four analyses are compiled in Appendix C of this report. For these, debris analyses it is assumed that all the debris is diverted away from the Original Event path, via the diversion structure.

3.5 Small Channel Debris Flow

All four initial start volumes, the debris contacted the residential properties the east of Kramer Avenue. However, the debris flow did not reach the residential lots immediately east of Kramer Avenue. Using the smallest initial volume, the debris flow stopped approximately 230 feet (Reach 18) east of Kramer Avenue and the largest stopping approximately 160 feet (Reach 23) east of Kramer Avenue. The model showed the debris flow stopping approximately 200 feet (Reach 20) and 180 feet (Reach 22) east of Kramer Avenue for initial start volumes of 71,000 cubic feet (2000 cubic meters) and 106,000 cubic feet (3000 cubic meters), respectively. The results of the four analyses are compiled in Appendix D of this report.

4.0 ENGINEERING CONCLUSIONS

Based on our results of the debris flow analyses for the tributary channel, a diversion structure is a possible option to reduce the risk of potential damage to the residential property along Kramer Avenue with no increased risk to the downhill Sand Dollar Subdivision. The change in the debris flow from the Original Event will increase the risk of potential damage to the undeveloped lots to the east of Emmons Street between Cushing Street and Kramer Avenue.

The findings from the preliminary analyses on the small channel debris flow shows there is a potential for damage to the residential lots to the east of Kramer Avenue between Emmons Street and Jacobs Circle. The analyses completed for the small channel debris flow did not include any mitigations to reduce the risk of potential damage but rather mainly to present the possible debris slow path.

5.0 FURTHER ANALYSIS

Our analyses show that a diversion structure is a possible improvement that will reduce the risk of potential damage from a landslide to the residential property along Kramer Avenue with no increased risk to the downhill Sand Dollar Subdivision. Our recommended diversion structure is a large earther berm, which will be constructed using the debris material from the Original Event.

The following questions remain:

Tributary Channel

- What is an appropriate range of volume of debris to use for analysis?
- How wide should the channel be above the diversion structure?
- How tall should the diversion be?
- How much water can be produced during a storm event that does not include a debris flow
- Where will the water go once the debris is settled out?
- What barrier structures will be needed to minimize the impact to properties at the toe of the debris slide?
- Where will water go during rainfall events that do not induce debris flow?
- What is the return interval for a rainfall event that will induce a debris flow?

Small Channel

- What is an appropriate range of volume to use for analysis?
- Where will the water go once the debris is settled out?
- What is the return interval for a rainfall event that will induce a debris flow?

For the small channel, the volume of debris in the initial state will have a significant impact on the potential for the debris to reach the properties below. Additionally, because the initiation zone is both lower in elevation and not as steep, more rainfall would be needed to initiate a debris flow.

For both channels, it would be helpful to conduct some subsurface explorations to assess the depth of soils above the bedrock. Due to access, it is anticipated this effort would be very labor intensive, involving using a hand-carried auger to drill several borings within each initiation zone. Hand measured survey data to confirm the lidar survey would also benefit the estimation process.

6.0 CLOSURE

We (Northern Geotechnical Engineering, Inc. d.b.a. Terra Firma Testing) prepared this report exclusively for the use Andrew Friske and his consultants/contractors/etc. for use in the planning

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process. With Andrew's permission, this report may be shared with others involved with the planning and assessment of the assessment of the properties potentially impacted by future debris flow events in the project area.

The data, interpretations, and recommendations presented herein are preliminary in nature and should not be relied upon for final decisions regarding the future use of the properties impacted. We do expect this report to be reviewed and questions raised regarding further studies. As stated above, based on our preliminary work, there is potential that mitigation structures can be built that will sufficiently reduce the risk on part of the project area.

This report should always be read and/or distributed in its entirety (including all figures, exploration logs, appendices, etc.) so that all the pertinent information contained within is effectively disseminated. Otherwise, an incomplete or misinterpreted understanding of the site conditions and/or our engineering recommendations may occur. Our recommended best practice is to make this report accessible, in its entirety, to any design professional and/or contractor working on the project. Any part of this report (e.g., exploration logs, calculations, material values, etc.) which is presented in the design/construction plans and/or specifications for the project should have an adequate reference which clearly identifies where the report can be obtained for further review.

7.0 REFERENCES CITED

Laprade, William T. *South Kramer Avenue Landslide: Jacobs Circle to Emmons Street Sitka, Alaska.* Shannon & Wilson, Inc., 2016

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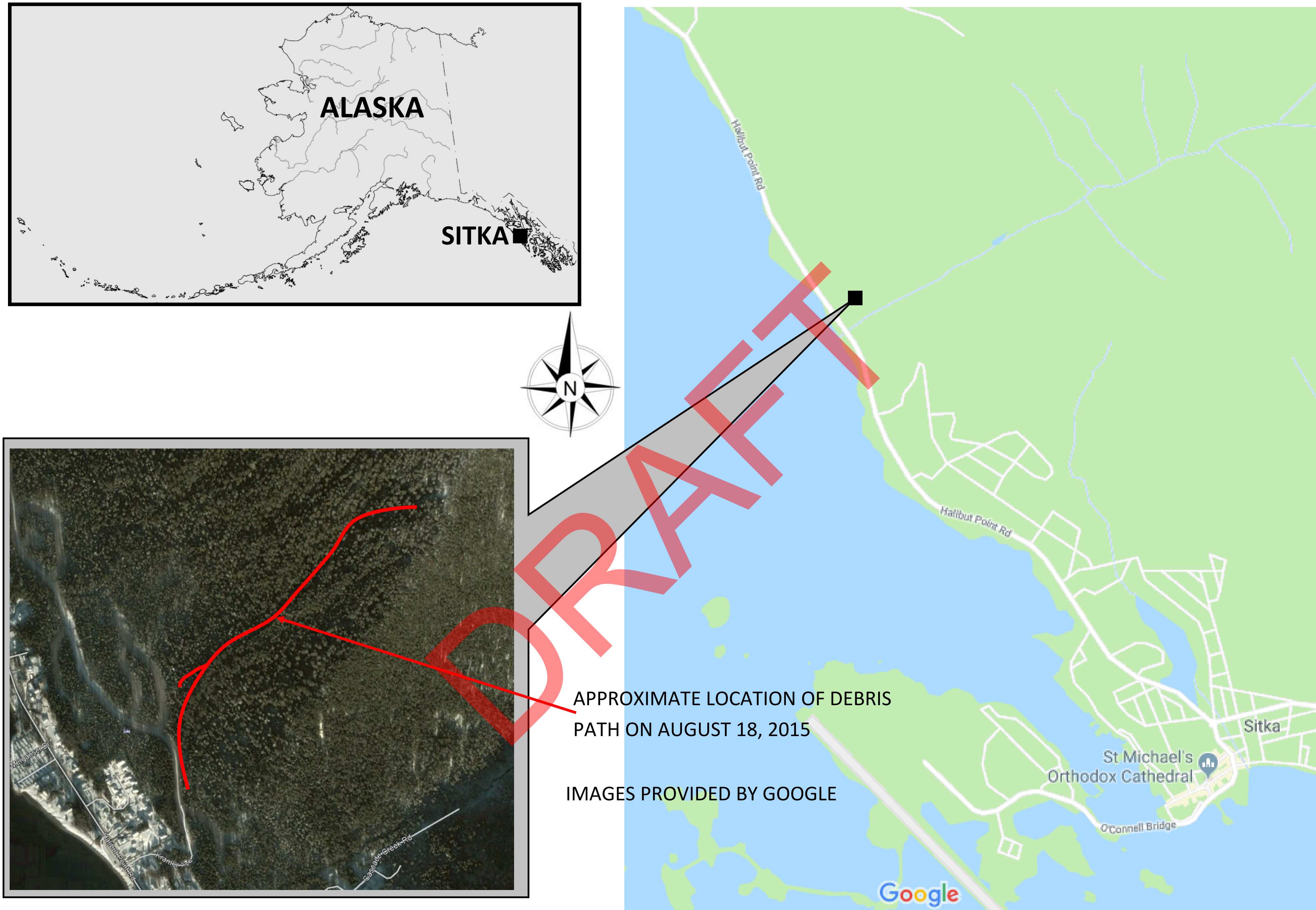
REPORT FIGURES



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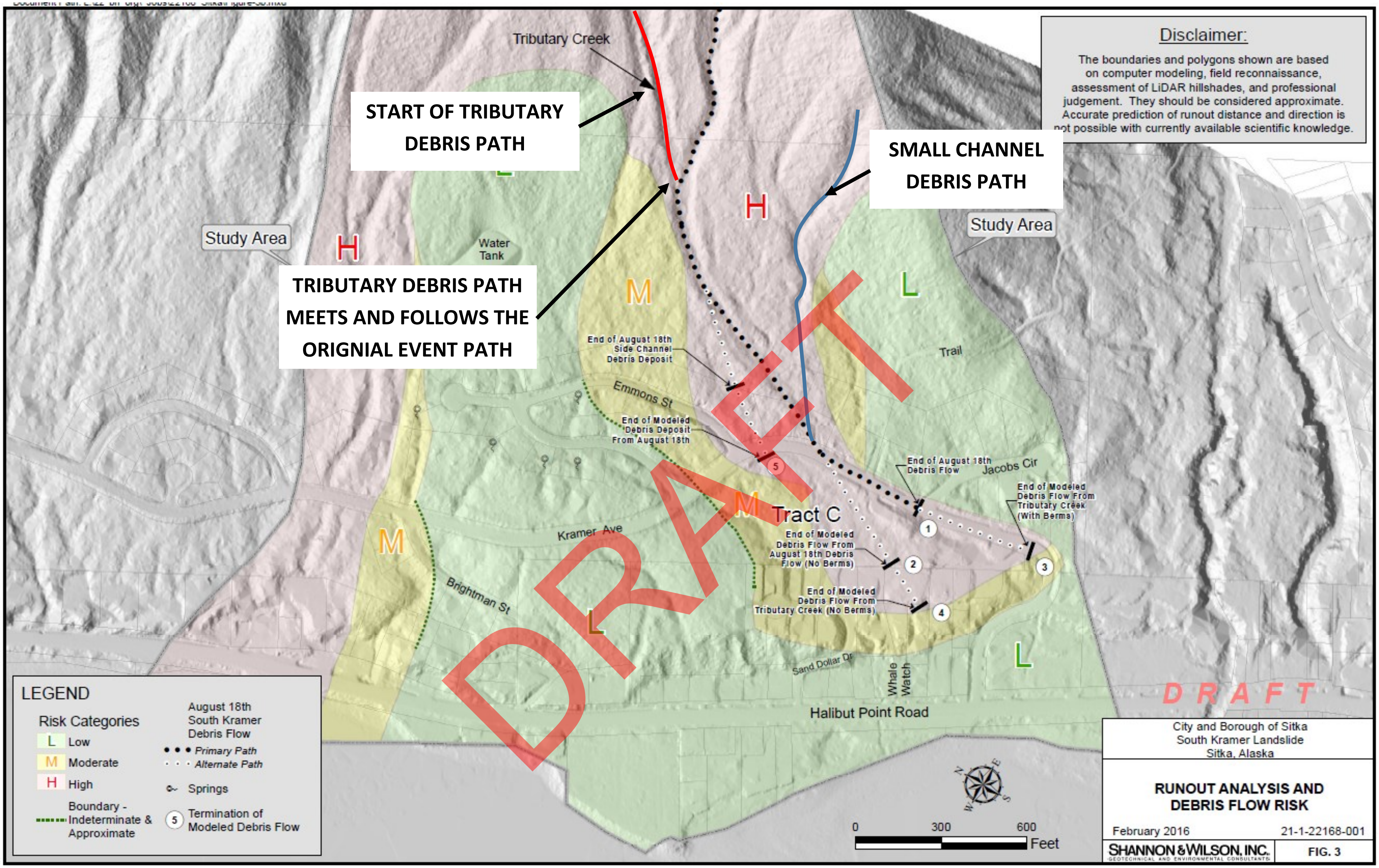
TERRA FIRMA TESTING

FIGURE TITLE: PROJECT SITE LOCATION	
PROJECT NAME: PRELIMINARY DEBRIS FLOW MODELING	PROJECT ID: 4349-16
PROJECT LOCATION: ANCHORAGE, ALASKA	FIGURE NUMBER: 1

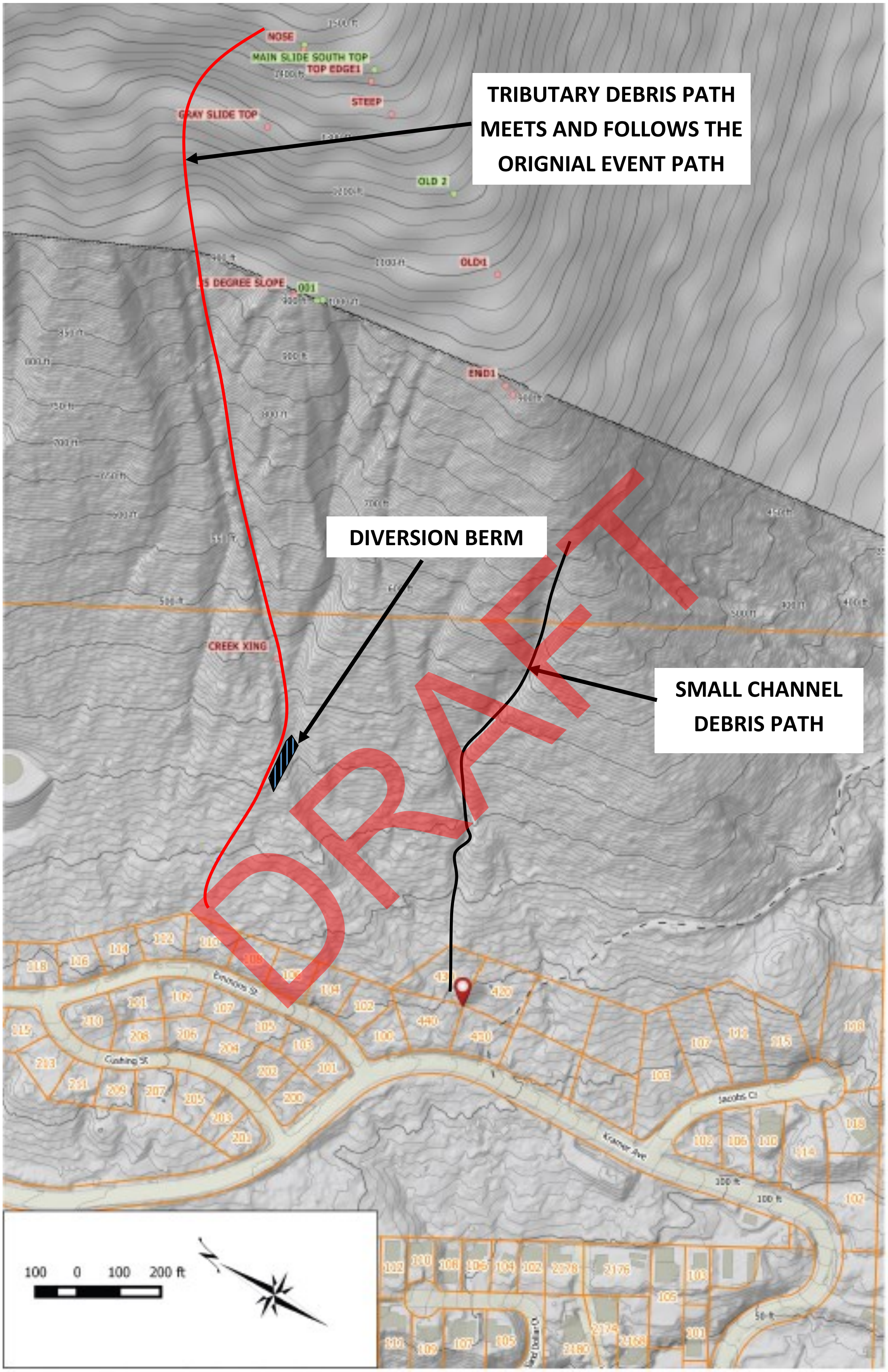


IMAGAGE PROVIDED BY:

LAPRADE, WILLIAM T. *SOUTH KRAMER AVENUE LANDSLIDE: JACOBS CIRCLE TO EMMONS STREET SITKA, ALASKA. SHANNON & WILSON, INC., 2016*

NORTHERN GEOTECHNICAL ENGINEERING, INC.
TERRA FIRMA TESTING

FIGURE TITLE: DEBRIS FLOW RISK MAP	
PROJECT NAME: PRELIMINARY DEBRIS FLOW MODELING	PROJECT ID: 4349-16
PROJECT LOCATION: ANCHORAGE, ALASKA	FIGURE NUMBER: 2



NORTHERN GEOTECHNICAL ENGINEERING, INC.
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FIGURE TITLE: TOPOGRAPHIC MAP	
PROJECT NAME: PRELIMINARY DEBRIS FLOW MODELING	PROJECT ID: 4349-16
PROJECT LOCATION: SITKA, ALASKA	FIGURE NUMBER: 3

APPENDIX A

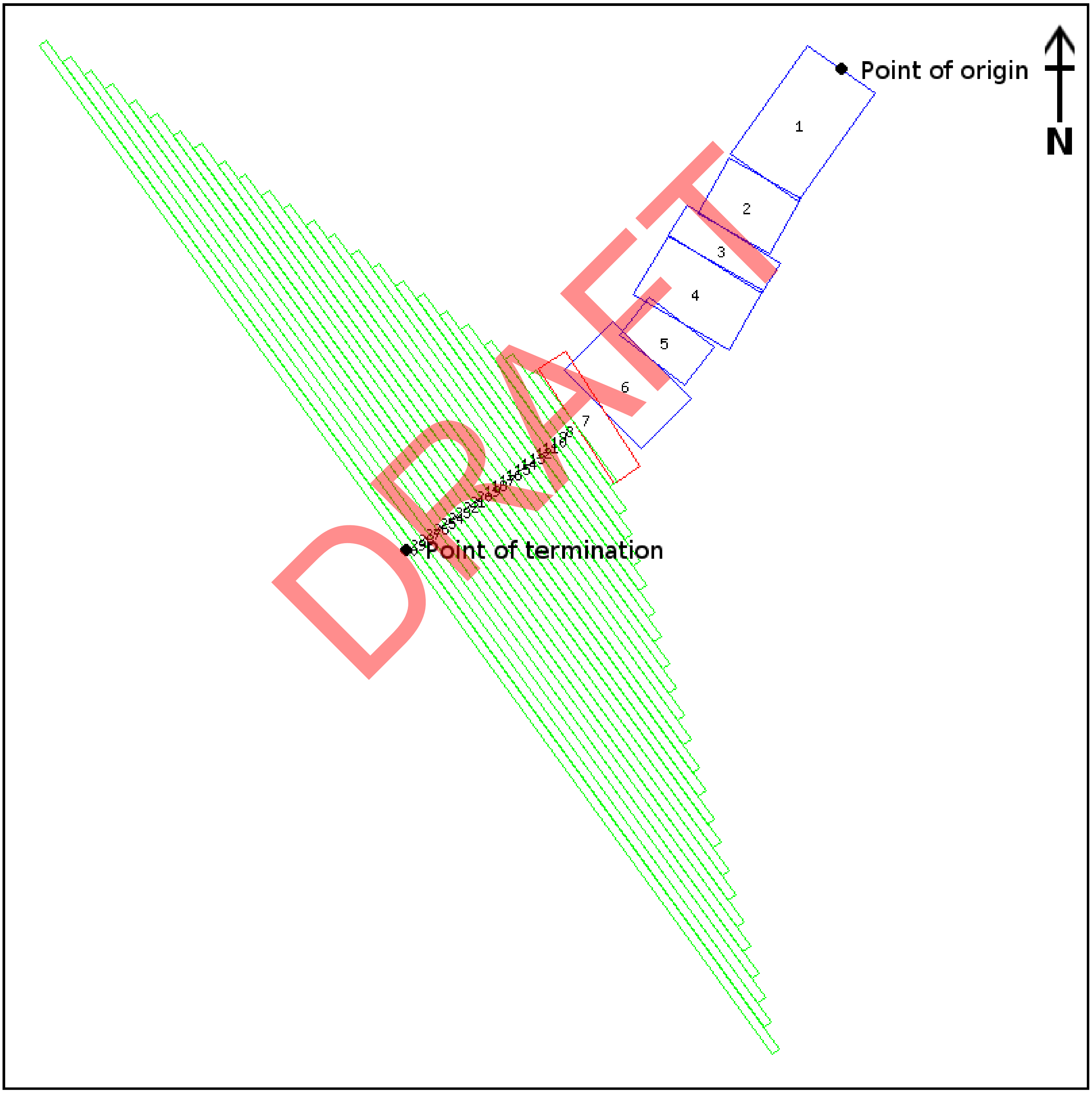
UBCDFLOW TRIBUTARY MODEL PLAN AND CROSS-SECTION VIEW

TRIBUTARY - PLAN VIEW

Unconfined flow is shown in green
Confined flow is shown in blue
Transition flow is shown in red

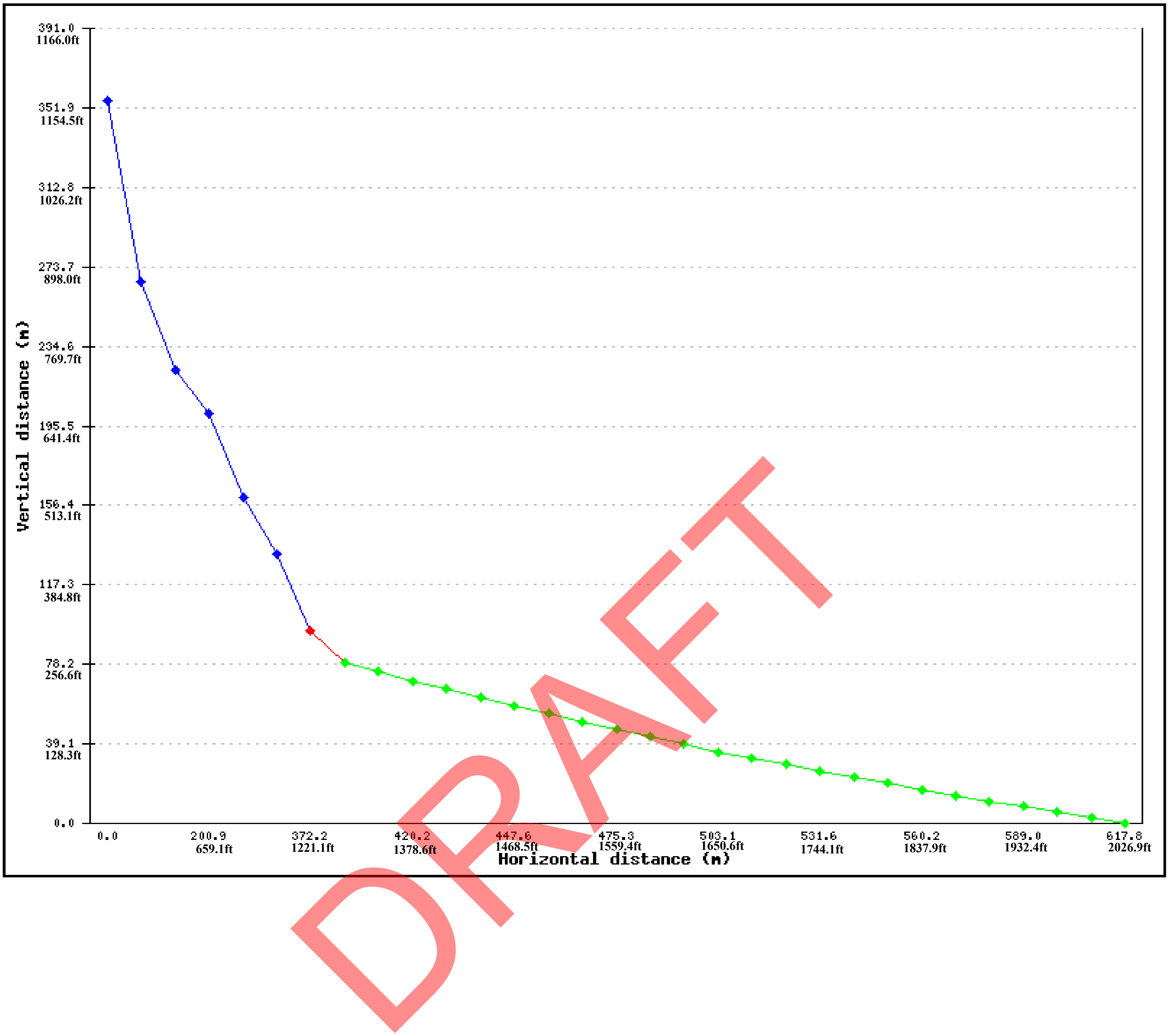
Total travel distance: 719 m /2359ft
Horizontal distance: 617.8 m /2026.9ft
Elevation change: 355.4 m /1166.0ft

Schematic Plan View (using all reaches described in input data)
Reach widths have been multiplied by 10.



Schematic Cross-Section View (using all reaches described in input data)

TRIBUTARY - CROSS-SECTION VIEW



APPENDIX B

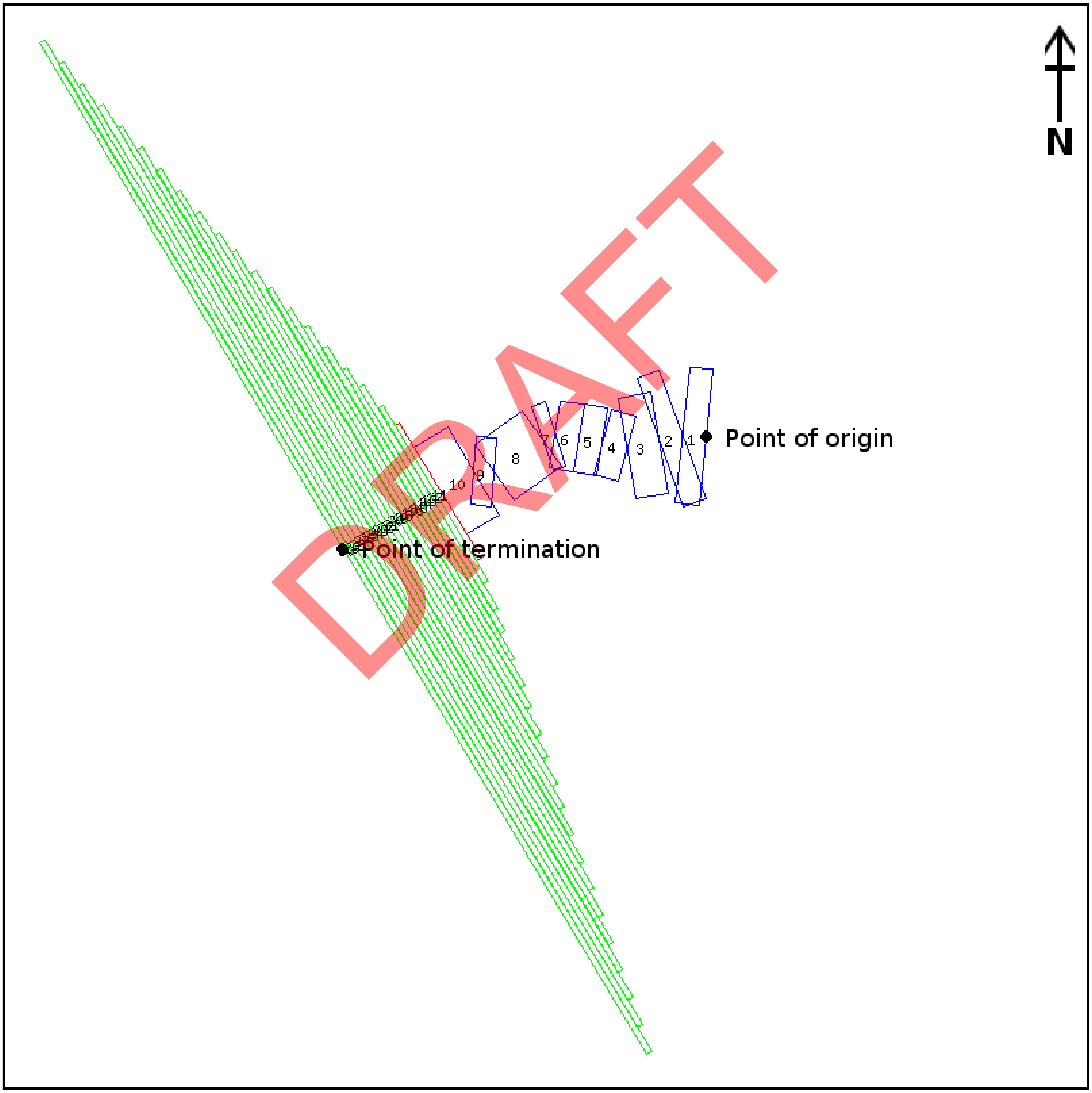
UBCDFLOW SMALL CHANNEL MODEL PLAN AND CROSS-SECTION VIEW

SMALL CHANNEL - PLAN VIEW

Unconfined flow is shown in gr
Confined flow is shown in blue
Transition flow is shown in red

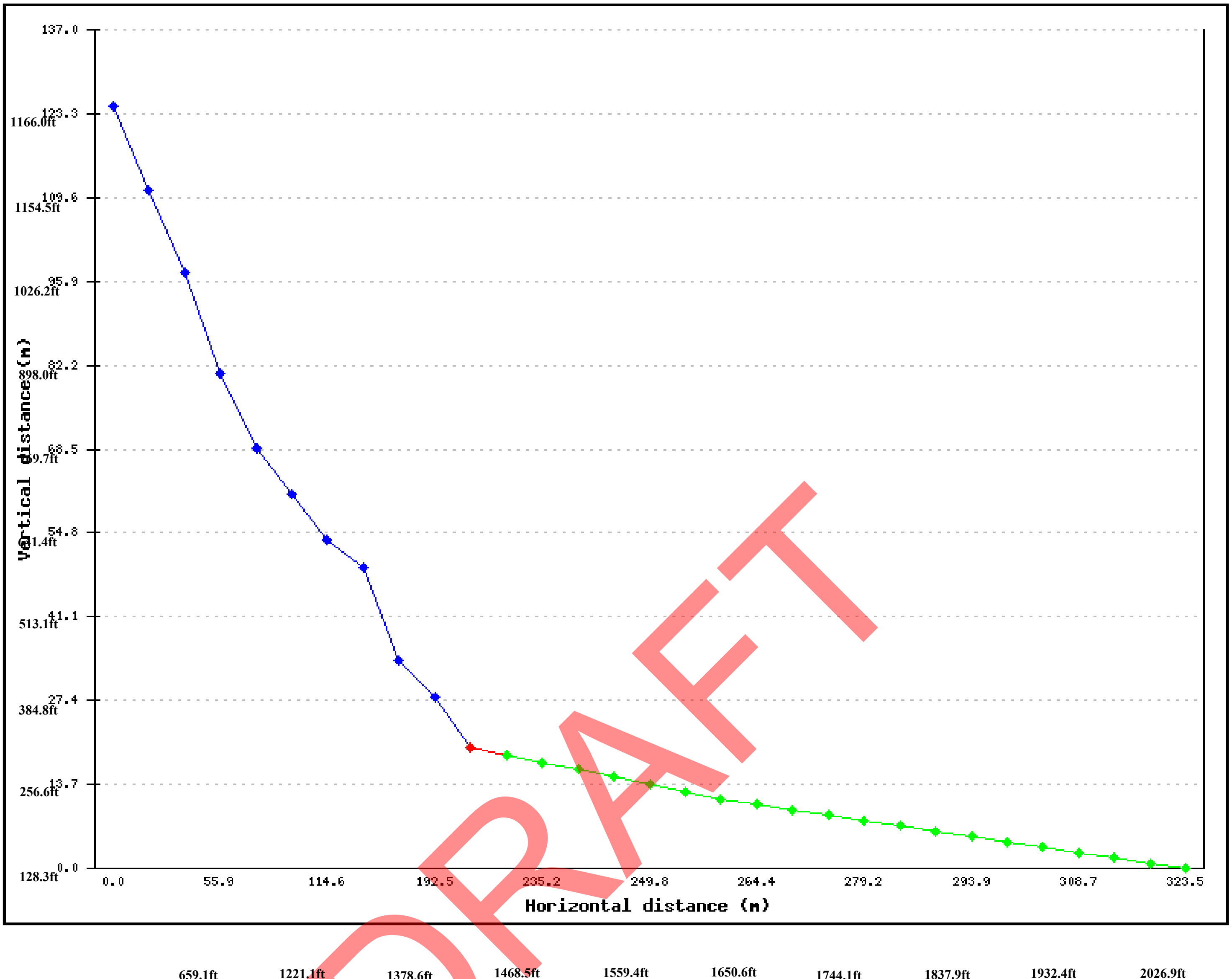
Total travel distance: 352 m /2359ft
Horizontal distance: 323.5 m /2026.9ft
Elevation change: 124.4 m /1166.0ft

Schematic Plan View (using all reaches described in input data)
Reach widths have been multiplied by 10.



Schematic Cross-Section View (using all reaches described in input data)

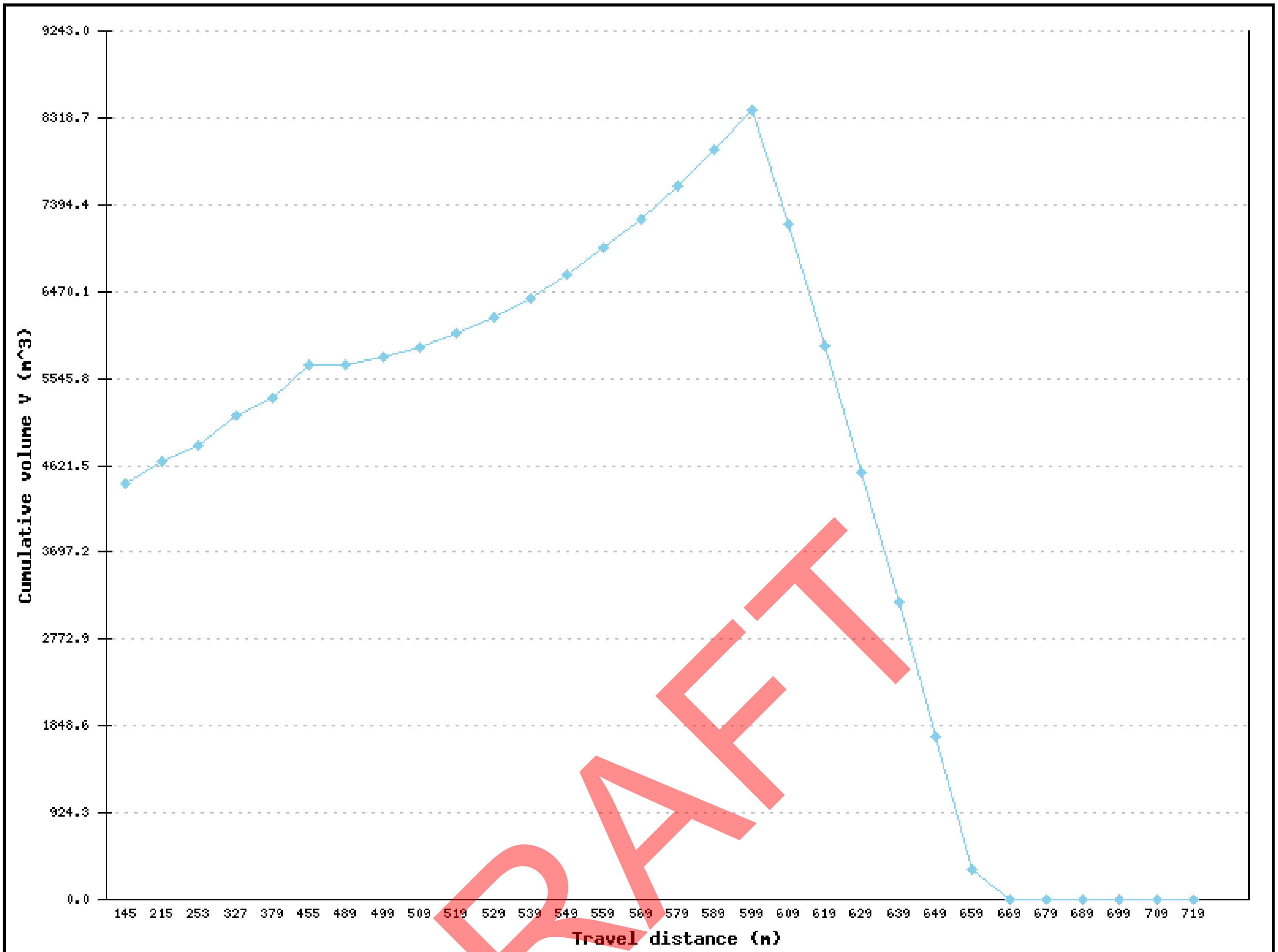
SMALL CHANNEL - CROSS-SECTION VIEW



APPENDIX C

UBCDFLOW TRIBUTARY ANALYSIS RESULTS

TRIBUTARY RESULTS - 4000 M³ INITIAL VOLUME

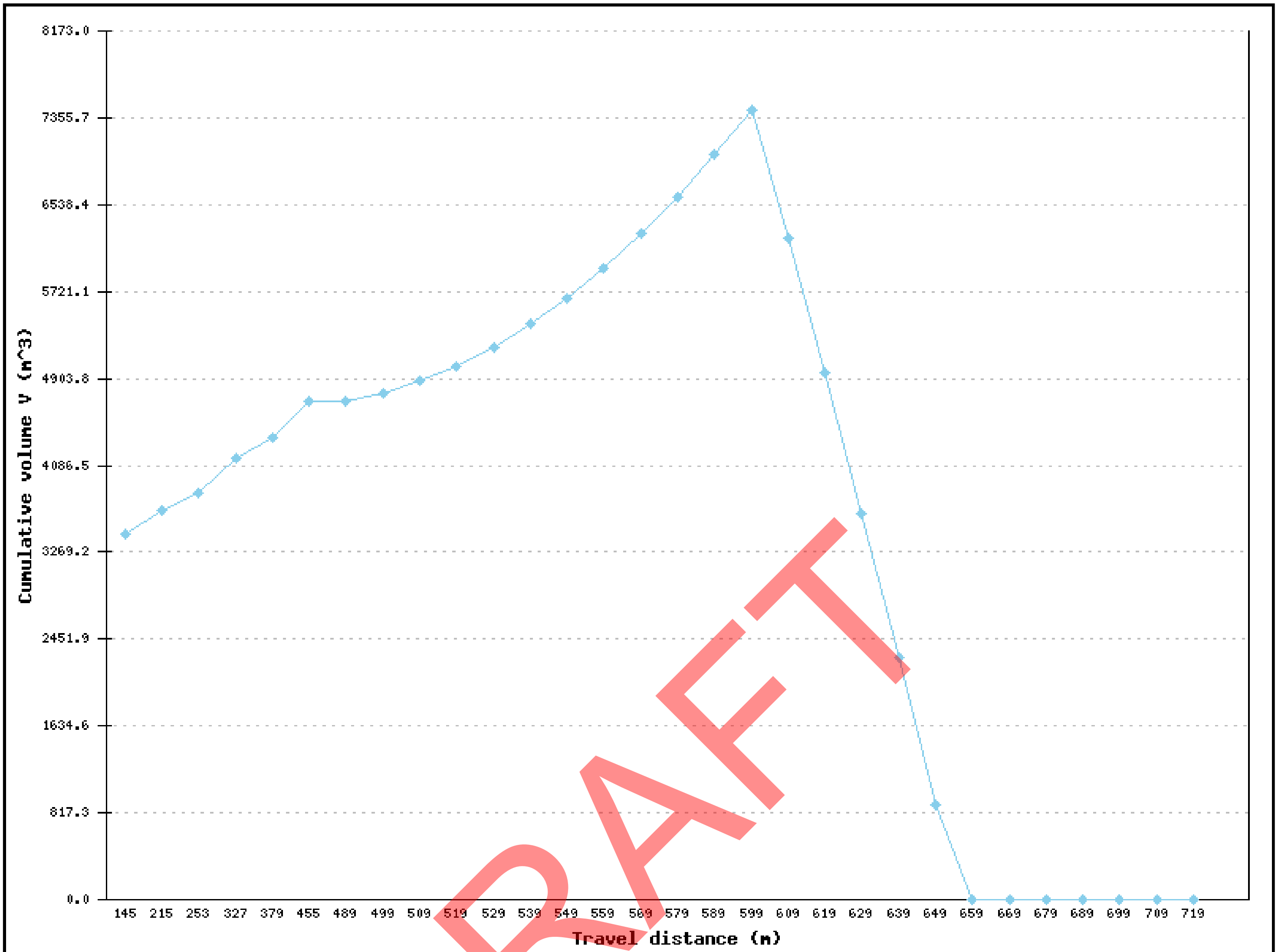


TRIBUTARY RESULTS - 4000 M³ INITIAL VOLUME

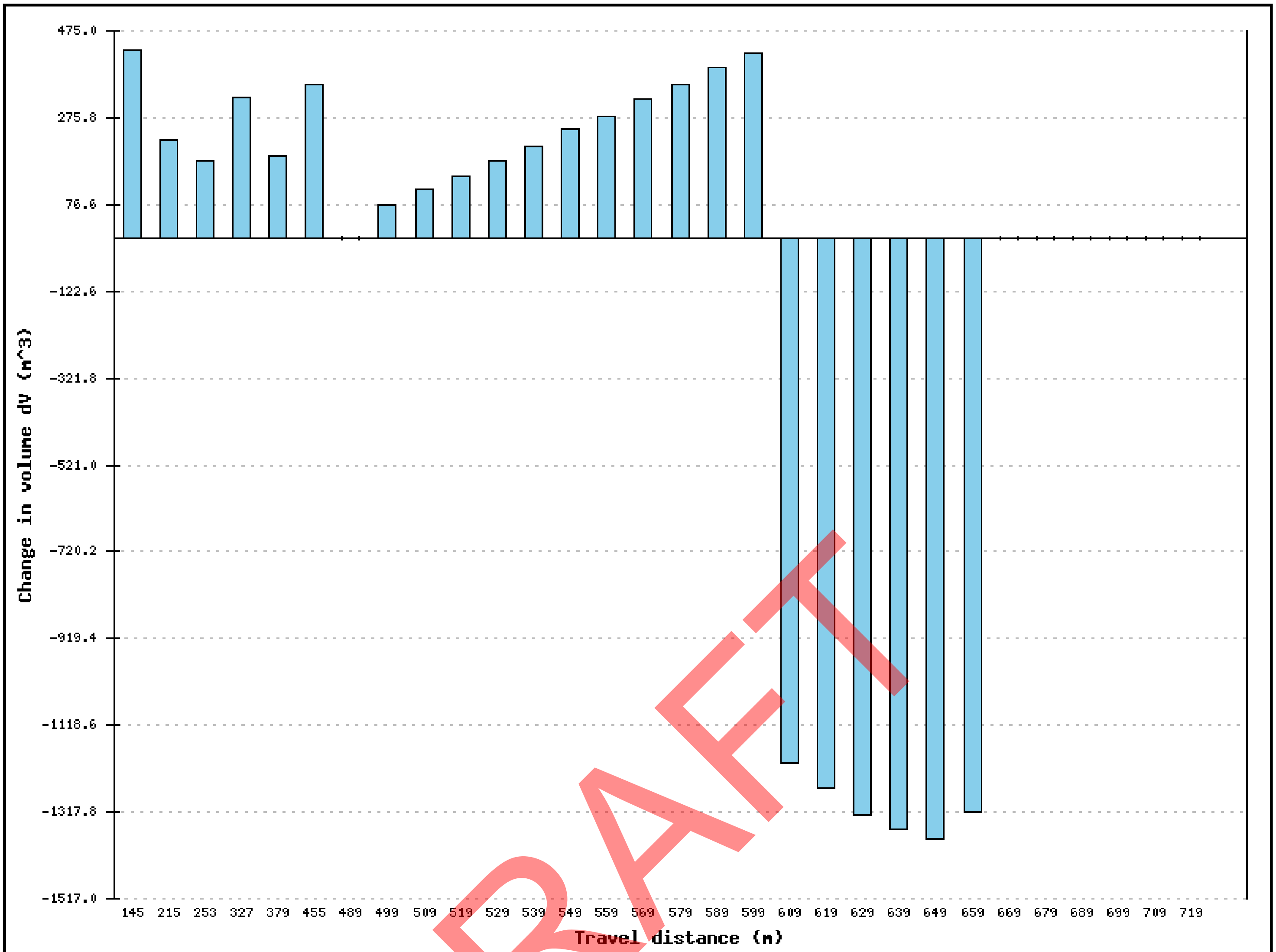
Reach	Travel distance (m)	dV (m^3)	V (m^3)
1	145.0	+431.5	4431.5
2	215.0	+224.5	4656.0
3	253.0	+176.5	4832.5
4	327.0	+321.5	5154.0
5	379.0	+189.5	5343.5
6	455.0	+351.5	5695.0
7	489.0	0.0	5695.0
8	499.0	+75.5	5770.0
9	509.0	+110.0	5880.0
10	519.0	+140.0	6020.5
11	529.0	+177.0	6197.0
12	539.0	+208.0	6405.0

13	549.0	+246.0	6651.0
14	559.0	+278.0	6928.5
15	569.0	+316.5	7245.0
16	579.0	+349.0	7594.0
17	589.0	+388.0	7982.0
18	599.0	+420.5	8402.5
19	609.0	-1221.0	7181.5
20	619.0	-1283.5	5898.5
21	629.0	-1350.5	4549.5
22	639.0	-1391.0	3160.0
23	649.0	-1427.0	1735.0
24	659.0	-1411.0	326.0
25	669.0	-1298.5	0.0
26	679.0	-	-
27	689.0	-	-
28	699.0	-	-
29	709.0	-	-
30	719.0	-	-

TRIBUTARY RESULTS - 3000 M^3 INITIAL VOLUME



TRIBUTARY RESULTS - 3000 M^3 INITIAL VOLUME

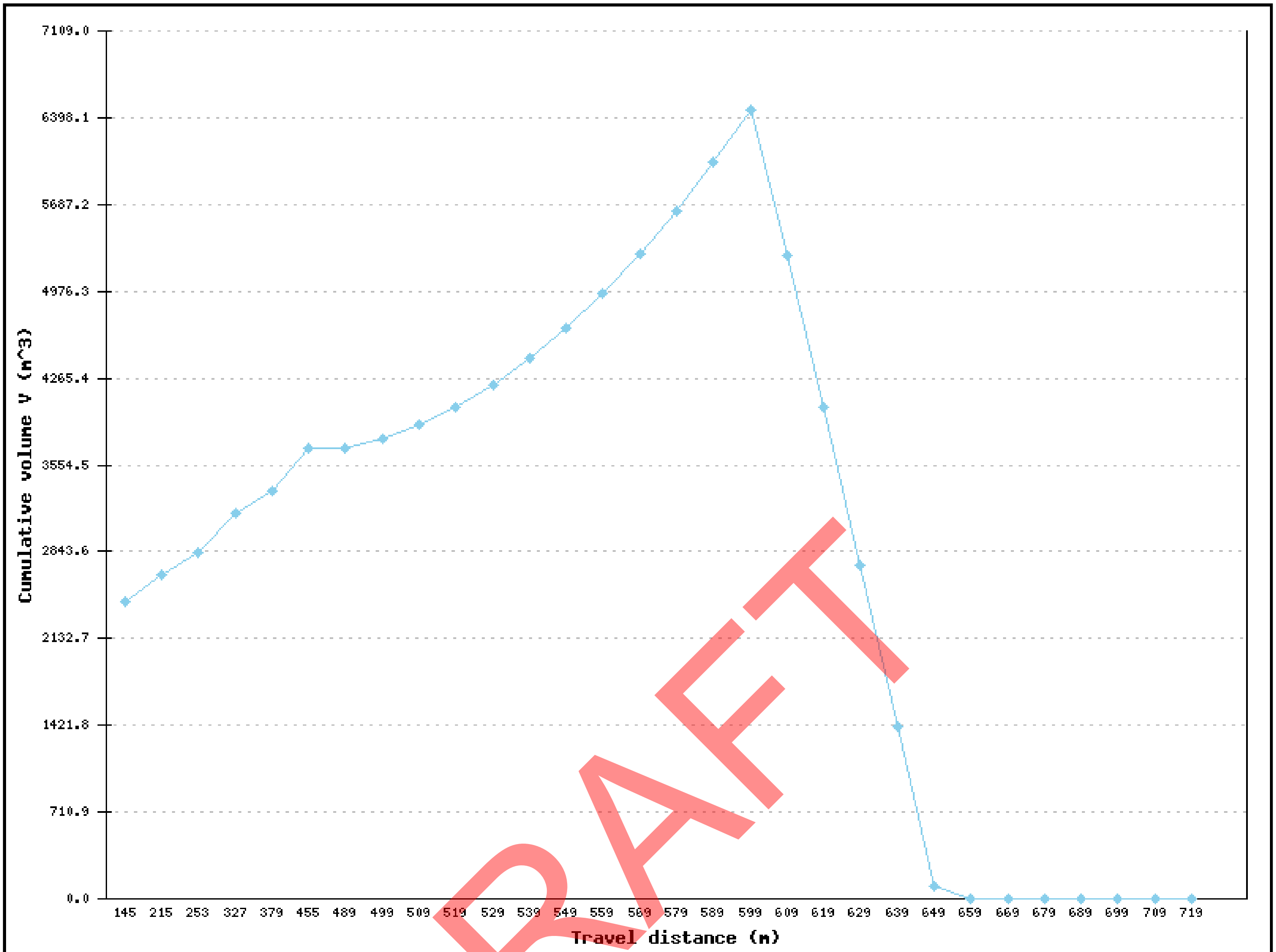


Reach	Travel distance (m)	dV (m^3)	V (m^3)
1	145.0	+431.5	3431.5
2	215.0	+224.5	3656.0
3	253.0	+176.5	3832.5
4	327.0	+321.5	4154.0
5	379.0	+189.5	4343.5
6	455.0	+351.5	4695.0
7	489.0	0.0	4695.0
8	499.0	+76.5	4771.0
9	509.0	+111.5	4882.5
10	519.0	+141.5	5024.0
11	529.0	+179.0	5203.0
12	539.0	+210.0	5413.5

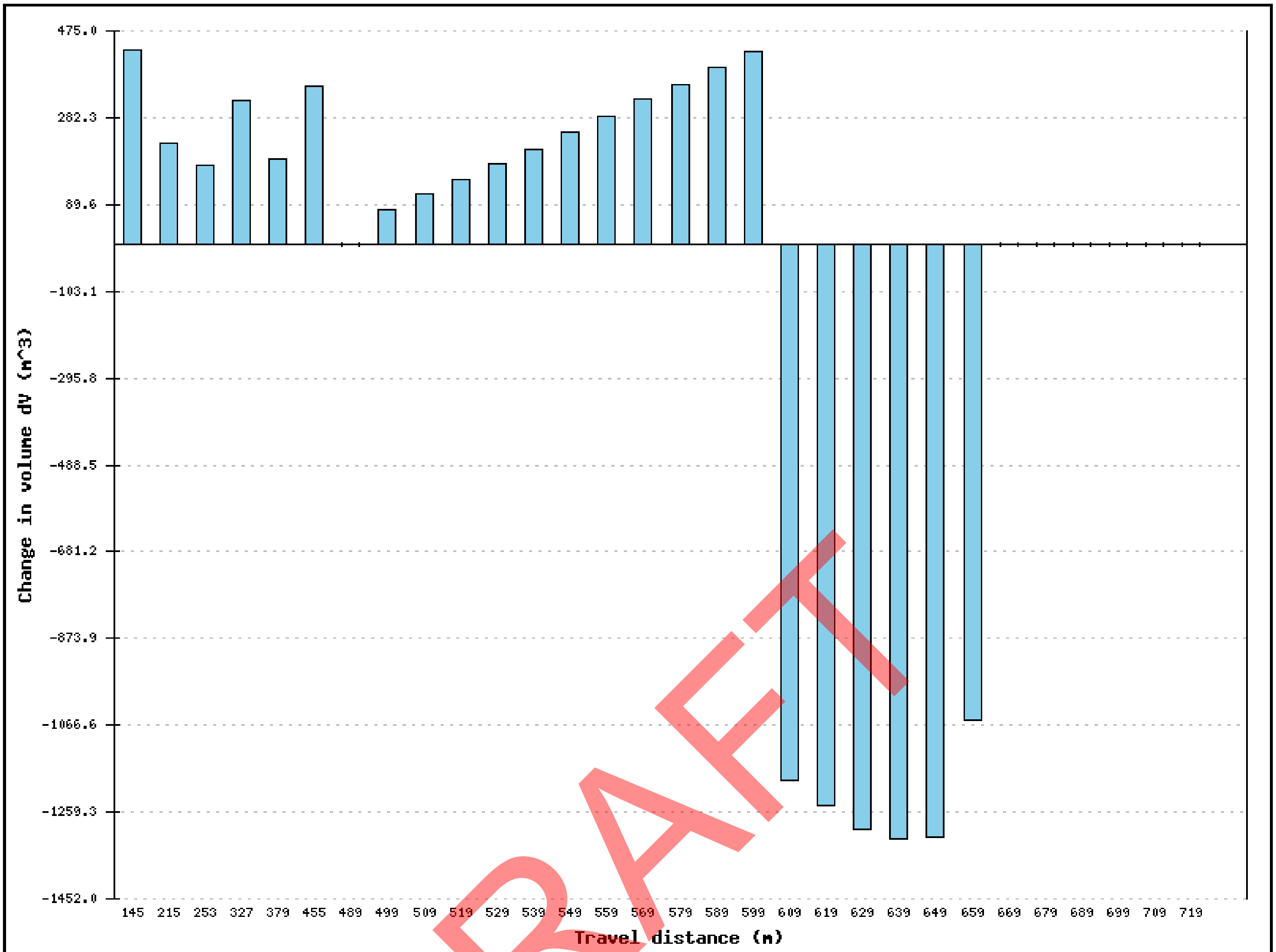
TRIBUTARY RESULTS - 3000 M^3 INITIAL VOLUME

13	549.0	+248.5	5662.0
14	559.0	+280.5	5942.5
15	569.0	+319.5	6262.0
16	579.0	+352.0	6614.0
17	589.0	+391.5	7005.5
18	599.0	+424.0	7429.5
19	609.0	-1206.0	6223.5
20	619.0	-1265.5	4959.5
21	629.0	-1326.0	3633.5
22	639.0	-1358.0	2275.5
23	649.0	-1379.5	896.5
24	659.0	-1320.0	0.0
25	669.0	-	-
26	679.0	-	-
27	689.0	-	-
28	699.0	-	-
29	709.0	-	-
30	719.0	-	-

TRIBUTARY RESULTS - 2000 M³ INITIAL VOLUME



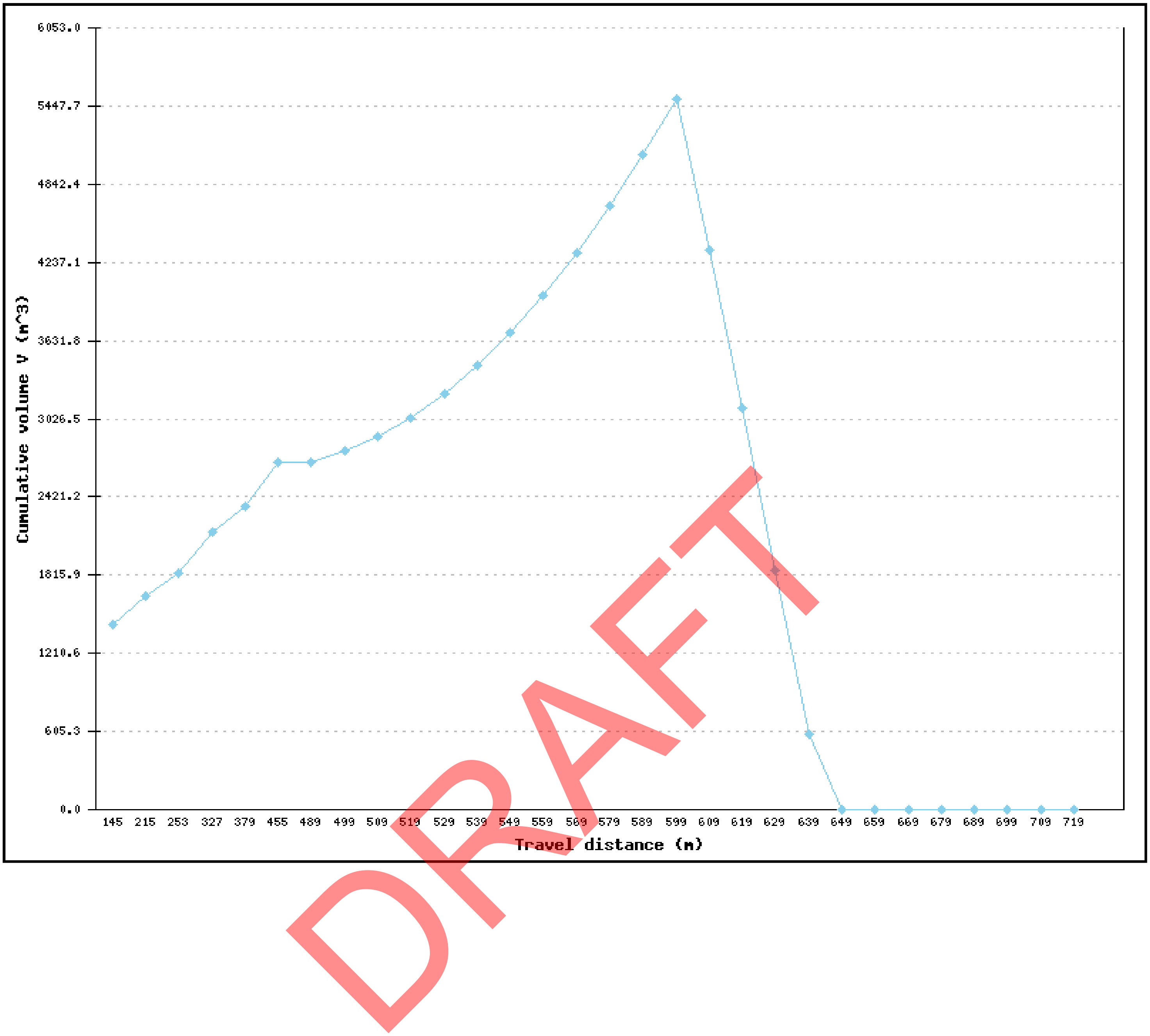
TRIBUTARY RESULTS - 2000 M³ INITIAL VOLUME



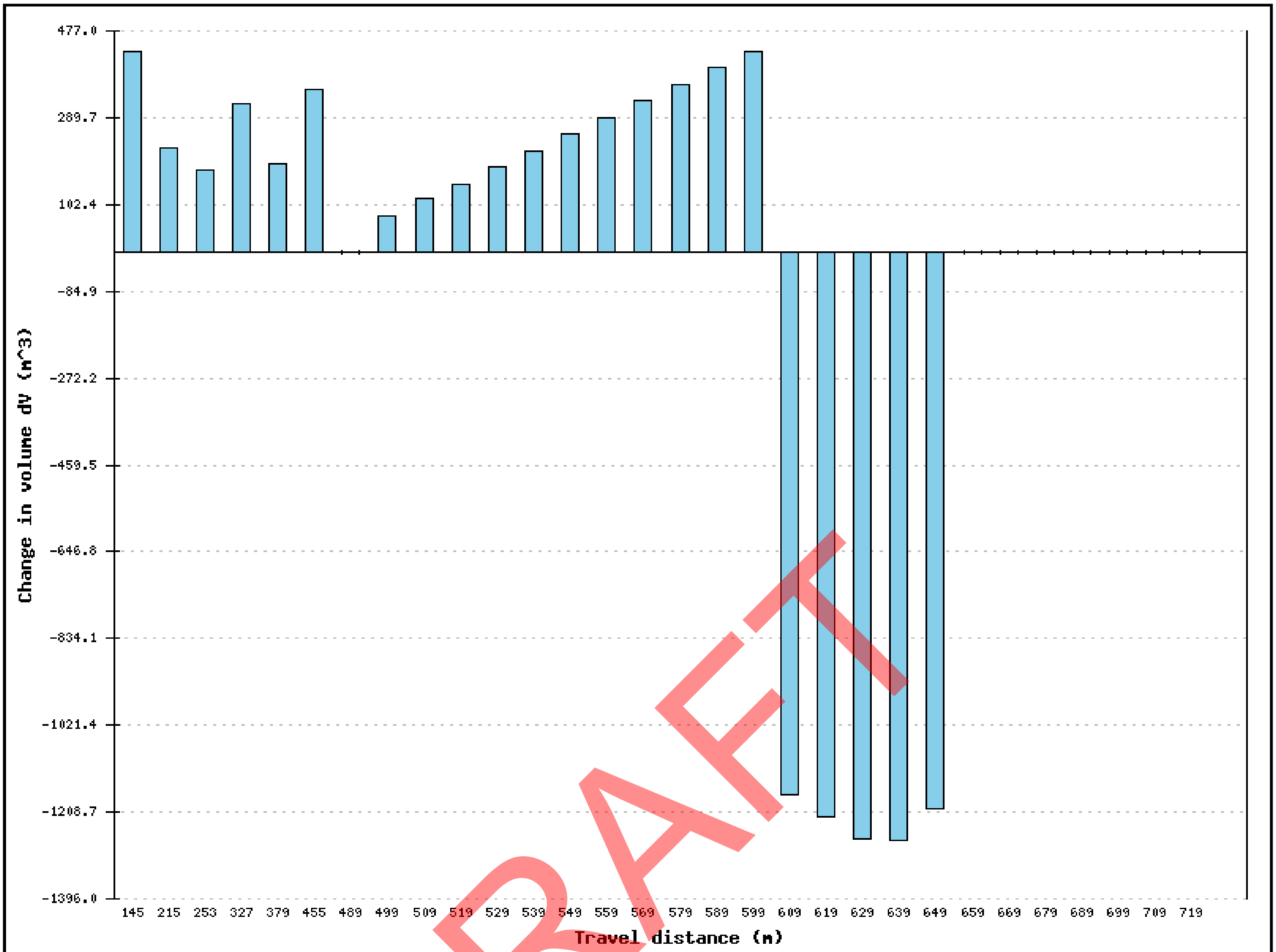
Reach	Travel distance (m)	dV (m^3)	V (m^3)
1	145.0	+431.5	2431.5
2	215.0	+224.5	2656.0
3	253.0	+176.5	2832.5
4	327.0	+321.5	3154.0
5	379.0	+189.5	3343.5
6	455.0	+351.5	3695.0
7	489.0	0.0	3695.0
8	499.0	+77.5	3772.0
9	509.0	+113.0	3885.5
10	519.0	+144.0	4029.0
11	529.0	+181.5	4210.5
12	539.0	+213.0	4423.5

13	549.0	+251.5	4675.5
14	559.0	+284.0	4959.5
15	569.0	+323.5	5282.5
16	579.0	+356.0	5638.5
17	589.0	+395.5	6034.0
18	599.0	+428.0	6462.0
19	609.0	-1191.0	5273.0
20	619.0	-1244.5	4029.5
21	629.0	-1299.5	2731.0
22	639.0	-1320.5	1412.0
23	649.0	-1314.0	98.0
24	659.0	-1056.0	0.0
25	669.0	-	-
26	679.0	-	-
27	689.0	-	-
28	699.0	-	-
29	709.0	-	-
30	719.0	-	-

TRIBUTARY RESULTS - 1000 M³ INITIAL VOLUME



TRIBUTARY RESULTS - 1000 M^3 INITIAL VOLUME



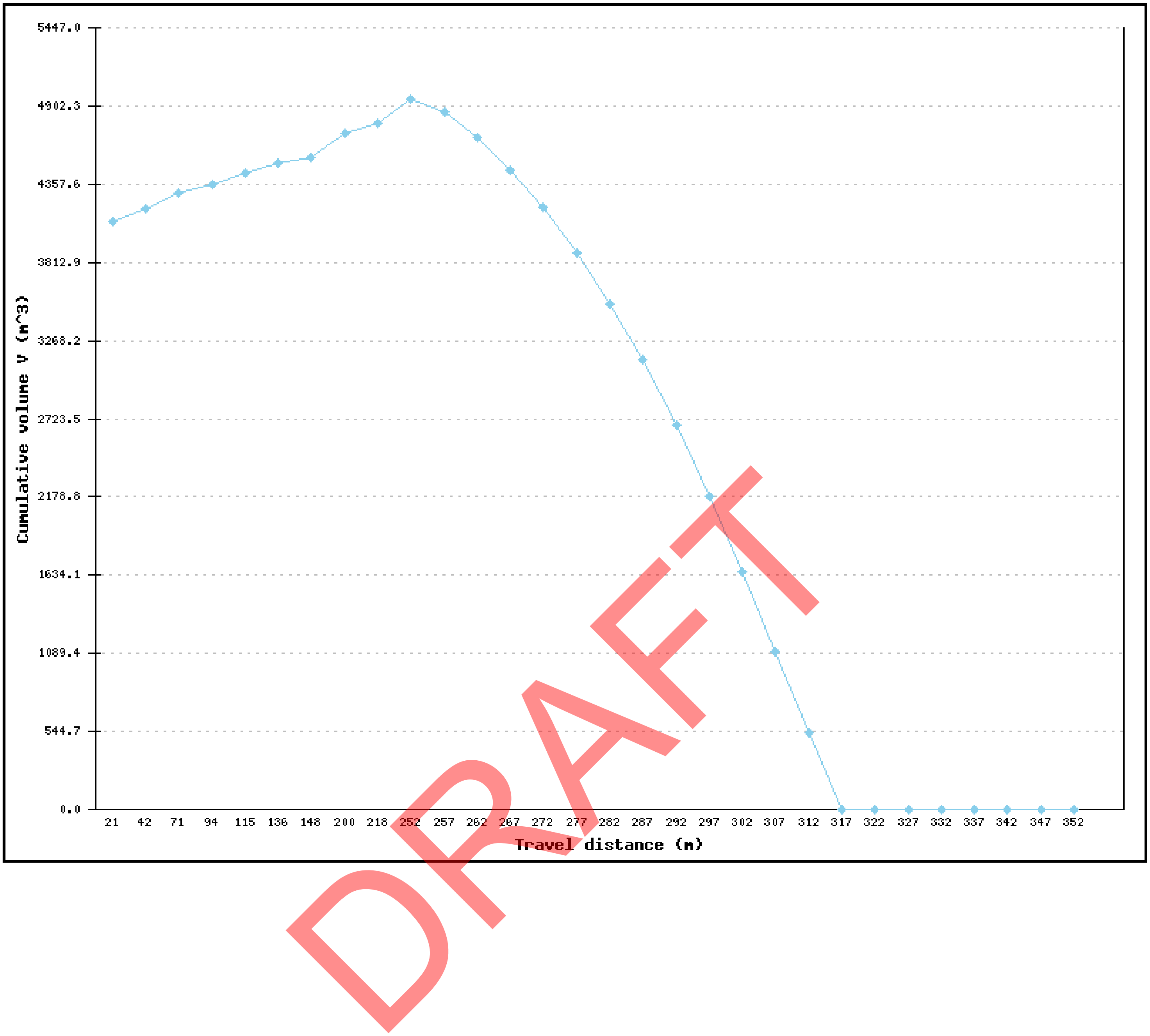
Reach	Travel distance (m)	dV (m^3)	V (m^3)
1	145.0	+431.5	1431.5
2	215.0	+224.5	1656.0
3	253.0	+176.5	1832.5
4	327.0	+321.5	2154.0
5	379.0	+189.5	2343.5
6	455.0	+351.5	2695.0
7	489.0	0.0	2695.0
8	499.0	+79.0	2774.0
9	509.0	+115.5	2889.0
10	519.0	+146.5	3035.5
11	529.0	+184.5	3220.5
12	539.0	+217.0	3437.0

13	549.0	+256.0	3693.0
14	559.0	+288.5	3981.0
15	569.0	+328.0	4309.0
16	579.0	+360.5	4669.5
17	589.0	+400.0	5069.5
18	599.0	+433.0	5502.5
19	609.0	-1170.0	4332.5
20	619.0	-1219.0	3113.5
21	629.0	-1267.0	1848.5
22	639.0	-1269.5	580.5
23	649.0	-1201.0	0.0
24	659.0	-	-
25	669.0	-	-
26	679.0	-	-
27	689.0	-	-
28	699.0	-	-
29	709.0	-	-
30	719.0	-	-

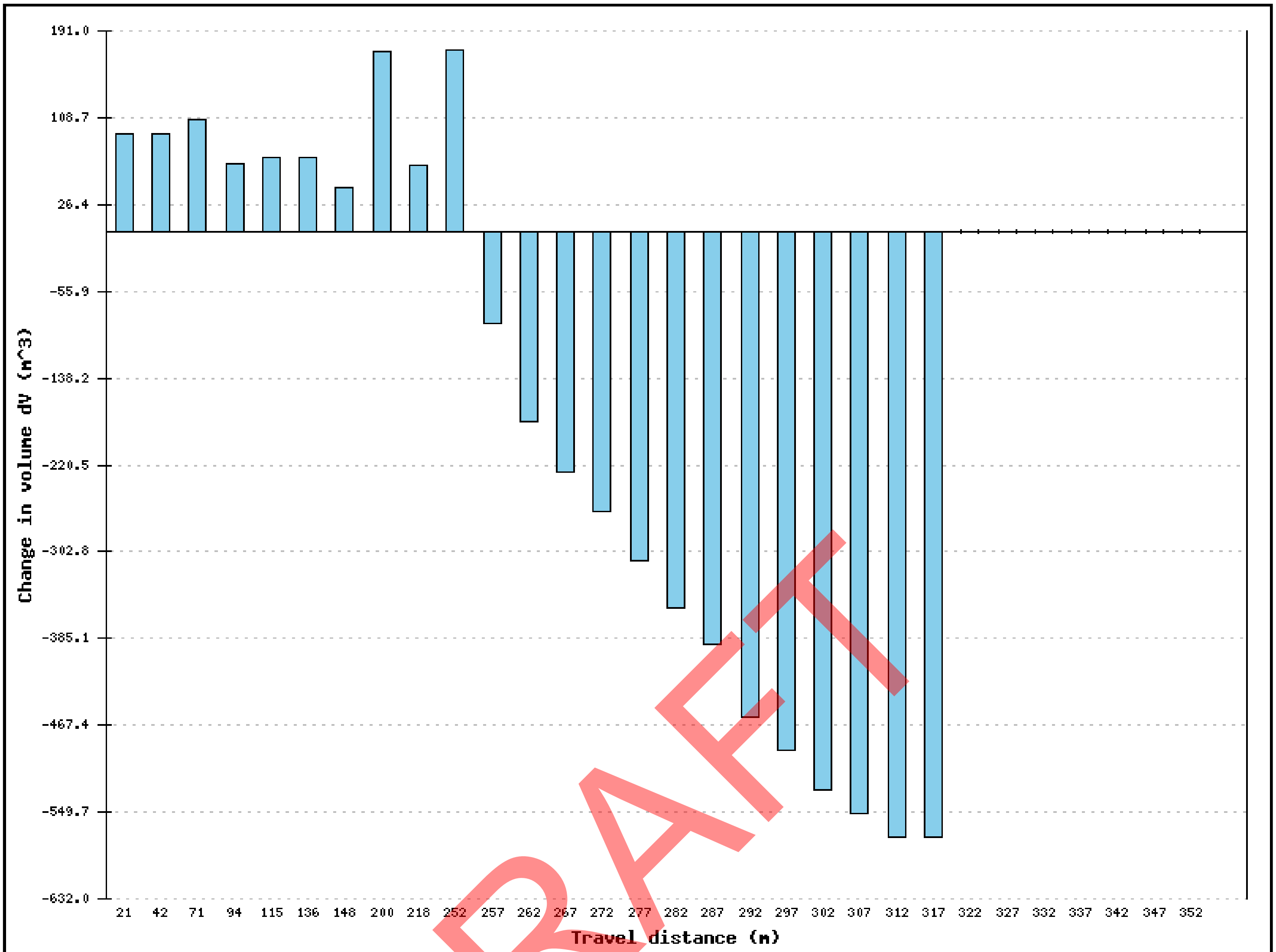
APPENDIX D

UBCDFLOW SMALL CHANNEL ANALYSIS RESULTS

SMALL CHANNEL RESULTS - 4000 M^3 INITIAL VOLUME



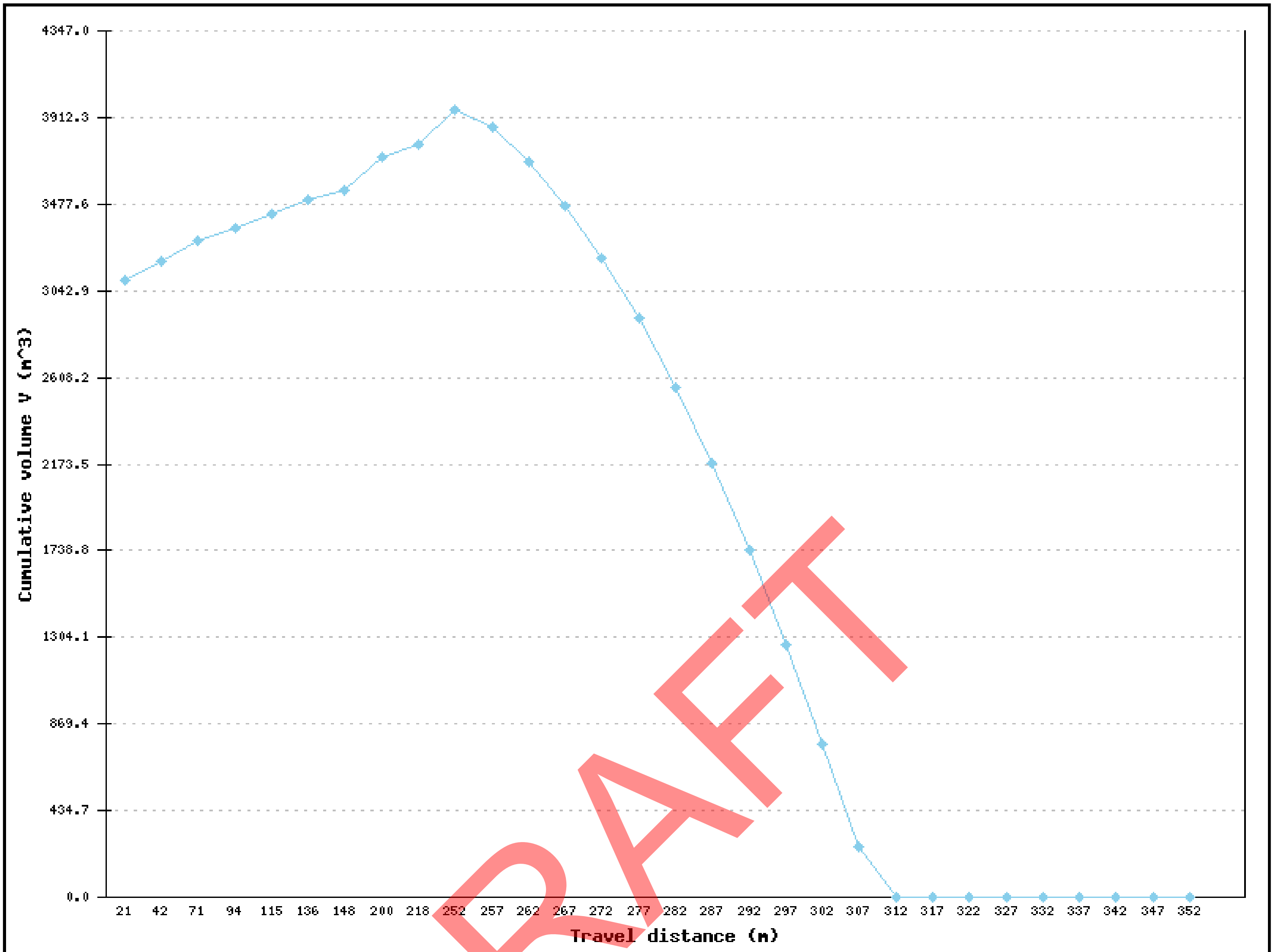
SMALL CHANNEL RESULTS - 4000 M³ INITIAL VOLUME



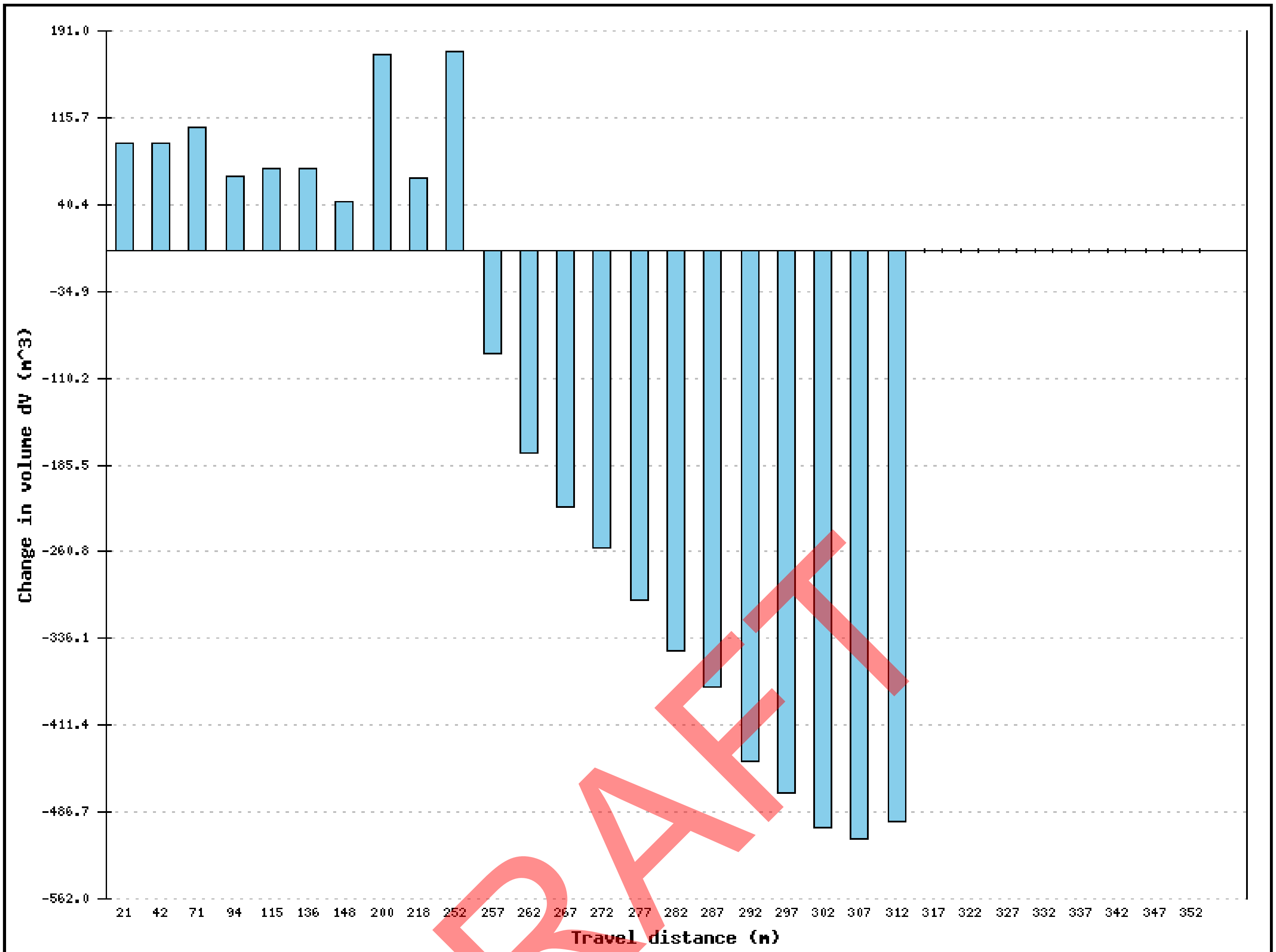
Reach	Travel distance (m)	dV (m^3)	V (m^3)
1	21.0	+94.0	4094.0
2	42.0	+94.0	4188.5
3	71.0	+107.0	4295.0
4	94.0	+64.5	4359.5
5	115.0	+71.0	4430.5
6	136.0	+71.0	4501.5
7	148.0	+42.5	4543.5
8	200.0	+171.0	4714.5
9	218.0	+64.0	4778.5
10	252.0	+173.0	4951.5
11	257.0	-89.0	4864.5
12	262.0	-179.0	4685.5

13	267.0	-229.0	4458.5
14	272.0	-265.5	4194.0
15	277.0	-313.0	3883.0
16	282.0	-357.5	3526.5
17	287.0	-391.5	3136.0
18	292.0	-461.0	2677.0
19	297.0	-492.5	2185.5
20	302.0	-531.0	1656.0
21	307.0	-552.5	1104.5
22	312.0	-574.0	531.0
23	317.0	-574.0	0.0
24	322.0	-	-
25	327.0	-	-
26	332.0	-	-
27	337.0	-	-
28	342.0	-	-
29	347.0	-	-
30	352.0	-	-

SMALL CHANNEL RESULTS - 3000 M^3 INITIAL VOLUME



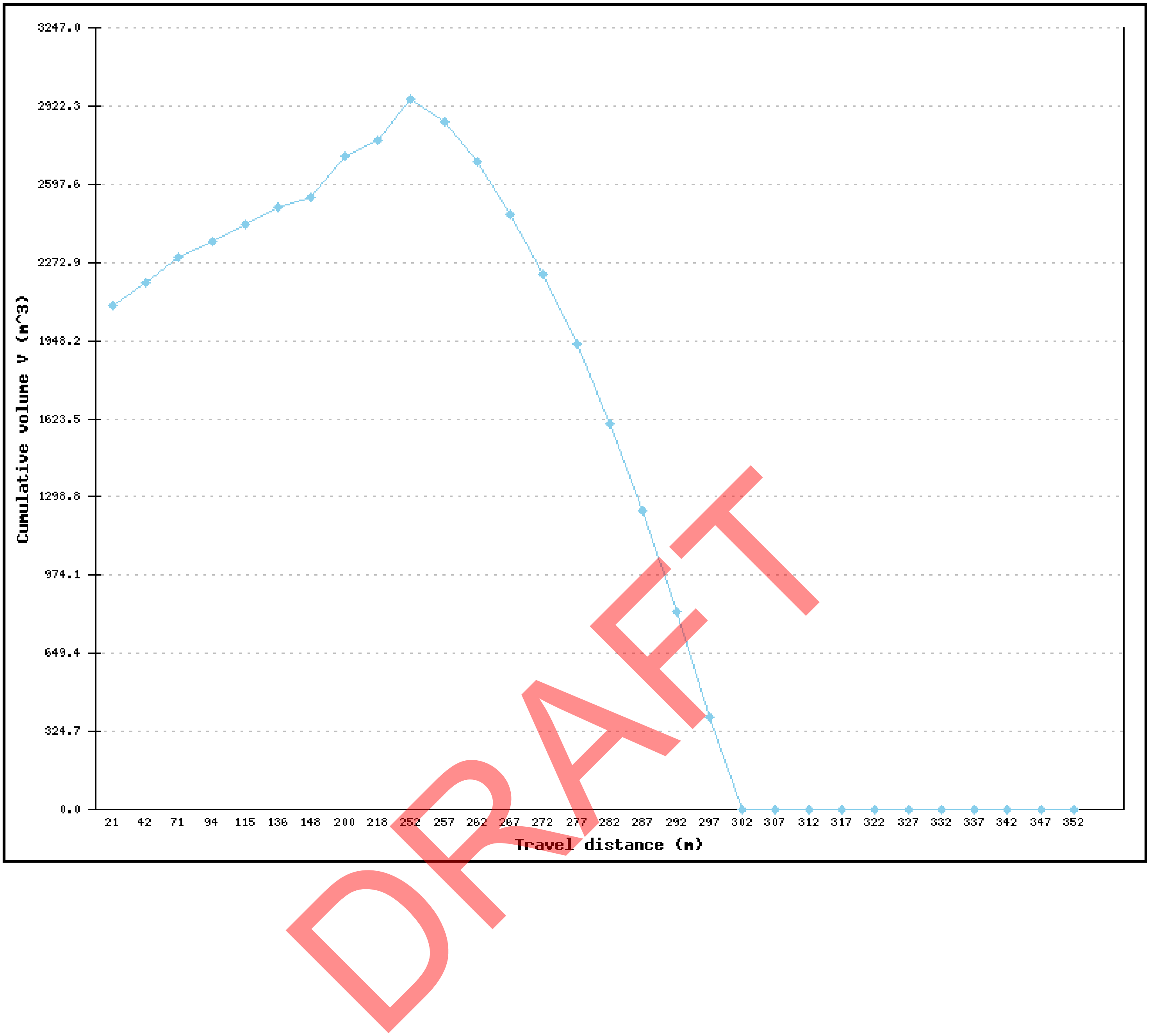
SMALL CHANNEL RESULTS - 3000 M^3 INITIAL VOLUME



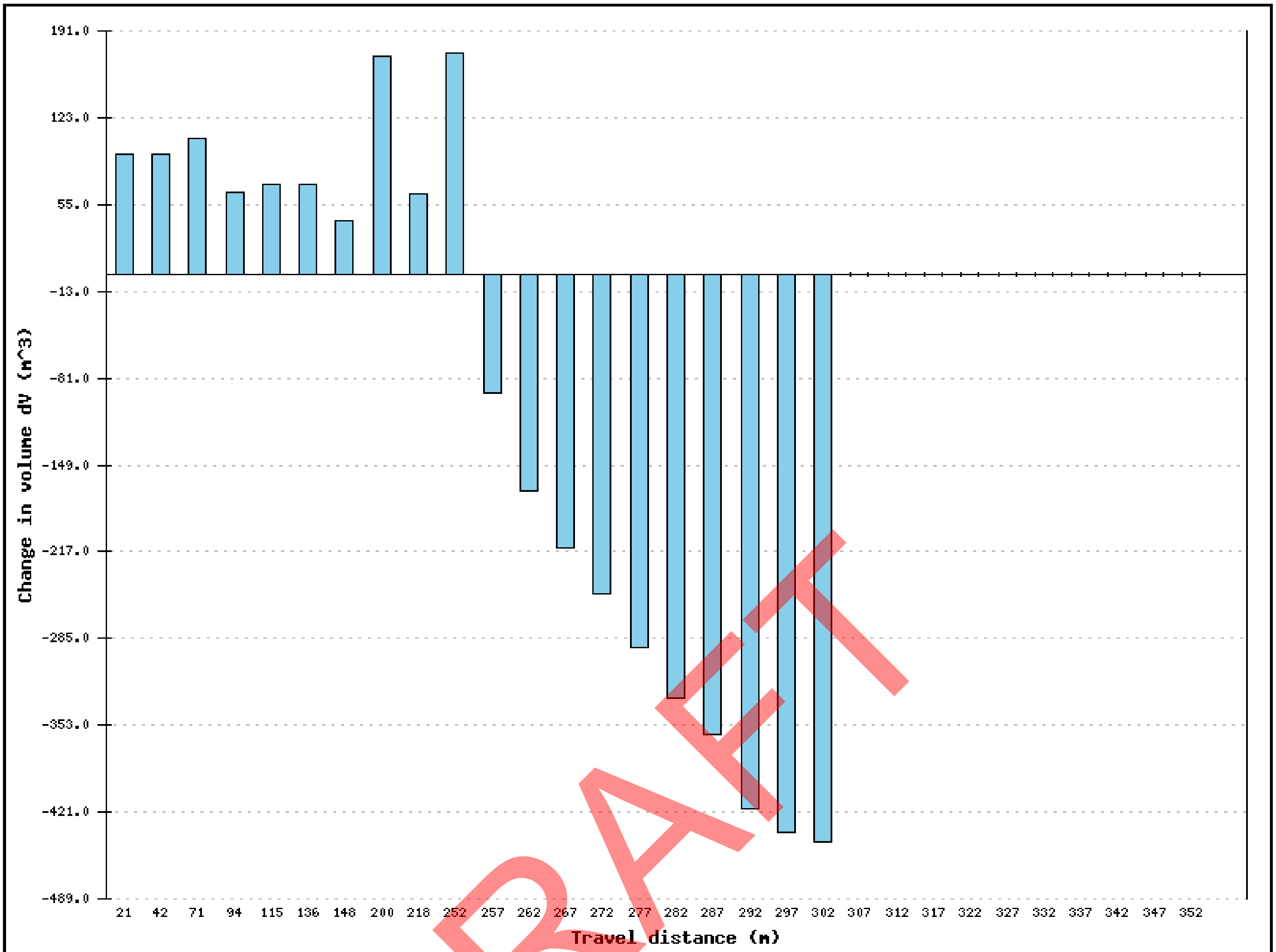
Reach	Travel distance (m)	dV (m^3)	V (m^3)
1	21.0	+94.0	3094.0
2	42.0	+94.0	3188.5
3	71.0	+107.0	3295.0
4	94.0	+64.5	3359.5
5	115.0	+71.0	3430.5
6	136.0	+71.0	3501.5
7	148.0	+42.5	3543.5
8	200.0	+171.0	3714.5
9	218.0	+64.0	3778.5
10	252.0	+173.0	3951.5
11	257.0	-90.5	3862.0
12	262.0	-175.5	3687.5

13	267.0	-222.5	3466.0
14	272.0	-260.0	3208.0
15	277.0	-303.0	2905.0
16	282.0	-348.0	2559.0
17	287.0	-380.0	2181.0
18	292.0	-443.5	1738.5
19	297.0	-471.5	1267.5
20	302.0	-501.0	767.0
21	307.0	-511.5	256.5
22	312.0	-497.0	0.0
23	317.0	-	-
24	322.0	-	-
25	327.0	-	-
26	332.0	-	-
27	337.0	-	-
28	342.0	-	-
29	347.0	-	-
30	352.0	-	-

SMALL CHANNEL RESULTS - 2000 M³ INITIAL VOLUME



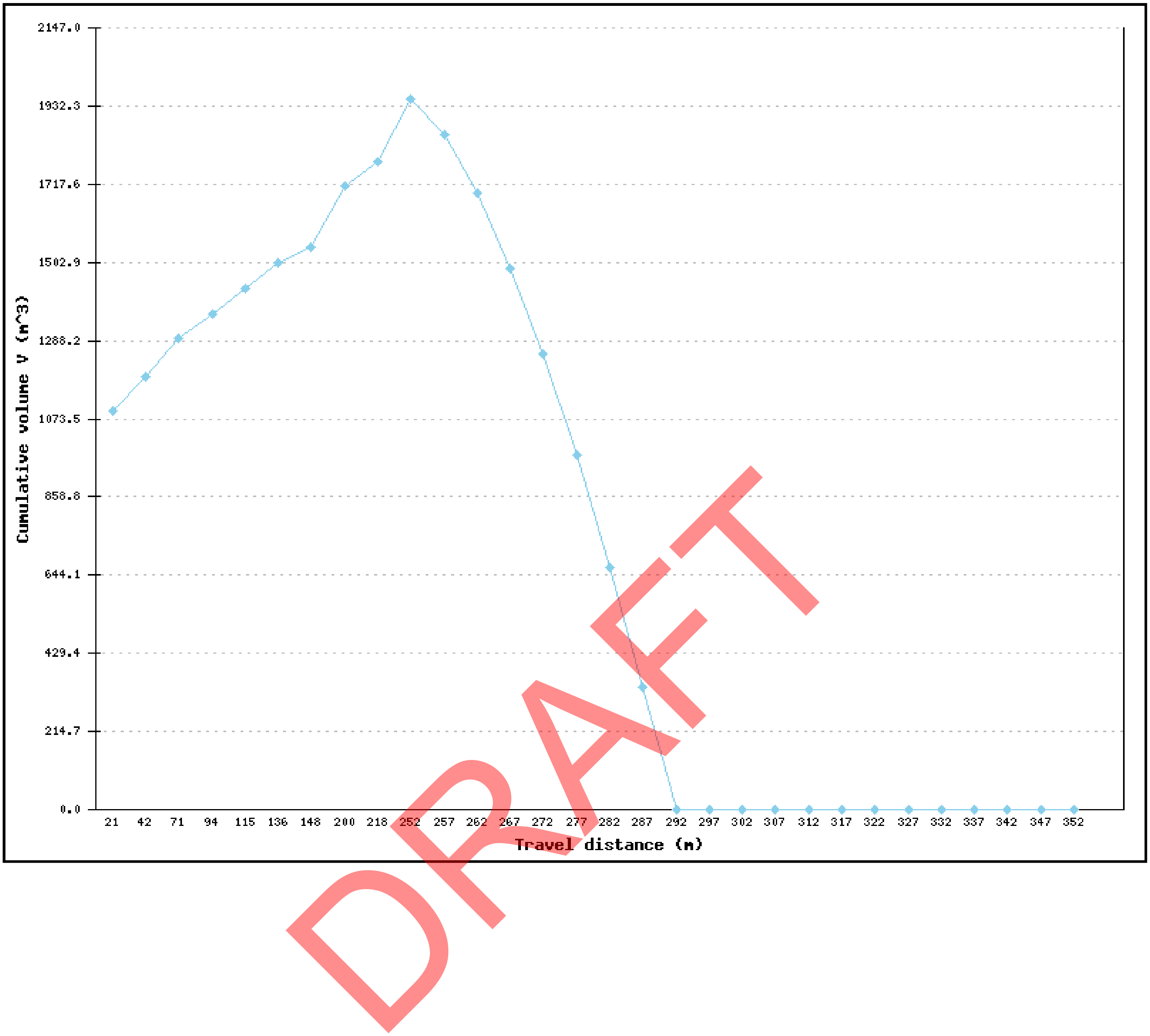
SMALL CHANNEL RESULTS - 2000 M^3 INITIAL VOLUME



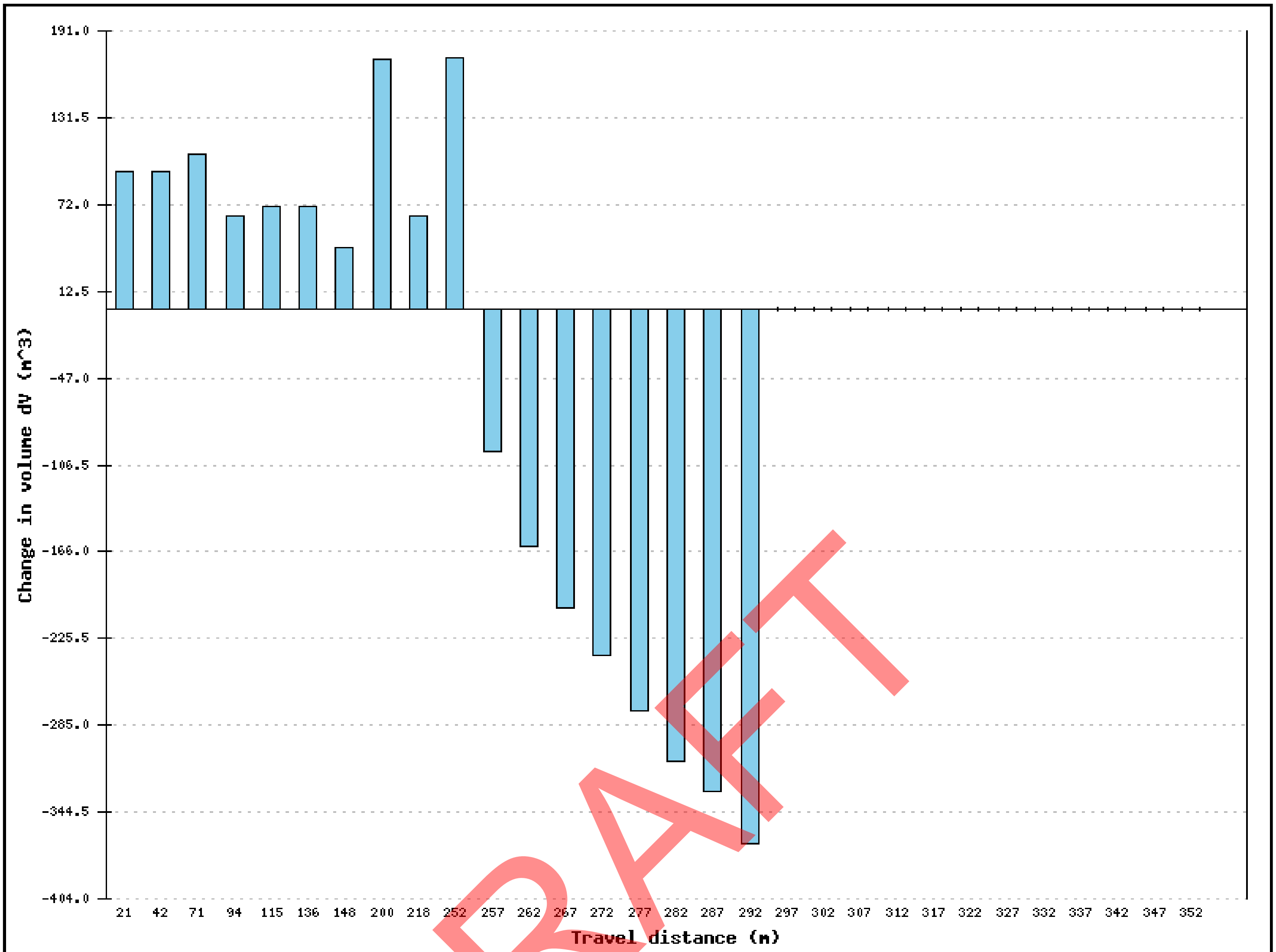
Reach	Travel distance (m)	dV (m^3)	V (m^3)
1	21.0	+94.0	2094.0
2	42.0	+94.0	2188.5
3	71.0	+107.0	2295.0
4	94.0	+64.5	2359.5
5	115.0	+71.0	2430.5
6	136.0	+71.0	2501.5
7	148.0	+42.5	2543.5
8	200.0	+171.0	2714.5
9	218.0	+64.0	2778.5
10	252.0	+173.0	2951.5
11	257.0	-93.5	2859.0
12	262.0	-170.5	2689.5

13	267.0	-215.5	2474.5
14	272.0	-250.5	2225.5
15	277.0	-292.0	1933.5
16	282.0	-334.0	1601.5
17	287.0	-361.5	1241.0
18	292.0	-420.0	822.5
19	297.0	-437.5	386.5
20	302.0	-446.0	0.0
21	307.0	-	-
22	312.0	-	-
23	317.0	-	-
24	322.0	-	-
25	327.0	-	-
26	332.0	-	-
27	337.0	-	-
28	342.0	-	-
29	347.0	-	-
30	352.0	-	-

SMALL CHANNEL RESULTS - 1000 M³ INITIAL VOLUME



SMALL CHANNEL RESULTS - 1000 M³ INITIAL VOLUME



Reach	Travel distance (m)	dV (m^3)	V (m^3)
1	21.0	+94.0	1094.0
2	42.0	+94.0	1188.5
3	71.0	+107.0	1295.0
4	94.0	+64.5	1359.5
5	115.0	+71.0	1430.5
6	136.0	+71.0	1501.5
7	148.0	+42.5	1543.5
8	200.0	+171.0	1714.5
9	218.0	+64.0	1778.5
10	252.0	+173.0	1951.5
11	257.0	-98.5	1854.0
12	262.0	-163.5	1692.0

13	267.0	-205.0	1487.0
14	272.0	-237.0	1250.0
15	277.0	-276.5	975.0
16	282.0	-310.0	665.0
17	287.0	-330.0	335.0
18	292.0	-367.5	0.0
19	297.0	-	-
20	302.0	-	-
21	307.0	-	-
22	312.0	-	-
23	317.0	-	-
24	322.0	-	-
25	327.0	-	-
26	332.0	-	-
27	337.0	-	-
28	342.0	-	-
29	347.0	-	-
30	352.0	-	-