Paleofloods in the Upper Colorado River, Moab, Utah

Updated peak discharges based on HEC-RAS hydraulic Analysis

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Paleoflood magnitudes based on results of hydraulic analysis using HEC-RAS (Hydrologic Engineering Center, 1997)

The analysis took place during April- October 2006 with the help of Rafi Halevi – hydrologic engineer.

The Observed Water Surface (OWS) was surveyed during the 25-26.5.2005 where measured peak discharge was 1140 m^3s^{-1}. This discharge calibrates the HEC-RAS water surface profiles computation. The channel bed was reconstructed by adjusting computed hydraulic water surface profiles of 1140 m^3s^{-1} to the surveyed water level – the OWS. Since the geometry of the channel at the site is unknown, several under-water channel cross section geometries were examined. The best fit was achieved for two options: (1) A channel 9m deep under water level with *n* manning of 0.04. (2) A channel 8 m deep using *n* manning of 0.035. The right and left under-water banks were reconstructed according to the geometry of the left and right banks above water level. Water surface profiles were iterated at discharges of 1000-15,000 m^3s^{-1} at both channel geometries. The differences between the 2 options were between 1% for the low magnitude floods and up to 9% for the largest floods.

The best fit to the highest paleoflood water marks is between 8000 and 9000 m^3s^{-1} (Figure 1). The elevations and associated peak discharges of the top of the pits at the BLM-TO site (cross section 9) are shown in figure 2. The rating curve for cross section 9 produced by the program provides peak discharges to each flood deposit (figure 3) provide magnitudes to each flood deposit according to its elevation above the OWS and above SWL (Table 1).

Table 1: Paleofloods at the BLM-TO site, minimal peak stages and HEC-RAS calculations of peak discharges

Location	Pits no.	No. of floods	Stages above SWL* (m)	Peak discharge (m^3 s^{-1})
Lower depression	12-14	12	4.2-6.3	1600 - 2300
Lower depression	10-11	8	6.5-8.5	2500 - 3500
Lower depression	9	5	8.5-9.7	<4300
Upper depression	3-8	9	10.0-12.2	4500 - 6000
Upper depression	2	4	12.4-13.5	6000 - 7000

Upper depression	1	2	14.8-15.1	>8,300
Total	1-14	40	4.2-15.1	1600 - >8300

* SWL- Summer water level, 14.6.2005

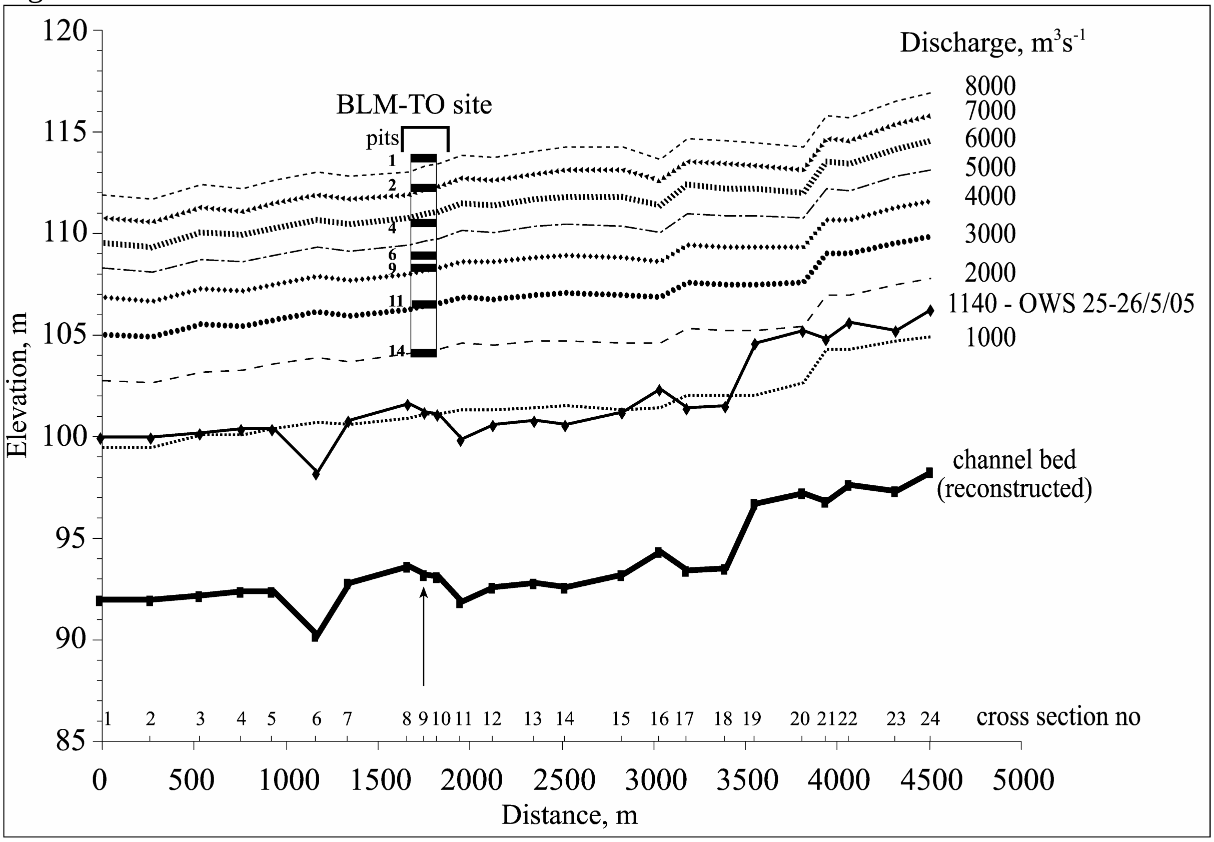
Flood no. 4 in pit 11 which was correlated to flood no. 8 in pit no. 10 was OSL dated to 170±40. Its minimal age than is about 130 years. The peak discharge of this flood was recalculated to about 3500 m^3s^{-1} and may be correlated to the 1884 flood (3540 m^3s^{-1}). The

Magnitude of paleofloods

The reconstructed paleoflood record include about 40 paleofloods during the last 2140±220 years. The preliminary slope-area calculations from the report to the MTA fund indicated that the estimated peak discharge for floods associated with the deposits range between >2000 and >10,000 m^3s^{-1} (15 m above summer water level and 12.5 m above the OWS). The HEC-RAS results are 15-20% lower and range from >1600 m^3s^{-1} up to >8300 m^3s^{-1} (293,000 cfs), which should be related as minimum and almost equal to the PMF peak discharge of the USGS for the Moab Valley. Most probably, 2 floods during the last 2140±220 years exceeded this value. About 20 floods during the last 2140±220 years exceeded 3400 m^3s^{-1} (120,000 cfs - the 500-year flood calculated by the USGS) and over 25 floods exceeded 2765 m^3s^{-1} (97,600 cfs - the 100-year flood). This shows that the large floods are more frequent then estimated by the USGS and that the maximum estimated peak discharge (PMF) was almost, but not, exceeded. Similarly it does not exceed the envelope curves of the Colorado River (Enzel et al., 1993). The geometry of all the cross sections are shown in figures 4a,b,c.

These results suggest that a further and more accurate paleoflood study is definitely needed in the future in order to improve the risk assessment for Moab and Moab Valley.

Fig. 1



Elevation, m
Distance, m
Discharge, m3s-1
8000
7000
6000
5000
4000
3000
2000
1140 - OWS 25-26/5/05
1000
channel bed
(reconstructed)
BLM-TO site
pits
cross section no

Fig. 2

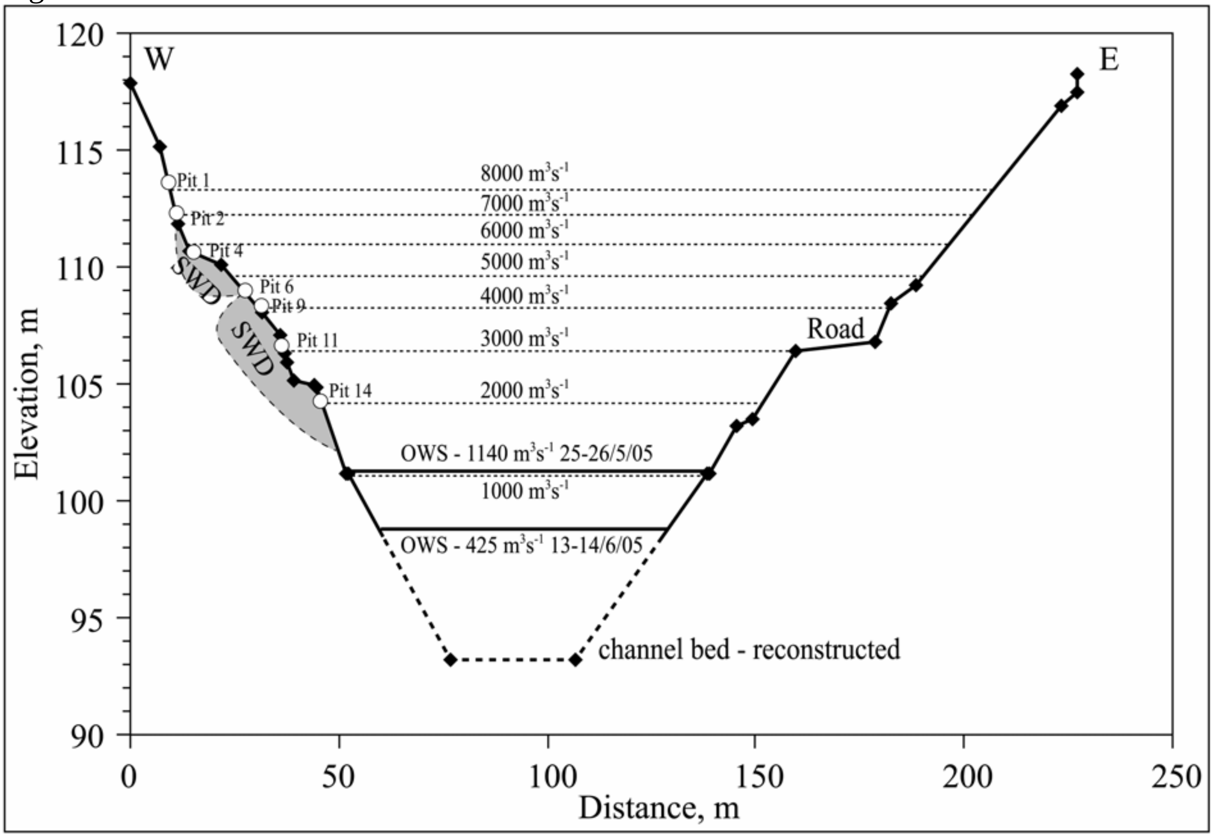

W
E
Pit 1
Pit 2
Pit 4
Pit 6
Pit 9
Pit 11
Pit 14
SWD
SWD
8000 m3s-1
7000 m3s-1
6000 m3s-1
5000 m3s-1
4000 m3s-1
3000 m3s-1
2000 m3s-1
OWS - 1140 m3s-1 25-26/5/05
1000 m3s-1
OWS - 425 m3s-1 13-14/6/05
channel bed - reconstructed
Road
Elevation, m
Distance, m
120
115
110
105
100
95
90
0
50
100
150
200
250

Fig. 3

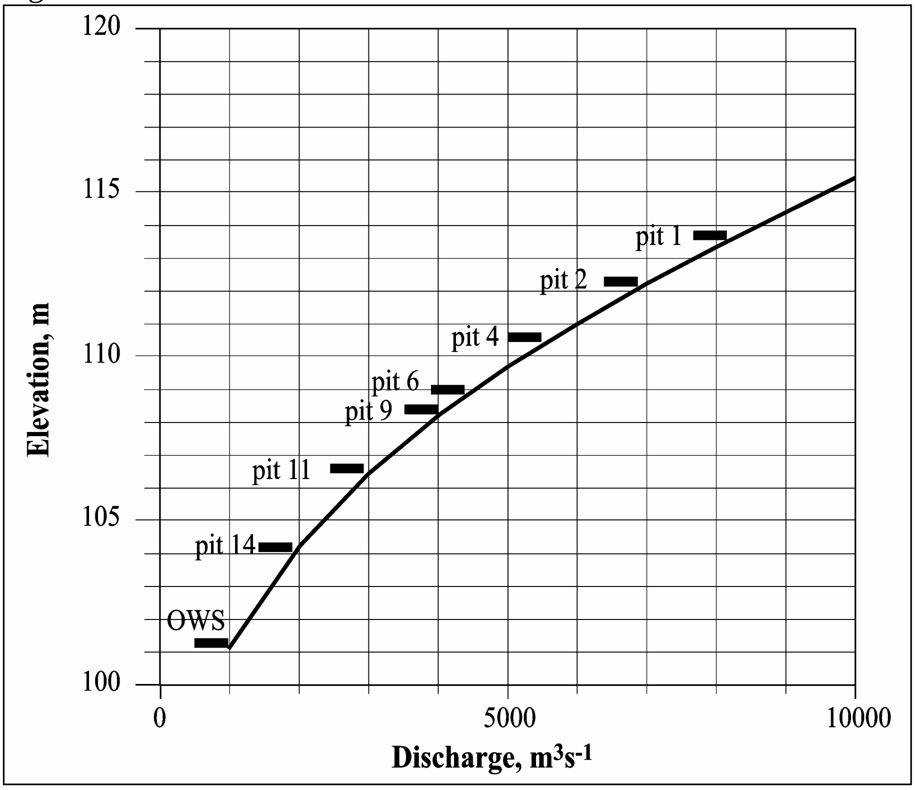

120
115
110
105
100
Elevation, m
0
5000
10000
Discharge, m3s-1
pit 1
pit 2
pit 4
pit 6
pit 9
pit 11
pit 14
OWS

Fig. 4a

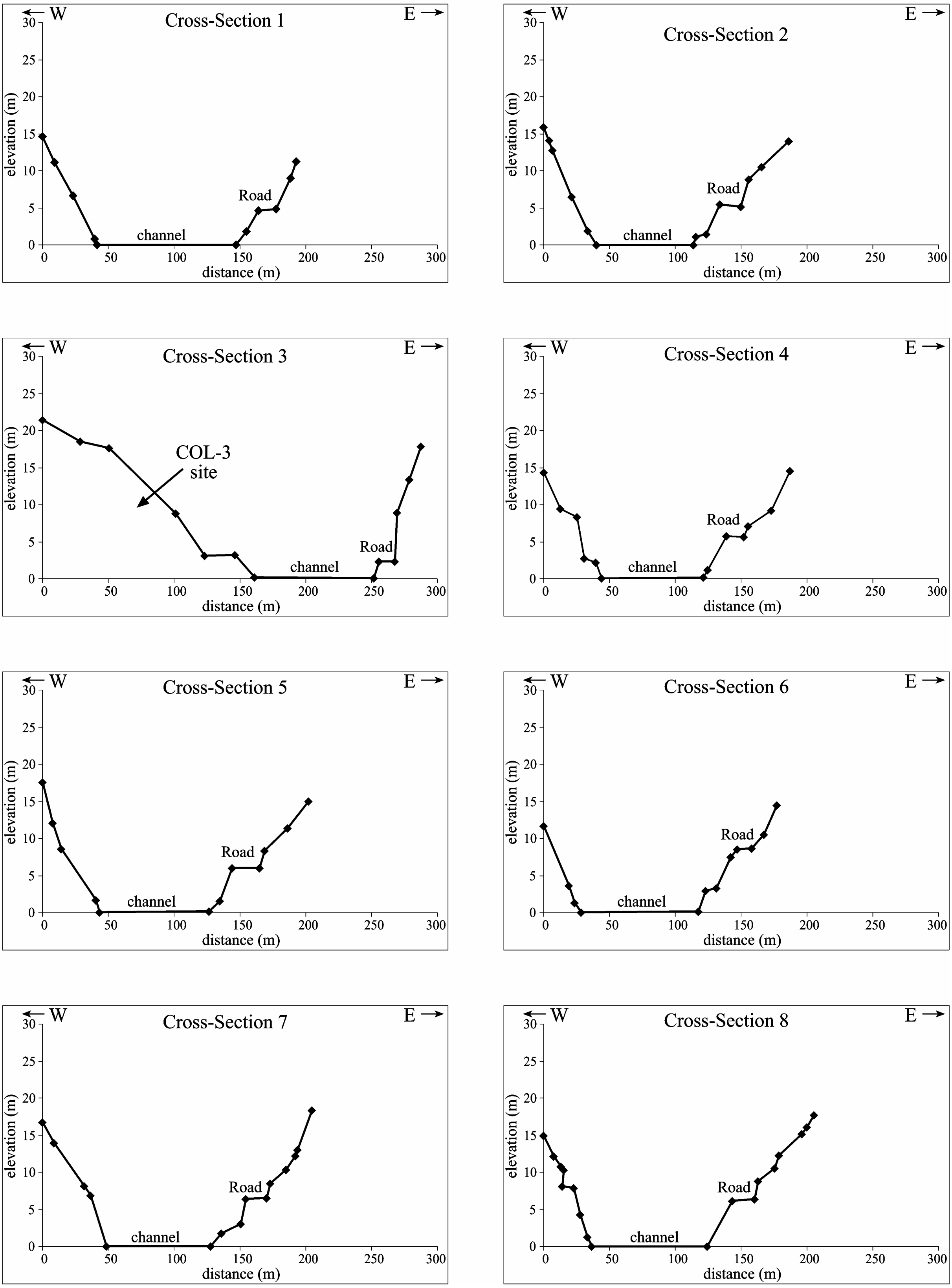

W
E
Cross-Section 1
Road
channel
Cross-Section 2
Road
channel
Cross-Section 3
COL-3
site
Road
channel
Cross-Section 4
Road
channel
Cross-Section 5
Road
channel
Cross-Section 6
Road
channel
Cross-Section 7
Road
channel
Cross-Section 8
Road
channel
elevation (m)
distance (m)
0
5
10
15
20
25
30
0
50
100
150
200
250
300

Fig. 4b

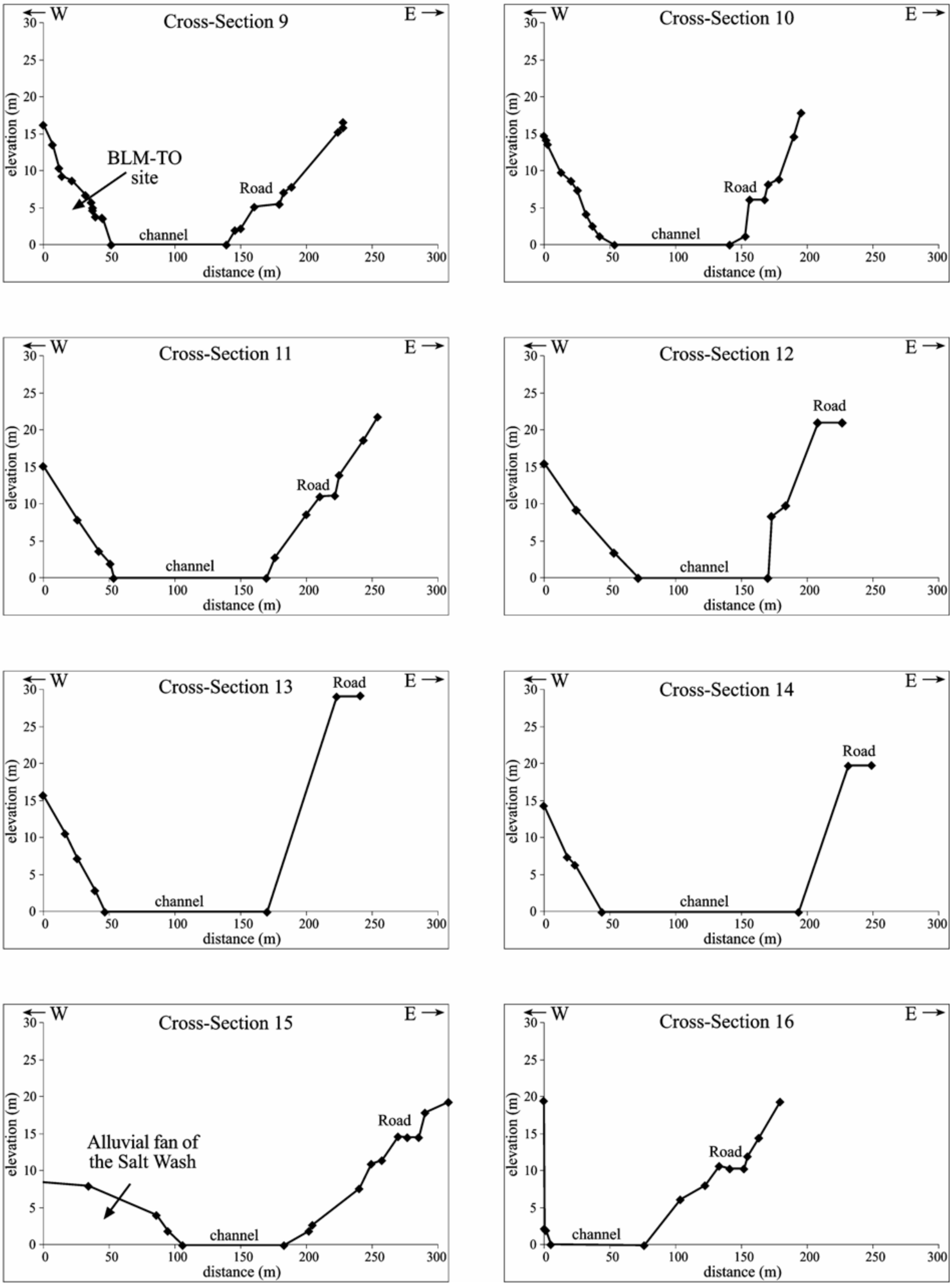
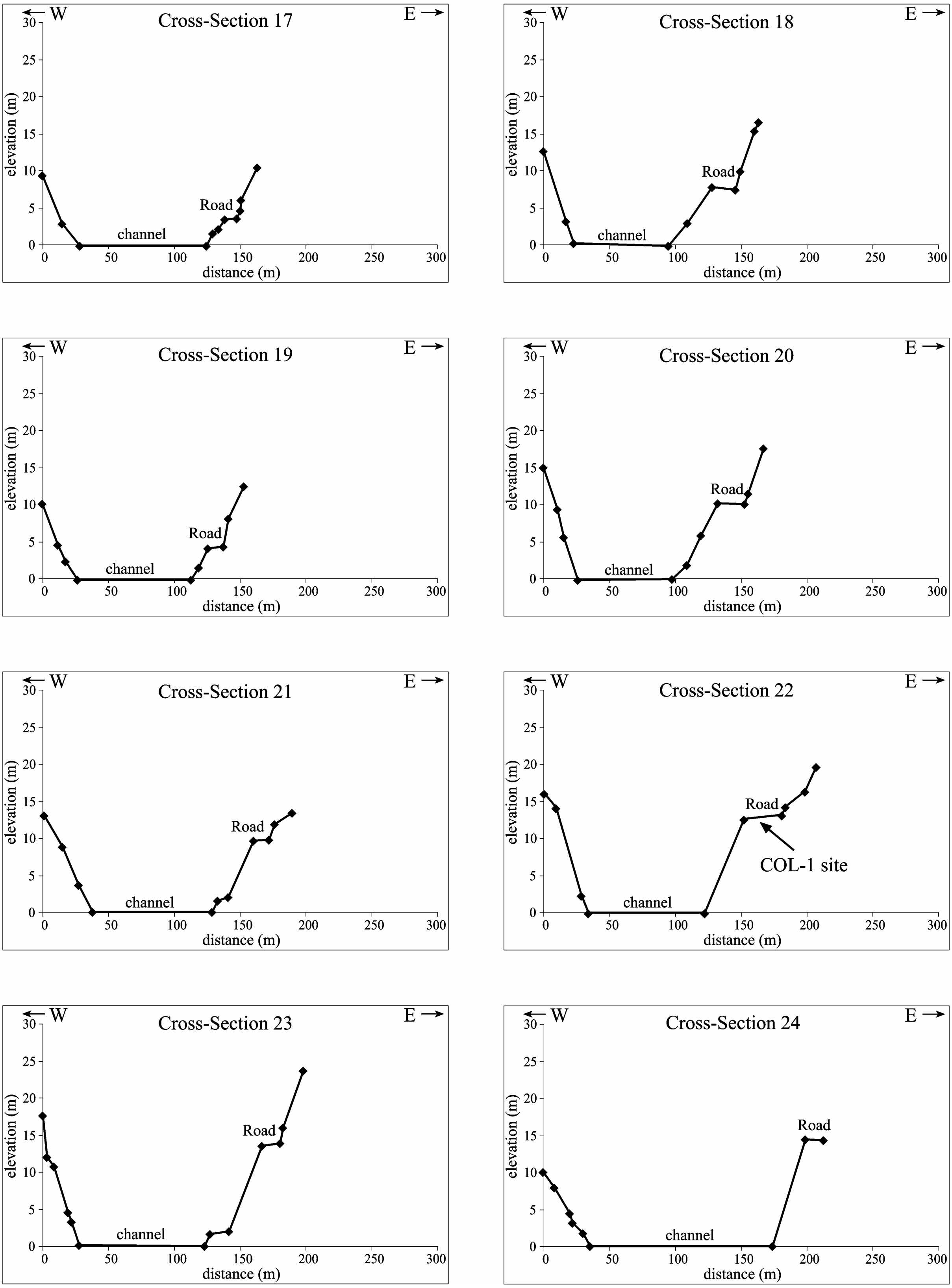

Cross-Section 9
W
E
elevation (m)
distance (m)
BLM-TO site
Road
channel
Cross-Section 10
W
E
elevation (m)
distance (m)
Road
channel
Cross-Section 11
W
E
elevation (m)
distance (m)
Road
channel
Cross-Section 12
W
E
elevation (m)
distance (m)
Road
channel
Cross-Section 13
W
E
elevation (m)
distance (m)
Road
channel
Cross-Section 14
W
E
elevation (m)
distance (m)
Road
channel
Cross-Section 15
W
E
elevation (m)
distance (m)
Alluvial fan of the Salt Wash
Road
channel
Cross-Section 16
W
E
elevation (m)
distance (m)
Road
channel

Fig. 4c



Cross-Section 17
Cross-Section 18
Cross-Section 19
Cross-Section 20
Cross-Section 21
Cross-Section 22
Cross-Section 23
Cross-Section 24
W
E
elevation (m)
distance (m)
channel
Road
COL-1 site