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A Field Guide to the Identification of the Ordinary High Water Mark (OHWM) in the Arid West Region of the Western United States

A Delineation Manual

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Robert W. Lichvar and Shawn M. McColley

Cold Regions Research and Engineering Laboratory
U.S. Army Engineer Research and Development Center
72 Lyme Road
Hanover, NH 03755-1290

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annual and interannual basis for any given locality, but generally, the season of peak precipitation shifts from winter in the north to summer in the south. The variation of precipitation in time, coupled with the orographic effect of highly variable topography across the Arid West, results in spatially variable precipitation patterns (Reid and Frostick 1977, Graf 1988a).

Typically, higher elevations tend to receive greater precipitation than low-lying areas (Lichvar and Wakeley 2004). Snowpack in mountainous regions may act as a buffer for mountain channel forms through moderating the release of runoff supplying more-consistent, lower-energy flow in the spring and early summer months. Alternatively, rainfall on a deep snowpack, which accumulated during a colder period, could result in high-energy flow and flooding of mountain channel forms while adjacent lower elevation channel forms remain dry (Lichvar and Wakeley 2004). Extreme weather events (e.g., summer thunderstorms) may produce locally intense precipitation over an entire watershed or perhaps just a portion of a watershed producing short-duration, potentially high-energy (depending on watershed size, relief, and soil conditions) flow in these areas and a complete lack of flow in others. The spotty, episodic precipitation patterns often lead to a lack of base flow (unless groundwater influences are present) and, as a result, decreased incision of Arid West channel forms. The lack of consistent flow in conjunction with the immature and poorly formed/consolidated soils typically found in arid systems make both the channel morphology and the channel position highly variable and generally reduce the growth of channel-armoring vegetation (Reid and Laronne 1995, Millar 2000, Lichvar and Wakeley 2004).

1.5 Arid West Channel Forms of Interest

Five major ephemeral/intermittent channel forms occur within the Arid West: (1) alluvial fans, (2) compound channels, (3) discontinuous ephemeral channels, (4) single-thread channels with associated floodplains, and (5) anastomosing channels. Each channel form may transition from one to another through space and time. At a delineation site, the current channel type can be determined through the use of a formal channel classification scheme (e.g., Rosgen 1996); however, classification is not required to perform delineations because all five channel forms are delineated in the same manner. Thus, a brief, descriptive overview of each channel form is provided below for background purposes only.

1.5.1 Alluvial Fans

Alluvial fans are widespread in the southwestern United States, where it has been estimated that approximately 31% of the land surface is covered by alluvial fan deposits (Antsey 1965). Alluvial fans have a general geomorphic form that is cone- or fan-shaped (Fig. 4) and are typically composed of boulders, gravel, sand, and finer sediment. Definitions for these features range from geological, which describe shape and location and include a qualitative treatment of hydraulic processes that result in flood hazard, to the regulatory FEMA definition, which delineates the type of alluvial fan that is most hazardous to public health and safety by itemizing the hydraulic processes expected to occur on a generic alluvial fan (French et al. 1993).

Figure 4. Alluvial fan with distributary channels at the confluence of the Colorado River and Bright Angel Creek, Grand Canyon, AZ (Lichvar and Wakeley 2004).

Measurable characteristics (Table 2) can be used to differentiate between three types of alluvial fans: (1) active alluvial fans, (2) distributary flow systems, and (3) inactive alluvial fans (French et al. 1993). Several processes may be observed on an active alluvial fan, including channel migration, debris flow, hyperconcentrated sediment transport, channel bank erosion, local bed scour, and flash flooding (French et al. 1993). Processes that occur in distributary flow areas include local scour and fill, divergent flow, stream capture, flash flooding, hyperconcentrated sediment transport, and shifting of runoff among existing channels due to vegetative and/or sediment debris dams (French et al. 1993). Inactive alluvial fans experience sheetflow, channel bank erosion, local deposition or scour, flash flooding, and hyperconcentrated sediment transport (French et al. 1993).

Table 2. Primary measurable alluvial fan characteristics. (Modified from the CH2M Hill and French 1992.)

Active Alluvial Fan (1)	Distributary Flow System (2)	Inactive Alluvial Fan (3)
Abandoned/discontinuous channels	Discontinuous channels	Continuous channels
Channel capacity decreases downstream	No definite trend in channel capacity	Channel capacity increases downstream
Channel flow changes to sheetflow	Channel and sheetflow	Channelized flow (overbank flow possible)
Debris flow possible	Minor (or no) debris flow	No debris flow
Frequent channel movement	Rare channel movement	Stable channels
Low channel capacity	Variable channel capacity	High channel capacity
No calcrete	Calcrete horizons possible	Calcrete horizons
No (or buried) desert varnish	Varnished surfaces possible	Varnished surfaces possible
No surface reddening of soils	Minor reddening of soils	Surface reddening of soils
Overall deposition	Local erosion and deposition	Overall erosion
Radiating channel pattern changes to sheetflow area	Radiating changes to tributary	Tributary drainage pattern
Slope decrease downstream	Slope increase at apex	Slope variable
Stream capture or avulsions?	Channel movement by stream capture	No channel movement
Uniform topography (low crenulation index)	Medium to low topographic relief (medium to low crenulation index)	Topographic relief (high crenulation index)
Uniform vegetation in floodplain	Diverse vegetative community	Diverse vegetative community
Variable channel geometry	Variable channel geometry	Regular channel geometry
Weak soil development	Variable soil development	Strong soil development

1.5.2 Compound Channels

Often considered the most common channel type in dry regions (Tooth 2000), compound channels are characterized by a single, low-flow meandering channel inset into a wider braided channel network (Fig. 5) (Graf 1988a). These channels are highly susceptible to widening and avulsions (channel relocation) during moderate to high discharges, re-establishing a low-flow channel during subsequent low flows.

Figure 5. Compound channel with a low-flow feature in the foreground, Mojave River, CA.

1.5.3 Discontinuous Ephemeral Channels

These channel forms are characterized by alternating erosional (Fig. 6) and depositional reaches, both of which may vary in length from 15 m to over 10 km (Bull 1997). They are constantly in flux, as headcuts (knick

Figure 6. Erosional reach (arroyo) along a discontinuous ephemeral channel, Susie Creek, NV.

points) originating at the downstream end of the sheetflood zone migrate upstream, causing dramatic temporal and spatial changes in channel morphology for any given location.

1.5.4 Single-Thread Channels with Adjacent Floodplains

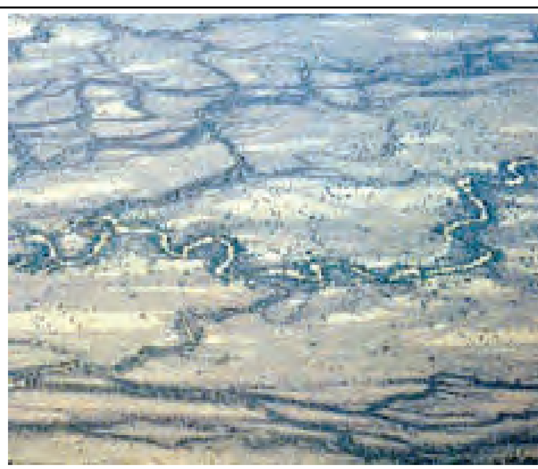
In the Arid West, occurrences of single-thread channels are often limited to perennial streams and rivers with origins extending into more humid regions, or small streams sourced by local springs. In either case, a more continuous supply of water is present. These streams and rivers consist of a single-thread channel with lateral adjacent floodplains that are either continuous or intermittent along the course of the channel (Fig. 7). In general, the morphologies of arid- and humid-region single-thread channels with adjacent floodplains are similar; however, transmission losses (Reid and Frostick 1997) and debris inputs from tributaries (Graf 1979, Webb et al. 1988), which may alter the form of the channel, are limited to arid-region examples.

Figure 7. Single-thread channel with adjacent floodplain, Alter Wash, NV.

1.5.5 Anastomosing Channels

Anastomosing channel forms (Fig. 8) are multi-thread channels with stable, fine-grained banks, transporting a suspended or mixed load (Schumann 1989). The characteristics necessary for the development of

Table 3. Natural controls on fluvial processes.

Stream Type	Photograph	Natural Processes
Discontinuous ephemeral streams 		– Alternating erosional and depositional reaches – Headcuts that form at downstream end of sheet flood zones and migrate upstream – Cycle of arroyo formation, widening, and backfilling into the valley floors – System in equilibrium as long as length of channelized areas relative to sheet flood zones remains constant
Compound channels 		– Rapid widening in response to increase in sediment transport capacity during extreme, brief, discharge – Activation of braided channels after extreme flow events – Meandering form that develops after long sequence of low to moderate discharges
Alluvial fans 		– Fans that emerge from upland areas into zones of reduced stream power and are maintained by distributary flow – Enhanced deposition because of decreased stream power from headwaters to valley bottom, loss in flow confinement, and loss of discharge – Channel avulsions resulting from overbank flows emanating from channels on fan surface
Anastamosing rivers	 (Copyright, Colin P. North, University of Aberdeen, Scotland; used by permission)	– Frequent channel avulsions – Smaller anabranch channels that grow headward towards the main channel in response to overbank flows emanating from aggrading main channel

involves determining the active channels and then determining the lateral extent of the OHW.

3.5.2 Compound Channels

Compound channels are characterized by a mosaic of terraces within a wide, active floodplain and frequently shifting low-flow channel(s). Figure 40 shows an example of the spatial arrangement of channel features associated with compound channels.

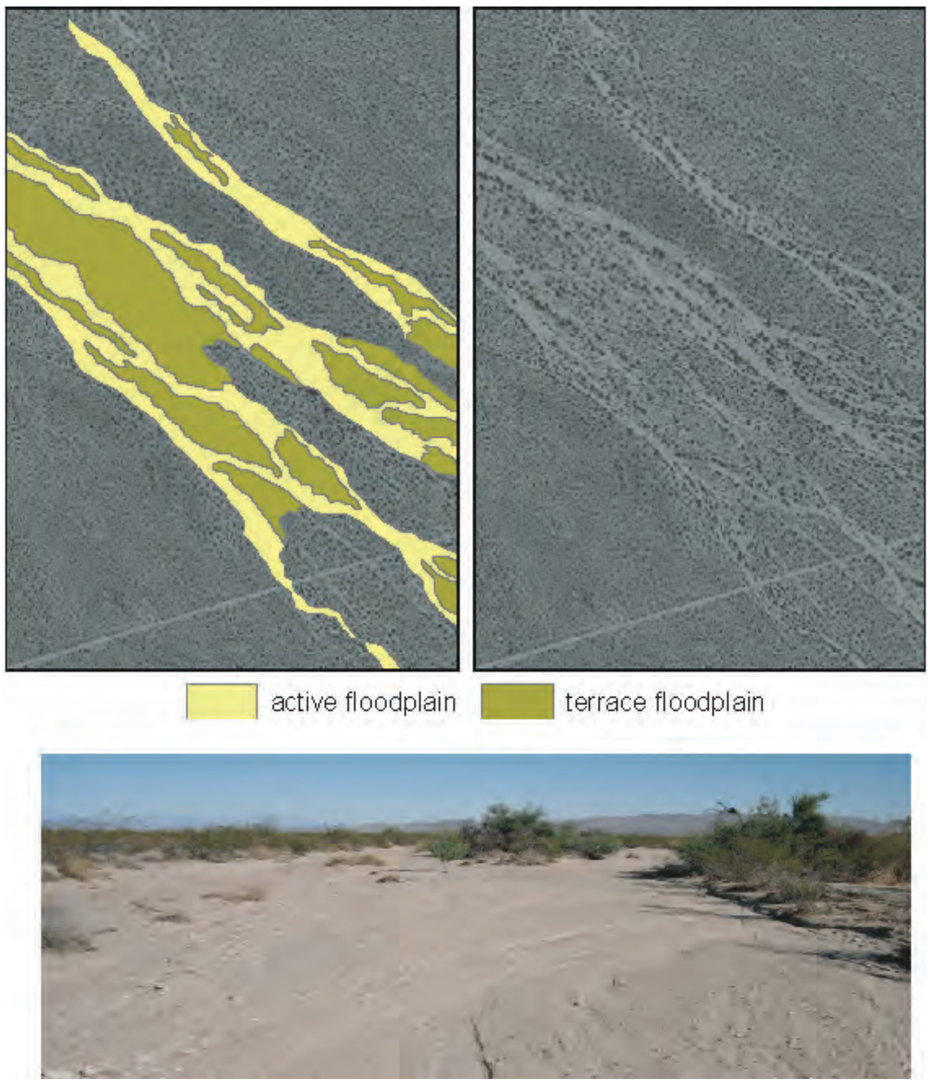


Figure 40. Example geomorphic mapping of a compound channel showing a mosaic of terraces within the active floodplain, Caruthers Creek, CA.