December 30, 2020

M E M O R A N D U M

To: Brian Hunt

From: Tom Grimshaw

Subject: Mustang Branch Meander Loop: A Major Geomorphic Feature in the Mountain City and Buda Quadrangles.

As part of our ongoing volunteer effort to map and describe the geology of the Mountain City Quadrangle (and portions of adjacent quads), I have discovered and documented a cutoff and incised meander loop of Onion Creek. The results are presented in the attached draft report.

Most of this fascinating geomorphic feature is in the Buda quad, which is on the east side of the Mountain City quad.

Please let me know if you have any questions or comments.

Mustang Branch Meander Loop, an Incised Cutoff Meander of Onion Creek, Hays County, Texas

Draft Report

Onion Creek originates in the Texas Hill Country and flows generally eastward, joining the Colorado River southeast of Austin. Where the stream crosses the Balcones Escarpment, it displays an outstanding geomorphic feature, a prominent cutoff meander loop. It is located about two miles southwest of Buda and west of Interstate 35 (Figure 1). Texas FM 1626 crosses one leg of the loop. Although Onion Creek no longer flows through the former channel, a smaller tributary stream, Mustang Branch (also called Mustang Creek), enters and flows southward and then around the loop of the meander. The geomorphic feature is therefore named the Mustang Branch Meander Loop (MBML).

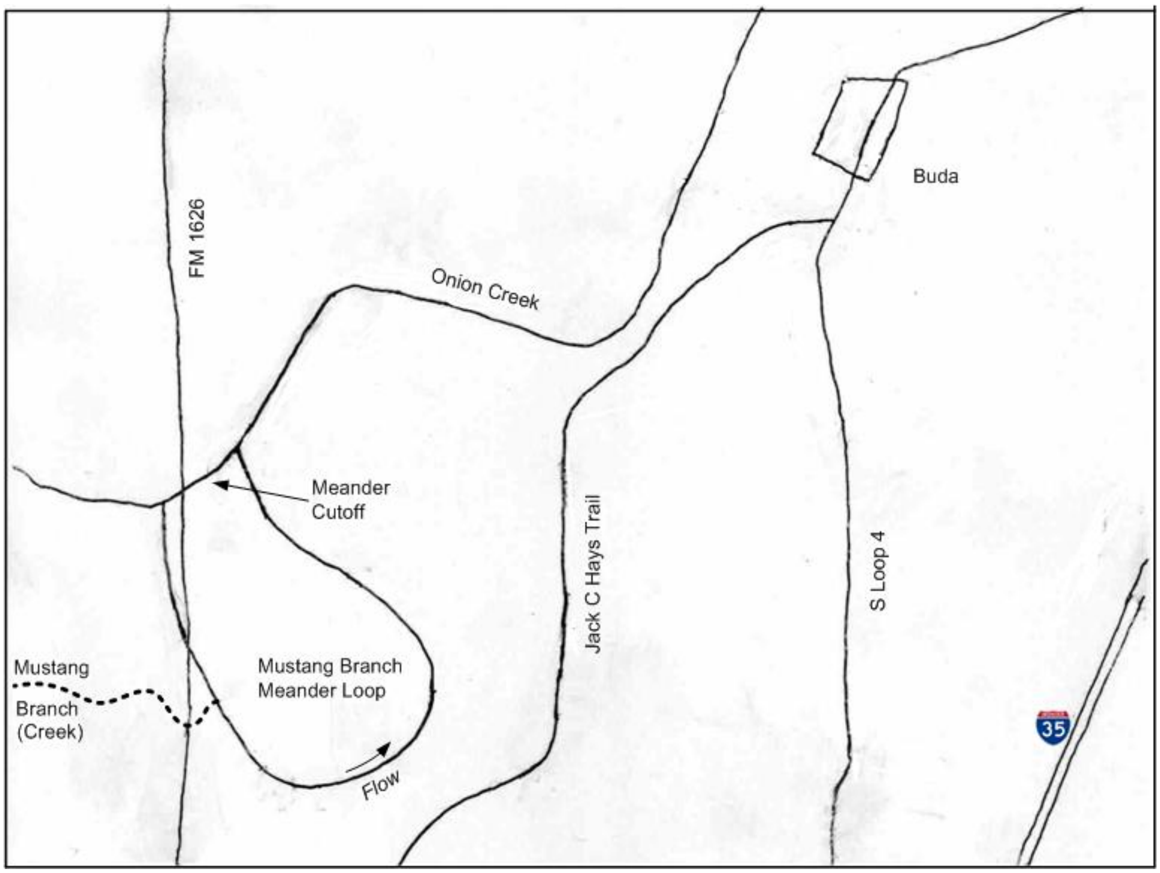

Figure 1. Location of Mustang Branch Meander Loop

The bridge and sign where FM 1626 crosses Mustang Branch are in Figure 2. A portion of the USGS Buda quadrangle showing the MBML is shown in Figure 3.

Figure 2. Southeast View of Sign and Bridge where FM 1626 Crosses Mustang Creek.

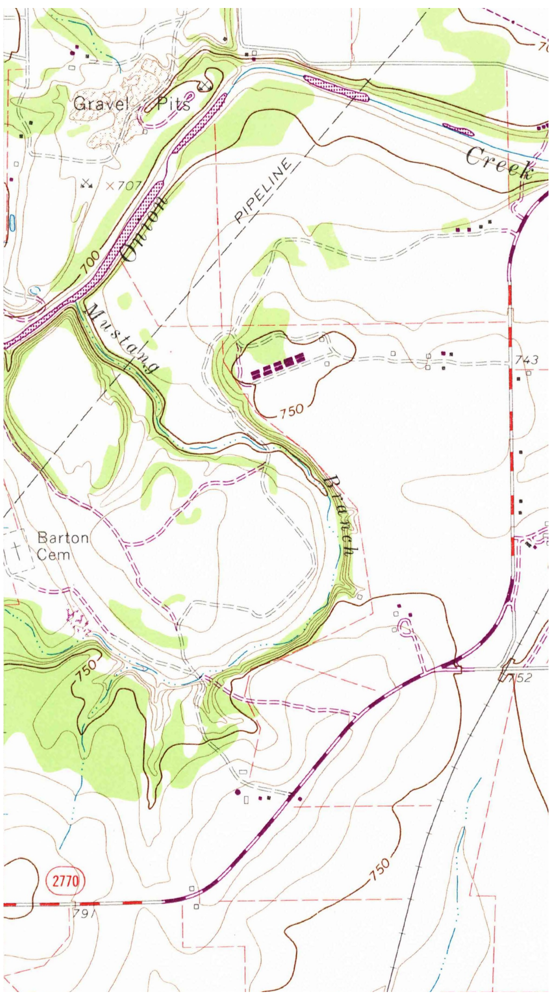

Figure 3. Mustang Branch as Shown at the Western Edge of the USGS Buda 7-1/2 Minute Quadrangle

Geomorphic Features

The MBML exhibits many features characteristic of a fluvial meander loop, including an abandoned channel, point bar gravel deposits, and a cut bank (Figure 4). The meander cutoff is between two parts of the former channel (indicated by the "Onion Creek" label in Figure 4).

Mustang Branch is a tributary to the channel (Figures 1 and 4), as it was before the meander was cut off. Because the flow of the tributary is now much smaller than the previous Onion Creek, Mustang Branch is considered an "underfit" stream. The MBML fluvial geomorphic features were formed by the much larger Onion Creek (before the cutoff) and not by the smaller Mustang Branch.

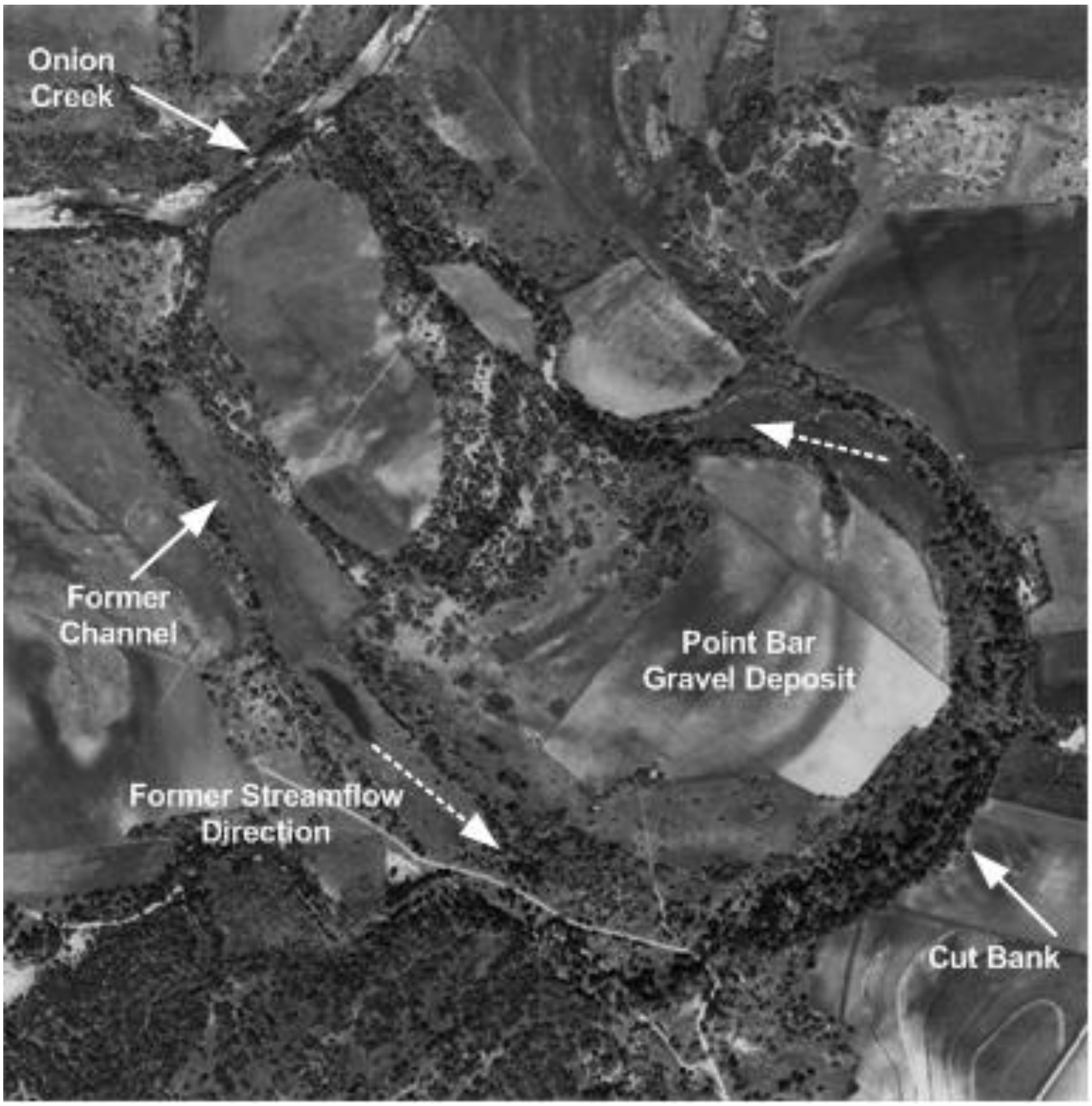

Figure 4. Fluvial Geomorphic Features of Mustang Branch Meander Loop. Mustang Creek can be seen just under "Former Streamflow Direction" label. 1958 Air Photo from the U.S. Geological Survey.

Geologic Context

The geology of the MBML reflects its location in the Balcones Escarpment between the Hill Country on the west and Gulf Coastal Plain to the east. The bedrock geology consists of Cretaceous limestone, clay and marl strata that are highly disrupted by the Balcones Fault Zone (BFZ). The general stratigraphic sequence at the MBML location, from oldest to youngest, is as follows: Georgetown formation (marl), Del Rio clay, Buda limestone, Eagle Ford clay, Austin chalk (limestone), and Sprinkle clay. The Georgetown formation and Del Rio Clay are shown in Figure 5.

Figure 5. Georgetown Formation Exposure on the South Side of Onion Creek at the FM 1626 Bridge. The trees above the exposure are on the overlying Del Rio clay.

The cut bank of the MBML was formed in the Austin chalk, which is resistant to erosion in the upper part and forms a cliff at the top of the bank. Since the meander was cut off, cut bank erosion has greatly diminished, and an apron of colluvium has accumulated at the base of the upper cliff. The Sprinkle clay overlies the Austin chalk at the top of the cliff.

The current channel of Onion Creek is on the Georgetown formation at and around the meander cut off location (Figure 6) and it is therefore an actively downcutting stream, at least in this stretch.

Figure 6. Onion Creek Streambed in Georgetown Formation. Taken Upstream from FM 1626 Bridge.

Before the cutoff, the MBML was also a vigorously downcutting stream, particularly in the stretch where it crosses the Austin chalk and formed the cut bank. The extent of downcutting since the meander cutoff – the difference in elevation of the current creek bed and the abandoned channel – has not yet been determined.

The MBML crosses a major northeast-trending fault of the Balcones Fault Zone twice in its arcuate course (Figure 7). The fault is referred to here as the Mustang Branch fault. Younger strata of the Austin chalk on the southeast side of the fault are downfaulted against the older Georgetown formation and Del Rio clay on the northwest side. The Eagle Ford clay has not been observed and appears to be "faulted out" by the Mustang Branch fault. The Sprinkle Clay overlies the Austin chalk on the south side of the MBML.

A preliminary map of faults of the Balcones Fault Zone in the vicinity is shown in Figure 8.

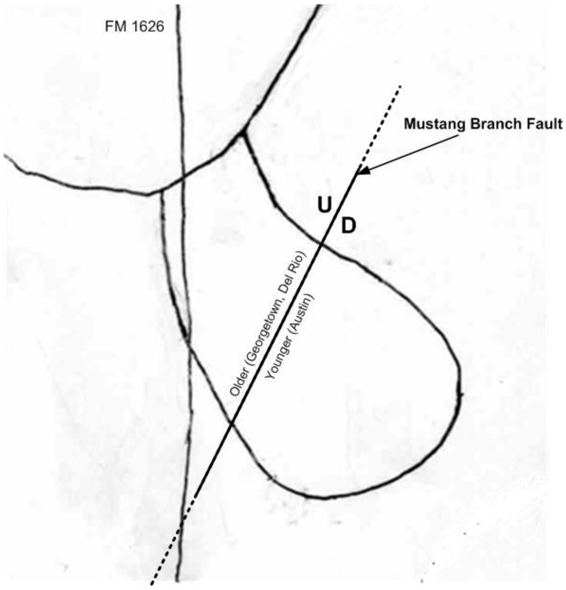

Figure 7. Conceptual Diagram of Mustang Branch Fault at the MBML

Figure 8. Preliminary Photogeologic Map of the Balcones Fault Zone Area around the MBML. The dashed fault across the meander loop separates the Del Rio Clay (and perhaps the Buda Limestone) on the northwest side of the fault from the Austin Chalk in the cut bank on the southeast side.

An extension of the Mustang Branch Fault to the northeast appears in a geologic map reported in Saribudak, et al.[1] (bold line in Figure 9).

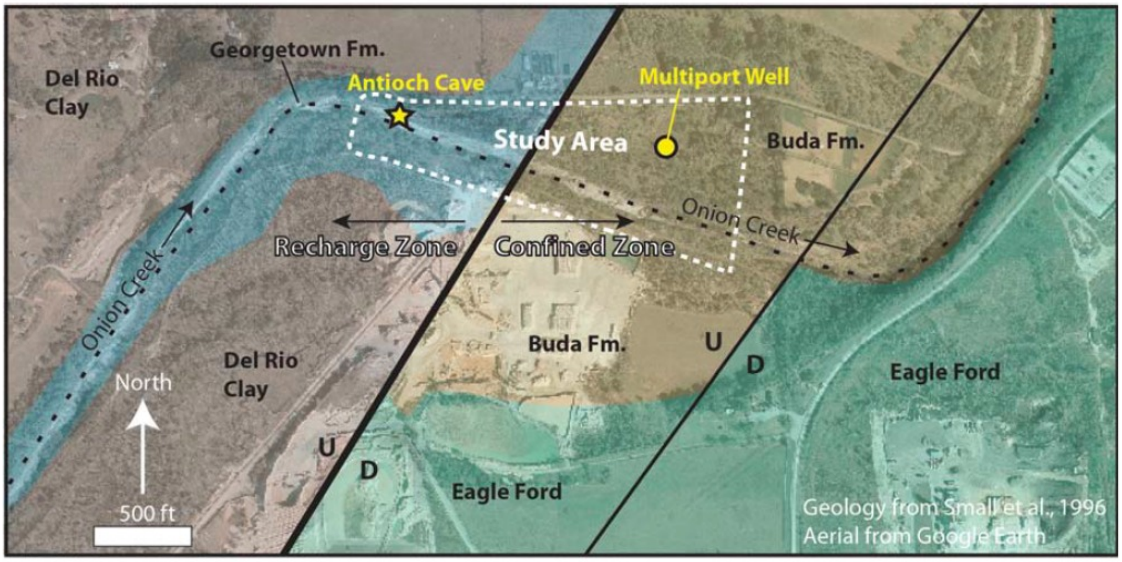

Figure 2. Bedrock geologic map of the geophysical study area, that is shown with a dashed white line. Note the location of the Antioch Cave to the west in the Onion Creek bed. Geology from Small et al., (1996).

Figure 9. Bedrock Geologic Map of the Study Area Depicted in Saribudak, et al.

Terrace Gravel

In addition to the relict geomorphic features of the MBML, there is evidence of much older fluvial activity of Onion Creek. A higher-elevation terrace gravel is located on the inside of the meander loop adjacent to the creek (Figure 10). The gravel is deposited on the Del Rio clay (Figure 11).

This gravel cap is no doubt a remnant of a more extensive deposit of alluvium that existed previously and has been mostly eroded away. Fluvial geomorphic features like those of the MBML are not observed in the relatively small remaining remnant. The mottled appearance of the gravel cap intimates fluvial activity, but a satisfactory interpretation is not possible.

[1] Saribudak, M., B. Hunt, and B. Smith, 2012. Resistivity Imaging and Natural Potential Applications to the Antioch Fault Zone in the Onion Creek / Barton Springs Segment of the Edwards Aquifer, Buda, Texas. Gulf Coast Association of Geological Societies Transactions, 62nd Annual Convention, Austin, Texas. Volume: 62, p. 411-421.

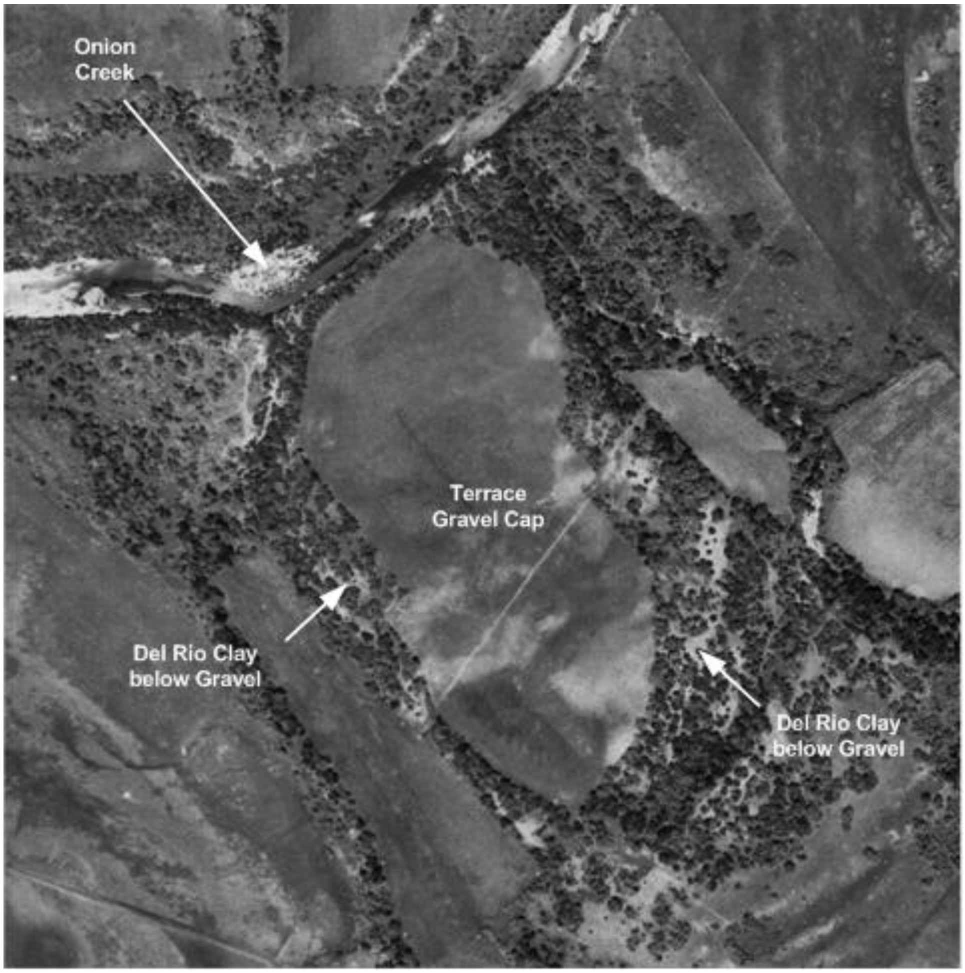

Figure 10. Upper Terrace Gravel of Onion Creek within the Mustang Branch Meander Loop.

Figure 11. Roadcut Exposure of Terrace Gravel Overlying the Del Rio Clay. The FM 1626 bridge over Onion Creek can be seen on the right side of the Photo.

Gravel Mining at the MBML

The gravels of the point bar have been mined extensively in the past (Figure 12), perhaps to the extent that the resource has been exhausted. FM 1626 can be seen on the left side of the figure. The bridge over Mustang Creek is in the lower left-hand corner. The mined area is based on inspection of a Google Earth image and would be better delineated with field verification.

Figure 12. Google Earth Image Showing Gravel Mine in the Point Bar Deposits of the Mustang Branch Meander Loop. FM 1626 can be seen on the left side of the image. The bridge over Mustang Creek is in the lower left-hand corner.

Geologic History

At least since the uplift of the Edwards Plateau relative to the Gulf Basin, Central Texas rivers have flowed generally to the east and southeast. Erosion in their drainage basins has removed a substantial thickness of previously deposited Cretaceous and Tertiary sedimentary layers. Onion Creek is one of the family of rivers and streams that has eroded and removed large quantities of rock from their drainage basins.

The Balcones Fault Zone formed as a result of tension along the boundary of uplift between the Edwards Plateau and the Gulf Basin. The rivers flowing east from the plateau to the basin have cut deeper into the Cretaceous layers northwest of the fault zone than to the southeast. Differential erosion of the more resistant Lower Cretaceous strata in the uplifted area than the less resistant Upper Cretaceous layers to the southeast resulted in the prominent Balcones Escarpment. Since it is located right at the edge of the escarpment, the MBML development is tied closely to the emergence of that prominent geologic geomorphic feature.

Onion Creek has removed a large quantity of Lower and Upper Cretaceous sedimentary layers from its drainage basin. It continues to be a downcutting stream up to the present. As shown by Woodruff[2], the creek formerly had a larger drainage basin before part of its flow was diverted by stream capture by the Blanco River. The existing channel, the MBML and the terrace gravel above it represent increasingly older phases of the geomorphic evolution of Onion Creek. It is possible that the MBML is inherited from a time when Onion Creek was a meandering stream before the uplift occurred and then became a relic geomorphic feature as the creek changed to a downcutting stream. Or it may have formed after the creek transitioned to a downcutting mode.

Relevant Questions

The Mustang Branch Meander Loop presents a number of intriguing geomorphic and landscape evolution observations and questions:

- Meander loops with this configuration often form in floodplains within valleys or distributaries of deltas.
- Uplift may subsequently cause meandering streams to become downcutting and incised. Classic examples are seen in the Colorado Plateau.
- Onion Creek is a downcutting stream. It flows on bedrock upstream of and at the meander loop cutoff.
- At what point in its geomorphic evolution did Onion Creek form the meander?
- At what point did the meander become incised? Was the meander formed before or after becoming incised?
- If before the incision, what was the surface like? Did Onion Creek have a lower stream gradient? Did it at that time have greater tendency to form meanders?
- If so, how much higher was that surface than the current stream elevation?
- How much downcutting has occurred? What thickness of the Cretaceous and overlying strata has been removed?
- What was the timing in relation to Balcones faulting and formation of the Balcones Escarpment?
- Was the meander formed when streamflow was higher than present? Perhaps before the Blanco River stream capture event described by Woodruff (1977)?
- What, if any, was the effect of higher streamflow during the more pluvial climate of the Pleistocene ice advances?

Conclusions

The MBML is an outstanding fluvial geomorphic feature of Onion Creek located at the edge of the Balcones Escarpment. It is an almost "textbook example" of a cutoff meander that was, like Onion Creek is today, a downcutting and incised part of the stream. Like the stream capture event described by Woodruff, the MBML may provide important clues to the geomorphologic evolution of the region around the Balcones Escarpment.

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[2] Woodruff, C.M., 1977, Stream Piracy near the Balcones Fault Zone, Central Texas. Journal of Geology, Vol. 85, No. 4 (July, 1977), pp. 483-490.