



alluvium  
till

**Jökulhlaup 2023**  
erosion below backloop bridge  
*Richard Carstensen • Discovery Southeast*



**02 P-to-P** Left to right: Pagenkopf, Bishop-Arra, & Peterson homes were all damaged. Closeups follow.



## 20230810 Affliction on alluvium

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This summer's glacial-lake outburst has been highest of any since first Suicide basin jökulhlaup was noticed in 2009. At 11pm. 0805, lake level crested at 15 feet, 2.5 feet above previous highest, recorded in 201607.

As [Aaron Jacobs told ABC News](#), flow peaked at 25Kcfs. <sup>1</sup> During outbursts, water pressure *lifts* the glacier, swelling into M-word Lake, and then barreling downriver. Best anatomical analogy is maybe a prolonged, half-day burp, but to some

<sup>1</sup> FEMA maps define the 100-yr flood here as 17Kcfs, & 500-yr event as 20Kcfs.

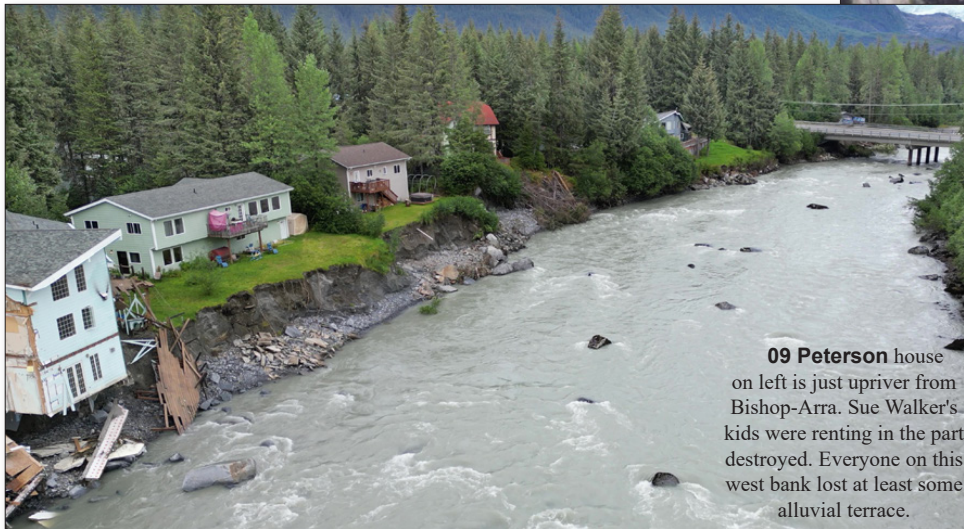
residents it felt more like an off-rail trainwreck.

Most widely viewed of human impacts, to owners & occupants of the Kent-Bufferoe parcel, was [summarized by DailyMail](#) on 0809:

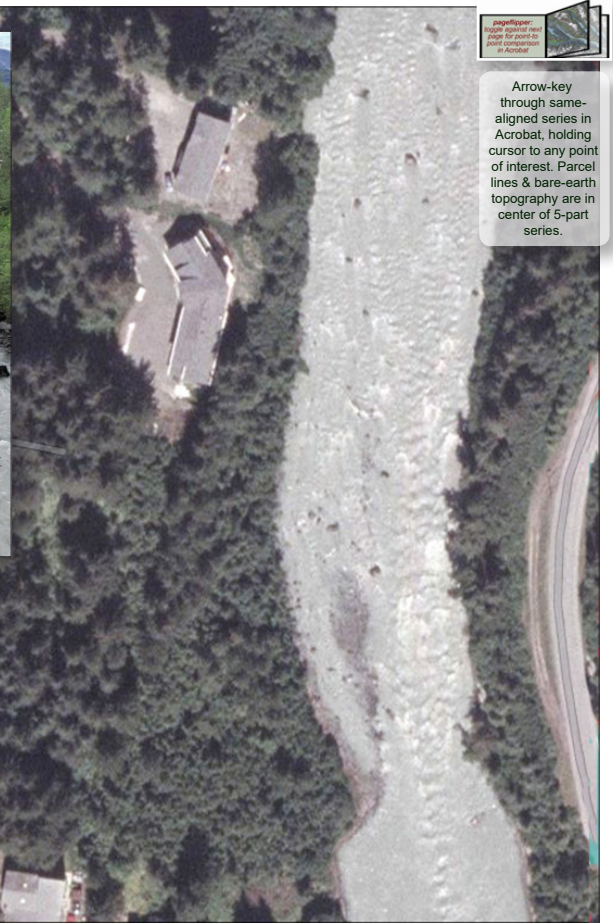
*"Elizabeth Wilkins & Tom Schwartz, renting the home, were out of town • their cat Leo is now missing • homeowners in Nicaragua • kayaker [Michael Penn] found [daughter Addy's] family mementos."*

For me, this journal/scoping document started as an info-gathering visit on 0807, a feeble endeavor at supporting my friends on the river. On reflection, it may take some time before the

Sam Nolan—[mari0deplumber](#)— posted a jawdropping tictoc timelapse that went 'global,' of Elizabeth Kent's place collapsing: 6 hours compressed into 2:52 minutes. • Every spruce, immediately on hitting the river, rotated its lighter crown to float top-first downstream. Useful to know when mapping logjams. • Timelapse showed foreground backeddies against Jerue parcel on west bank.



**09 Peterson house** on left is just upriver from Bishop-Arra. Sue Walker's kids were renting in the part destroyed. Everyone on this west bank lost at least some alluvial terrace.



**Pageflippers:** Right column view same for point to point comparison in Acrobat

Arrow-key through same-aligned series in Acrobat, holding cursor to any point of interest. Parcel lines & bare-earth topography are in center of 5-part series.

## Pageflippers: Peterson to Pagenkopf

shock of loss and displacement subsides enough for them to wade into any of this geeky analysis.

So, apologies to anyone for whom this academic study of affliction feels heartless or insensitive. Although nobody died (except housecat Leo?) sudden homelessness is a *kind* of death. Maybe that's why we cling to stories like master-photographer Penn returning Addy's family photos, washed ashore in a ziplock on Sayéik—and the heartwarming examples of friends & neighbors *showing up*.

**Right: Pageflipper 1 of 5:** No development yet on Bishop subdivision. Seems that water alone can't move car-sized rocks, so largest boulders have been in place since glacier dropped them, mid-1700s.  
<sup>1</sup> Did this flood budge them? Dan Kirkwood has rafted this reach, and thinks some *did* move.

<sup>1</sup> "Upper river resists erosion, hasn't degraded in response to uplift." Jacobs (2015 p12)





Checking in with Nate Bishop's sister Brita on 0806, I learned that an army of friends had already cleaned out the house. By 0807, Wooch Eel'óox'u héen was back down to normal summer highflow, and I drove out for a look. Those 20 minutes on-site propagated into days of hydro-homework and cartographic storytelling. Rivers and lake-burps and glacier-tracking are suddenly more interesting than even mountain goats :) Seems like this natural historian's take on what happened might count for my version of 'showing up,' however sweatless or virtually.

**06 Nate's from bridge** By 0809, stout builder-friends and calloused hands had dragged those fallen

**Pageflipper 2 of 5:** Compare rocks to the other low-water aerial in 2023.

Cutbanks exposed in above view are sorted fines about 6 feet deep. Is there a sudden switch to large-boulder till below that? On this 2011 aerial, exposures in riverbed off (future) Pagenkopf's corroborate. Terminal moraine is 500 yards down-river, on the lot where freshly-built Riverside Condos are causing owners to re-assess whether it's karmically wise to name your home for proximity to a home-wrecker.





cement slabs under the cantilever, to serve as temp-footings for jack-up posts. Maybe will buy some time until next year's burp.

**08 Slabs** Downriver pano from north wall, 0807. ABAK already floating by against far bank.

**0810 Showing up** Cathy & Rod walked the river 5 days after peakflow, and sent me photos of *Above&Beyond* guides using their rafts to collect debris hung up on bar islands and sweepers.

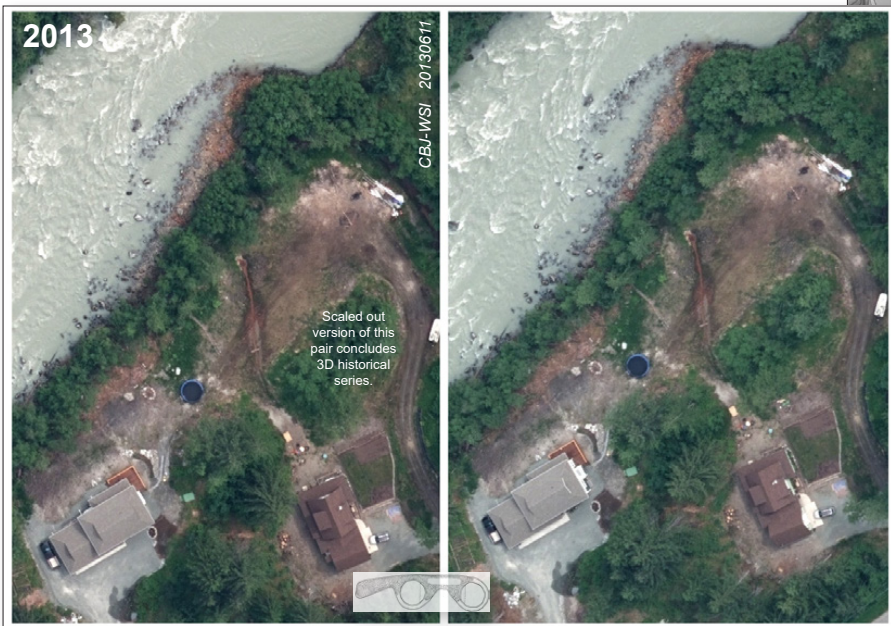
Weirdly, I know almost everybody cast out by the flood, or quoted in the news. <sup>1</sup> That viral imploding house? I visited Elizabeth there with Bob Armstrong in May, 2021, to Zoom with several elementary school classes for Seaweek. On a break between [masked Q&A sessions](#), we walked out to the now-famous bowling-pin spruces to botanize and search for **bank swallows**. <sup>2</sup> never guessing that former Discovery naturalist 'Tall Tom' would soon be not-living there.

<sup>1</sup> Statistically improbable! Scanning names of riverside homeowners on CBJ's parcel map, I recognize only ~10%, and 'know' fewer. <sup>2</sup> A lot of banknesting **swallows & kingfishers** were rendered homeless on 0805,

**Pageflipper 3 of 5:** City's orthos for our wetland surveys. Color infrared tells darker, starry-branched spruces from 'lumpier', brighter deciduous alder. When leaves have dropped we can get better ground detail for post-flood orthos and SFM (structure from motion) terrain models. Not much change since preceding 2011s, except for addition of Catherine Melville's home on roadside lot above Nate & Amanda's. She's relieved *not* to have a riverview this week, although I suppose that could change by the time she's my age. (Sooner, if Suicide lake-burps keep intensifying?) This mission coincided with LIDAR acquisition, from which I created bare earth topography with 1-foot contours on next page.



2013



**Stereopair** Hard to extract exact timing of LiDAR DTMs, right, but possibly taken same day in June, 2013. Rafters of otherwise-placid Woch Eel'óox'u héen know View Drive (1885 recession) to Riverside Condos (1765 terminal) as a more steeply dropping boulder patch. For 2 centuries since onset of recession, river erosion has been unable to appreciably alter

**Pageflipper 4 of 5:** In 2013, Bishop-Arras were ~13 feet above river level on the June DTM. LiDAR shows wave **surfaces**,\* but assuming consistent water depth, the thalweg (deepest part) dropped at ~1.3% from bridge to Nate's, then at 2% over a headward-cutting 'bite.' It'll be interesting to map the flood's enlargement of that bite. Comments follow on till and recent river evolution.



\*Only specialty acquisitions such as 'green-lidar' penetrate water.

04

Scale bar roughly calibrated from ~7-foot doorframe. Compare Nate's #6. More on this ironband in notes for 0813



bottom topography in this reach. Incising rivers 'swiftly seek-grade' through loose alluvial sand, but increasing boulder size at some threshold creates an immovable 'sill,'

**04 Pagenkof's** Joe and Leah have the southernmost lot on the old Maier parcel that Nate purchased and developed through the 2010s. As with bridge-view of Nate's place (06), I've added a 10-foot scale bar against the fresh escarpment. Looks like the alluvium-to-till contact might be a couple feet deeper here. Halfway down is a 2-foot thick

1 In a river's aggrading stage, sediment choking causes lateral migration and building up of floodplain. But formation of Sit'áa, glacier lake, early 1900s, created a sediment trap where suspended silts & coarser bedload settled out. At that time, the 'starved' or 'hungry-water' river started downcutting.

7 • Flooding on Wooch Eel'óox'u héen

**Pageflipper 5 of 5:** Most recent online imagery from mid-June this year allows comparison of rock placement with even-lower 2011. No detectable rock displacement. Near bottom, that bulge in the bank is probably from a recessional that Lawrence never dated, halfway from 1765 to 1860. It deflected Minkranch Swale outwash toward center valley, beginning roughly 1820. Unfortunately for Joe and Leah, the top ~8 feet was not resistant till but exportable alluvium.



Pageflipper: scroll wheel or mouse for point to point comparison in Acrobat

Google Earth 20230617

2023:



11

irony stratum that probably results from groundwater movement through a more conductive bed, legacy of a time when outwash was trapped behind the ~1820 recessional. Judy Maier says that when her family first homesteaded here, before river incisement, a mink rancher up-slough could pitchfork spawners out of this tributary for his animals. Only a sludgy surface trickle remains,

full of iron flocc.\* Maybe Joe's redbed is where the majority of seepage through Minkranch Swale now drools into the river? <sup>2</sup>

<sup>2</sup> Deb Rudis notes there is also a pipe outfall at Joe & Leah's that I missed during my visit. The creek in Minkranch Slough is a newly designated ADF&G anadromous stream for coho fry, but pipe is not salmon-friendly.

**11 Petersons'** Alluvium's great for lawns, but the river who bequeathed it sometimes wants it back. Imagining peak floodstage against these obliques, you'd picture it nibbling up at lawn level. But on Nolan's Kent-house timelapse, it never reached much higher than base of alluvium.





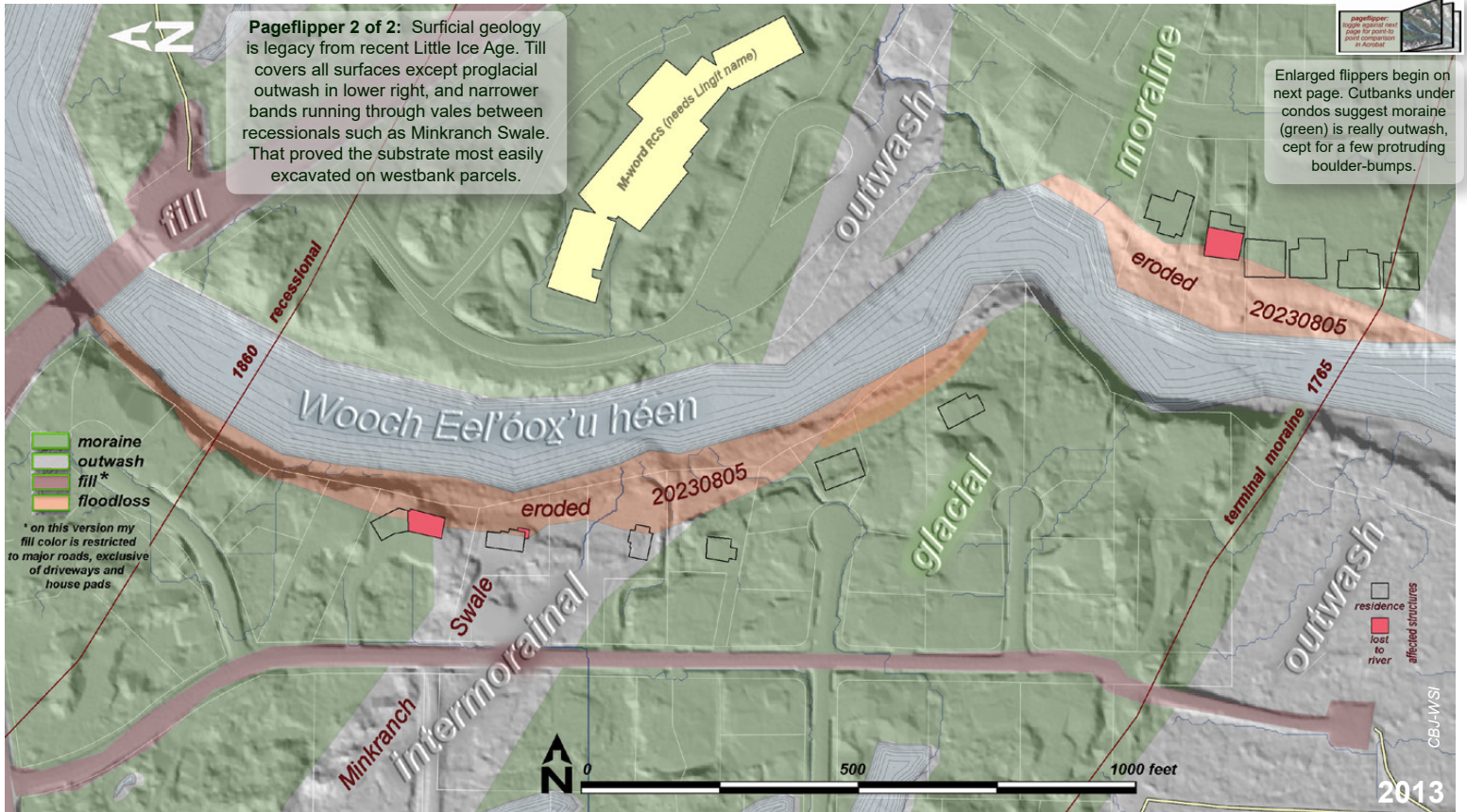
Pageflipper 1 of 2: Context of reshaped reach below backloop bridge. North rotated left. Toggle against next page for topography and surficial geology..

pageflipper  
toggle against next  
page for point to  
point correspondence  
in Another

AOL 20200728

Pageflippers: backloop to terminal

2020





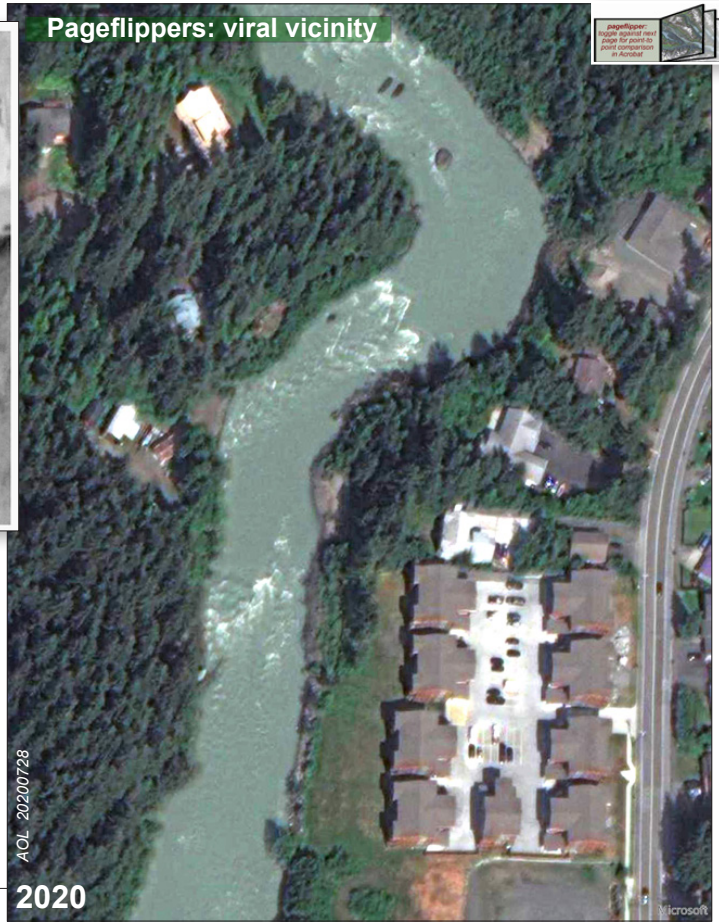
### Stereogram series

I like to clump stereopairs within my journals & reports—especially if they comprise a historical series. This way, you can set up a [stereoscope over your phone](#) or tablet and flip through the series without losing the 3D 'landscape model.'

Unlike my 2D pageflippers, north on stereograms is rarely up. Use my 'fickle' north arrows and 2-headed arch over the terminal moraine (TM), to keep track of shifting orientation.

**1929 stereo** For me, the big eye-opener from this examination of reaches between backloop and terminal moraine has been the unexpectedly smooth character of a 45-acre section east of the river (yellowcircled) that my traced Miller75 surfgeo shows as morainal. It's not! Residential roading and leveling has made

### Pageflippers: viral vicinity



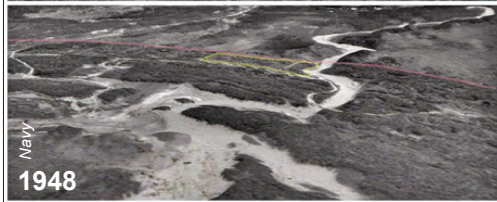
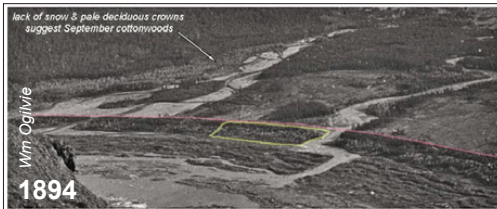
**Pageflipper 1 of 3:** Okay, we're back to north-up on these right-side flippers—focusing on Kent house & Riverside Condos. Toggle against following bare-earth (pre-site-leveling) to see how this section looked before the flood rearranged things. ●

Developer of Riverside Condos applied to the City to clear off his trees, presumably in order to armor the bank, then only ripped bottom corner.



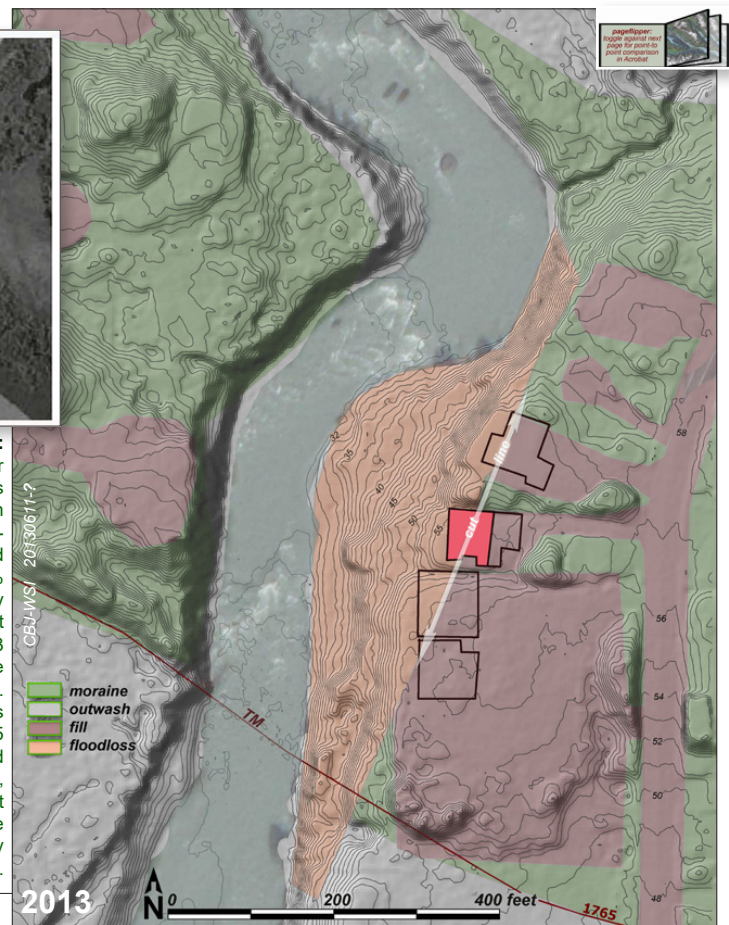
it nearly impossible to guess at glaciofluvial landforms. So, what was here, predevelopment?

**1948 stereo** On this pair & 1929, the 45-acre



patch not only lacked strong morainal 'ridges,' but *had no forest!* This might have been the first large clearcut in Aak'w Taaak (Mword Valley). On Ogilvie's 1894 view, left, the less conspicuous terminal (pink) had a thin dark spruce band, with mixed

**Pageflipper 2 of 3:** 500 yards downriver from Nate's, 3 riffles in overlaid ortho form over morainal step-downs where the bed drops 3 feet at 3% grade, then nearly flattens. • The Kent house (red) was 23 feet above this June 2013 river level. Timelapse shows that our 20230805 outburst only had to climb halfway, to maybe the 45-ft contour, to undermine alluvium back to my estimated cut line.





deciduous forest upvalley that would shift to pure-conifer in 50 more years(?), then disappear. My arcpro tipup for same-aligned 1948s shows the yellowborder 45 acres leveled.

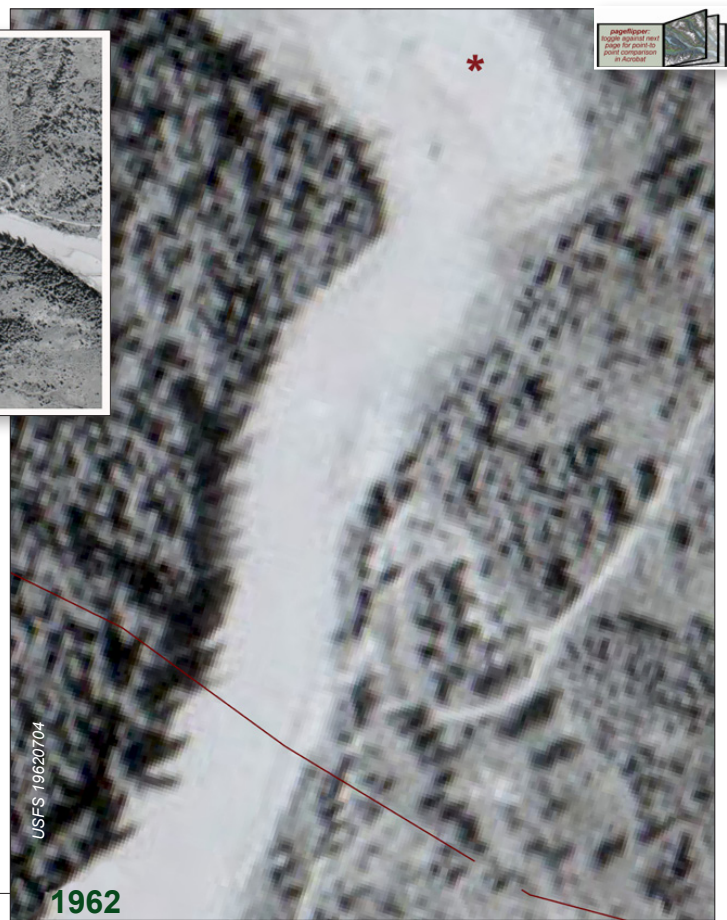
Before chainsaws, logging was generally selective—too much work to fell whole forests with crosscut handsaw. Rare exceptions—the most attractive stands—were typically pure spruce, near beaches or roads for easy cable yarding.

But conifers on glacial rib-moraines are pretty runty. Nothing a logger would salivate over, even today, a century later. What substrate could grow a forest worth handstripping in the mere 150 years between LIA-max and the 1920s?

Or was it logged? An alternate, but maybe compatible explanation is on the next page.

**1962 stereo** This higher-res stereo, maybe 40 years after forest loss, includes a curving wet depression labeled 'outwash', that *doesn't* parallel concentric recessional moraines spanning most of the Rec-area and upper-valley suburbia. If someone like my mentor Don Lawrence had made a careful ground-truthed

**Pageflipper 3 of 3:** Early USFS "resource photo" missions were still B&W but gave us better resolution than preceding Navy 29s & 48s. Comparing left & right banks, upvalley from redline terminal moraine, the right, east side was patchy & paler. Shadows of the surviving 'reject-trees' were shorter. • From red asterisk, toggle back to hillshade and 2020. There's now a 10-foot high cutbank in this old gravelbar, indicating rapid channel incision wherever it was unarmored by boulders (or, in downriver sections, rhizome-bound peat mats).



map of surficial landforms before first roads and subdivisions, the majority of our 45-acre clearcut(?) patch would probably lie not on till but alluvium. That is, deep, sorted beds of dissolvable fines similar to those the river just exposed under Kent and Riverside Condo parcels.

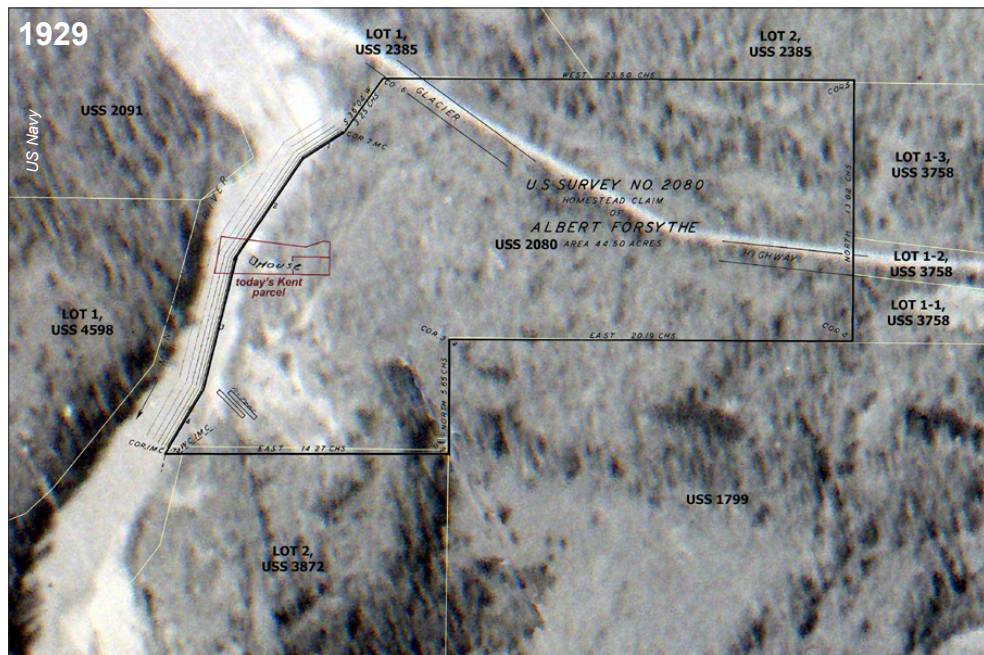
USS claims often shed clues on the era of early homesteader invasion. Here, I've overlaid the 44.5-acre USS #2080, executed Sept 1931, on the slightly older Navy photography. Claimant Albert Forsythe was probably the builder and occupant of this house and fox pens, <sup>1</sup> both of which already showed on 1929 stereo. His house, on probably the prime building-&-riverview surface of the entire USS 2080, was centered on the future Kent-Buffaloe parcel, outlined here in red. Albert would have appreciated the level alluvium, but I'm guessing he had to first log off some fast-growing spruces. Stereo in 1929 showed none of the incision that would be evident by 1962. The river flowed almost level with bordering moraines and floodplain, so it was bold of Albert to build there.

In addition to their lovely hand-drawn maps, USS documents are worth reading for clues to landform and successional status. Soil and vegetation notes by US Transitan Charles Seelye for corners, and transects between corners, mentioned no diameters for spruce or cottonwood greater than 16 inches. More typically, trees were about 10 inch-diameter. Land was described as *rolling*; soil, as *rocky and gravelly sandy loam, 2nd rate*. Undergrowth, *berry bushes, willow and alder*.

Seelye's *General Description*:

*"The land embraced by this survey is rolling and of glacier formation, covered with a thin growth of spruce, hemlock and cottonwood timber. The cottonwood is a young growth evidently having grown up since the area was burnt over, as a result of*

<sup>1</sup> Seelye's map calls them fox pens but his notes call them mink pens, 14x120 feet long bearing SE.



*which most of the other timber is dead. The Glacier Highway passes through the eastern portion of the Survey. Applicant is engaged in fur farming.*

Could both disturbances have happened here? Seelye was a competent interpreter of habitats and disturbance. So wouldn't he have noticed and recorded stumps from widespread timber-felling if that had occurred? He

mentioned only charred snags from the burn. Too bad we have no photos from the ground.

Seelye at least confirmed the site wasn't 'naturally' treeless, but had once supported older conifers. Fire is rare in Aak'w Aani, and usually anthropogenic. Did Forsythe or a predecessor cut, then burn?



**1984 stereo** Our first high-resolution color imagery for Áak'w Táak (M-word Valley) was shot just after construction of MRC. Traveling north over the section labeled 'Riverside Drive,' you *don't* rise and fall over a series of progressively younger rib-moraines, as you would to the west across the river. The land gently rises from 46 to 58 feet, then falls toward Minkbranch Swale again at just 50 feet. I've labeled these road-surface contours on [preceding hillshade map](#). Granted, it's on a cut-&-fill gradient that mutes original topography.

But check out this area in 3D on the 84s, above. Pretty darned smooth. There are some isolated bouldery 'nubbin moraines,' still mercifully forested. But nothing linear remains. That's due not only to bulldozers but to patterns of glacial recession. In

this central part of the valley, alluvial smothering diced once-linear recessional into scattered till 'cairns,' 4 to 8 feet high. <sup>1</sup> In the first century of tentative, 'fit&start' recession—maybe while most glacial waters still raced out the marginal yazoo-swaales of westside Kaḵḵigoowu Héen and eastside, Thunderfoot, J-word River—braiding, migrating, channel-choking centervalley streams slowly buried the boulder-ribs, leaving only few of their

<sup>1</sup> LiDAR is least invasive way to measure & interpret features in my yellowcircle landform. (Residents wouldn't appreciate backhoeing through fill pads to neoglacial underlayment). On LiDAR bare earth, high-hit returns from vegetation are stripped away to show ground surface, with precision enough for 1-ft contours.

highest crests protruding. This nutrient-rich, sorted & well-drained substrate is where a sawmill-&-burn-worthy spruce stand quickly grew . . . and fell.

The result? Unfortunately, afflictible alluvium is directly in the firing line of more lake-burps from Wooch Eel'óox'u héen.



On a much grander scale, the terminal moraine of Tsalḵaan Si'ti, *ground-squirrel-land (Fairweather) glacier* illustrates how once-linear rib moraines are cut&filled into jaggedy 'carnassial-rows.' A similar process may have created the pimply plain at Áak'w Táak's valley-center LIA maximum.



**Below:** 500 yards above Brotherhood Bridge, the river has been an unbraided single channel through loose alluvium and deltaic sand since a right-angle dogleg (palest blue) was first mapped in 1910. I traced this 3-part series in pre-GIS days when the most current photograph was 1996. Outburst in 2018 finally ate through the oxbow neck.

Compared to this unidirectional and fairly predictable erosion-deposition down in 'the sandbox,' my following series for the till-armored backloop reach has been 'locked-in'—narrowing rather than migrating.

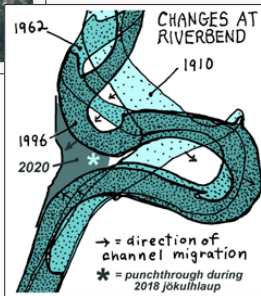
**2013 stereo** Resolution on this pair was an order of magnitude finer than earlier missions, allowing the preceding blowup from just [Bishops-to-Pagenkopfs](#). Here, we scale out to the entire reach from backloop to terminal moraine (TM). It'd be interesting to learn more about ownership and clearing-history of the Riverside Condos

lot, still undeveloped in this 2013 pair. Why did it take so long for this desirable parcel to become high-density housing? Was its vulnerability understood yet ultimately dice-rolled?

Before jökulhlaups started in 2009, <sup>1</sup> my

<sup>1</sup> Commonly cited origin year for outbursts from Suicide Basin is 2011. However, Jacobs (2015 p3) wrote they were first observed in 2009, & almost annually since.

[following pageflippers](#) for this mostly morainal reach show *lack* of 'whipping-rope' migration. Instead, while the channel centerline stayed put, we watch once-roomy alluvial corridors, traversed by briefly braiding glacial outwash, steadily narrowing as hungry-water Wooch Eel'óox'u héen carried away its own former deposits.





## 20230813 Second visit

David Job recruited me for a work party at Bishop-Arra's today. I must have a nailbelt buried somewhere in our storage unit, but my blue-collar days are so far behind me that I had to throw my handtools in a computer bag. It was great to see the Bishop friends-circle pitching in—so much expertise and muscle that I was quickly relegated to pulling screw-nails.

**24 Deck recycling** Last steps in disassembling the downriver-side deck that was drooping in this . . .

**24 Before & after** Coarse rock has been spread out from the truncated driveway, armoring especially the upriver bank. New posts are based, for now, on cement slabs dropped from the undermined driveway.



Amanda says she's been advised by construction friends on options including skidding the house back from the bank, and teaming with neighbors on a continuous riprap. Prevailing opinion is that fortifying



only your own riverfront won't work. I also checked in with Catherine Melville, next house above her, who has put me in touch with others on River Road.

I'm happy to weigh in with the neighborhood association, not as an expert on any aspect of bank protection or risk assessment, but to provide a cartographic retrospective on where we've been, geologically speaking—and where we could be headed, based on fluvial trajectories and land-form configuration.

**30 Pagenkopf substrate** I noted on [previous photo 04](#) that a reddish band indicated groundwater movement, probably through Minkranch Swale. Alluvium in this west-bank neighborhood could have originated from several directions. Just before I got to Joe's, this fresh collapse

buried a lot of the cutface. But David's shot, moments before, shows the pristine exposure.

**Before & after** Alain Saaiman, next lot downriver from Joe and Leah's, came over to Bishop's with Ted Deats to confer with Amanda's volunteers. Curious about variations in the alluvial cap, I walked back with Alain to check out his waterfront. Ortho on right from mid-June this year, compared with postflood bankline, shows Pagenkopfs & Saaimans both lost about 100 feet of river front. Difference is that Alain's house was set back farther, and is around 4 feet higher judging from LiDAR contours.





19



16

**16 Blasco** Boy, there's a lot of earth-moving machinery in this town! And all of it seemed to be bustling around on the riverbanks today. *Bobcat of Juneau* must be raking it in (sorry, pun intended ;) Blascos lost ~30 feet of lawn, outboard of those tarps, and have been fastest and most voluminous at large-boulder placement. All afternoon, a steady parade of dump trucks

passed us on River Road.

**19 Saaiman-Pagenkopf** Heavy rains yesterday. Is that why so many folks have draped tarps over their raw escarpments? Or are they underlayment for more boulder dumping?

Before&after views on previous page show that in mid-June this year, the Saaimans could hardly see the river from their screen of trees.



**26 Alain's new bank** When examining this bank I hadn't yet scrutinized the reach on pre-jökullhlaup aerials. So I was shocked when Alain showed me a video of his niece romping around on the yard, far to the left of this pano at about the level of his shoulders.

**27 Fresh dump** I suppose you can have both erosion and deposition at any particular site from one event, if subsiding

waters lose power and switch from cutting to filling. Exposed fabric in distance is on his neighbors' lot, next downriver, the Keys. As with the Dixon-Carr lot, a traffic circle limited their options, forcing construction closer to the riverbank.<sup>1</sup>

<sup>1</sup> Owner names come from a 2020 CBJ parcel layer. It's possible some lots have changed hands.





**14 Rapid armoring** McKeowns (foreground) and Riverside Condos (mid-distance) have wasted no time trucking in massive boulder fill. There's a lot of smaller stuff in the mix, though, which the river should have no trouble removing in the next lake-burp. Compare, for example, to size of rock, bottom left, and across the river on Jerue's lot. That tear-shaped bar island wasn't present on [2020](#) or 2023 orthos. Did it form 'overnight' here in response to backeddies shown on Sam Nolan's timelapse?

14



23

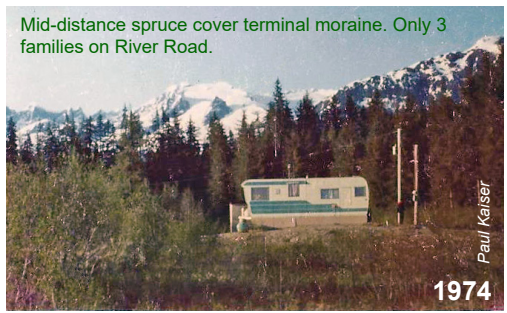


32



2023

Mid-distance spruce cover terminal moraine. Only 3 families on River Road.



Paul Kaiser

1974

**23 Marion Way** Paul Kaiser is part of the extended Bishop family, and of the Kaiser earth-moving dynasty. We tossed his carload of cement chunks over Nate's bank, and then walked out Kaḡdigoowu Héen Dei, south of the terminal.

Cutting east down an old haulroad to the riverbank, I set up the tripod for high-res midzoom p1k pano. The 2023 mid-June ortho (north-left for easier eyeballing) shows the raw 1-acre sandbar washed away in the outburst. Yellow boxes compare a rippapped shelf that survived while scrub and tree-covered banks upriver failed, leaving a pair

of lonely staircases, with Gene Cheeseman for scale. <sup>1</sup>

**32 Paul-pad retake** On nextpage hillshade you can make out a spur off today's Kaḡ trail that you'd easily miss in the field. On a pad at the end, Paul found a powerpole, only giveaway that someone once lived here. He said he'd send me a picture of . . .

**1974** . . . the trailer he placed here at age 24, when he and his dad and brother developed the gravel quarry across from today's Hobbs family subdivision.

<sup>1</sup> Gene, star of reality TV show *Gold Rush*, operated heavy equipment at age 6. He's an agent of disturbance probably midway in lifetime volume-tally between Suicide jökulhlaups and Neoglaciation. While explaining Valley history Paul spotted him, 110yds ESE. Marion Way is named for Marion Hobbs, my Adlersheim neighbor when I lived at Asḡ'ée (Eagle Beach).



**33 Overbank sand** At peak flow on 0805, floodwaters reached the back edge of Kaiser quarry, about 6 feet above current highflow level and ~250 feet west. Paul investigated some debris washed up into the alder-fringe that appeared to be recent. So while this soupy sand may have been dropped during the mollified ebb, at some point currents were really booking through this last little gap in the alders.

**Surficial geology** Green is *supposedly* bouldery glacial till. Grey is alluvial foreplain, mostly sand. However, as previously noted, this outburst flood surgically sought out little and not-so-little pockets of sorted alluvium hidden in the 'green.' Any more lakeburps of that magnitude or higher will find more of it, turning more of my surge-in-progress floodloss-orange.

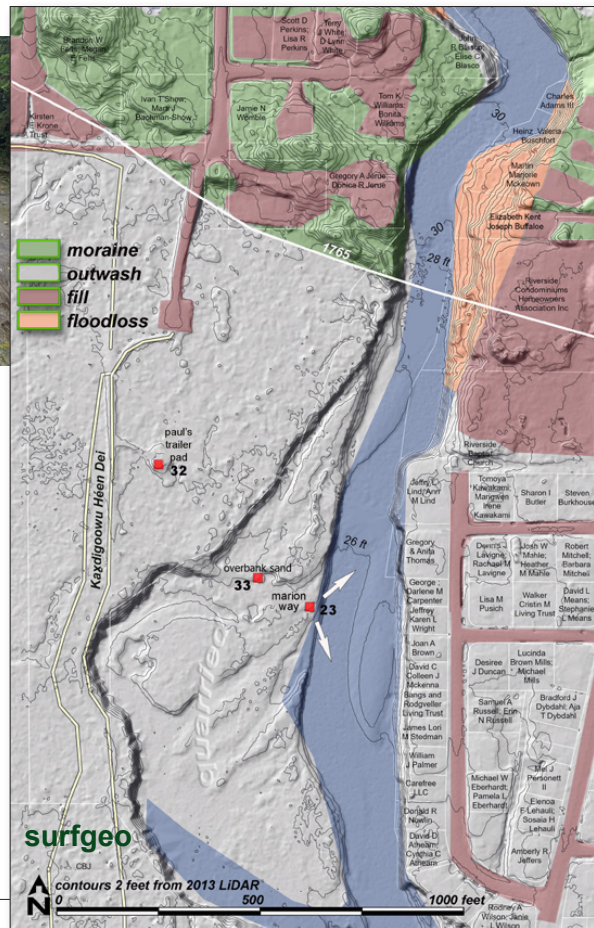
A boyhood friend of Paul's, since moved down south, ended up arbitrating riverside development proposals and was often assaulted by teams of lawyers. Usually, he could overrule them, it being a more enlightened state than The Last Frontier. Also helped, since builders

are typically true-believers, to quote Matthew, that wise-folk build on the rock:

*"everyone who hears these words of mine and does not do them will be like a foolish man who built his house on the sand. And the rain fell, and the floods came, and the winds blew and beat against that house, and it fell, and great was the fall of it."*

Another buddy of Paul's was watching eastbank gawkers during the 0805 flood from the safer west-side, and became concerned they were getting too close to the edge. Turned out the lawn they stood on was underlain by erosion fabric, much of which was already failing in the current. Suddenly, the whole yard was yanked out into the channel, like somebody whipping off a tablecloth, almost carrying the bystanders with it. Would Wooch Eel'oox'u héen have considered that funny?

*"The river laughs last."* [hydrologist Dan Bishop, proprietor, Environaid.](#)



## Flood maps & metrics

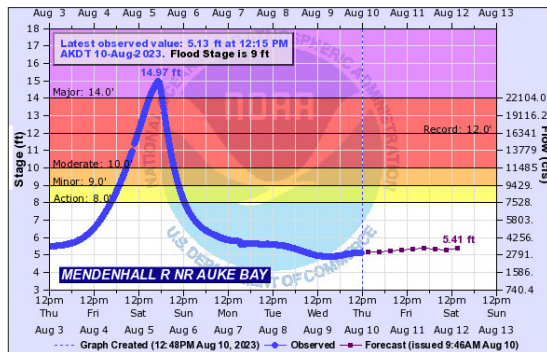
For several years I've been meaning to find out if our interagency jökulhlaup sentry-team<sup>1</sup> has used CBJ's 2013 LiDAR to fine-tune maps of flood risk. Answer; yes. Aaron Jacob's 2015 report to CBJ, p9, describes:

*"LiDAR and [groundbased] survey information, to develop cross-section and terrain data for inundation analysis."*

From the Weather Service site you can download a [package of shapefiles](#) for modeled lateral flooding extent, at 1-foot vertical increments from 63 to 72 feet. On right, I've displayed just 2 of those over the same terrain model the team used to generate them. Central, darkest blue is a 'normal' level from coarser IFSAR model (5m pixel).

Comparing these 66 and 72-foot polygons (*for lake vicinity? haven't yet drilled into metadata for this . . .*) to my selected 2013 river surface contours, they're obviously not just

1 City & Borough of Juneau, National Weather Service, USGS, Alaska Division of Geological & Geophysical Surveys, University of Alaska Southeast, and Alaska Climate Adaptation Science Center.

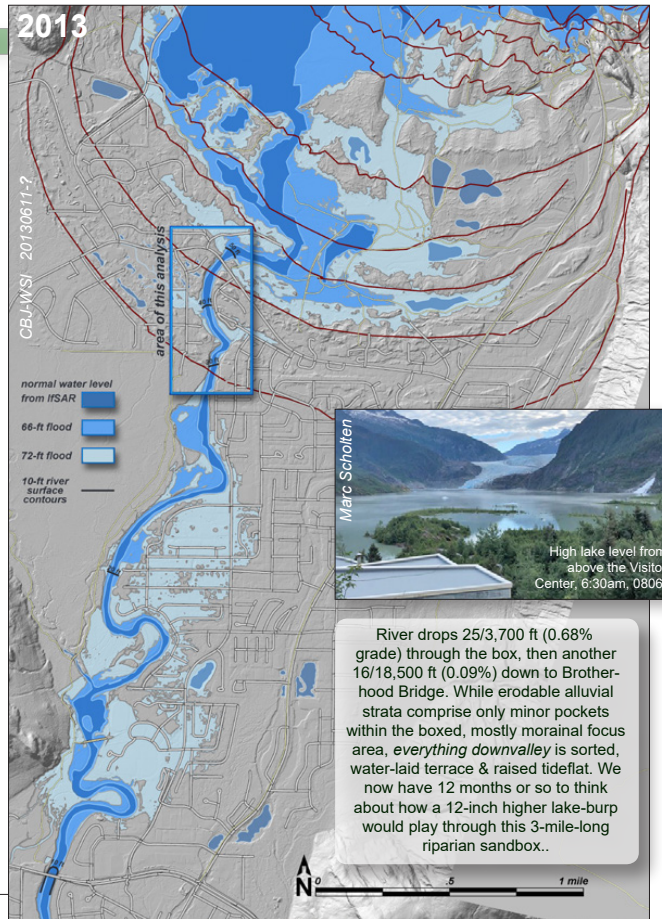


downvalley extensions of those contours, but rather *sloping* water surfaces, accounting for terrace inclination,<sup>2</sup> surface roughness, and other factors way beyond my daisypicker cartographic abilities.

This map, however sobering, really only shows how much land would be covered by spillover high flows at progressive flooding levels. The relatively peaceful event of 0805, at this scale, would barely have thickened that central darkest-blue channel-width, *and didn't need to*. The affliction of jökulhlaup-2023 was less about overflow onto lawns or driveways, and more about removal of the *land they were built on*, licked out from under them like melting icecream.

2 Neal & Jacobs reports note that with incision, Áak'w Táak's surface is no longer active *floodplain*, but a detached ~2-mile wide *terrace*.

NWS's [page for Mword River](#) on 0810 charted what we might name the 15-ft "*affliction stage*" 5 days prior, way above their threshold "*flood stage*" of only 9 feet. Gage values on left, volume-per-second on right.





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## Pageflippers: channel incision

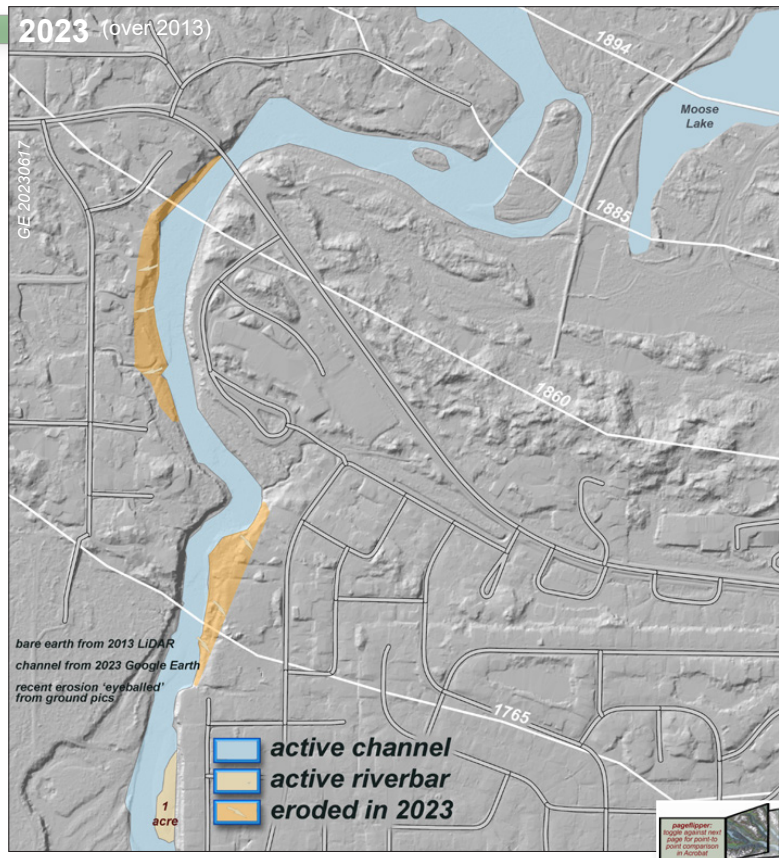
**2023 Dug in** Several days into this study of recent erosion in one small reach of Wooch Eel'óox'u héen, remembering [channel-migration overlays](#) that I created for uncontained downstream sections during Water Watch studies of the 1990s, I realized it might be illuminating to create a similar one for this more contained morainal area.

Layering several historical snapshots onto a single map—like for the famous oxbow cutoff at Riverbend—is intelligible if channels actually *move*. But here, the story is less about moving than shrinking. Once again, pageflippers to the rescue!

This time, instead of old-to-new, let's start with the current situation, and flip back 128 years until the glacier elbows up to that 1894 line. Compared to all earlier channel-&-riverbar maps, this one's dug-in so deep that almost no bare marginal deposits were visible. Just a single, one-acre patch remained near bottom.<sup>1</sup>

While the river is traced from a 20230617 aerial, the hillshade is a decade older, from CBJ LiDAR. Ubiquitous roadbeds and housepads extend north, ending only at our more pristine rec-area boundary. Even there, features such as Moose Lake and its containment dike are anthropogenic cut & fill.

<sup>1</sup> All except the impressionistic 1895 map were traced from nadir aerials at average summer water level. Blue on this one's from an aerial taken mid-June this year.



**1962 Swales dried-out** The Forest Service's first low-elevation mission was on July 4th, so river stage (blue) was moderately high. Its average width wasn't appreciably greater than today's, but this earlier channel had room to 'play' over a broader, 32-acre active floodplain that has since been exported downriver. Changes to water vs bar acreage are [plotted at end of this series](#).

On a 10-year flood, you could picture all those beige gravel-cobble bars turning briefly blue as well—otherwise they'd have been vegetated.

Succession by 1962 made it harder to see earlier barren swales at \* that were abandoned as retreating ice drained elsewhere, and as the river's channel slowly incised.



Cathy Connor's photo, 5 days after the flood, shows overbank deposits on an inner, recent terrace. Spruces ~5 inches in diameter are probably 30 or 40 years old. Obviously, the 0805 event didn't erode all banks equally. Could this have been a back eddy, like the foreground swirls in Sam Nolan's timelapse?



**1948 Dredge Swale** Intermorainal outwash channels tend to be abandoned suddenly, when recession over glacier-rumpled terrain creates new outflow emergence points, or diverts existing ones. High-energy floodplains free of sluggish-water fines are great places to dredge up sorted sand and gravel for the roads and first subdivisions that began to proliferate, mid-century.

Dredge (obviously) and more evasively-named Crystal Lake were both excavated from such swales. By 1948, Dredge had been dredged but Crystal, next swale north, had not. Draining flow through Dredge Swale probably ceased a decade before this photo, but at annual high flow, it was likely backwatered from new N-S flowpaths coming out of nascent Sit'áa (M-word Lake). My 1929 scale-out view, next page, gives east-valley context.



**1929 Dredge & Crystal Rivers** For reasons unknown, the Navy who based in Sét ka (G-word Channel) and photographed nearly all of Southeast Alaska, never flew the western half of Áak'w Táak Sít (M-word Glacier) or the valley west of Wooch Eel'oox'u héen. <sup>1</sup> My speculative rubberstamping from later photos in the paled-out NW corner should not be taken as gospel.

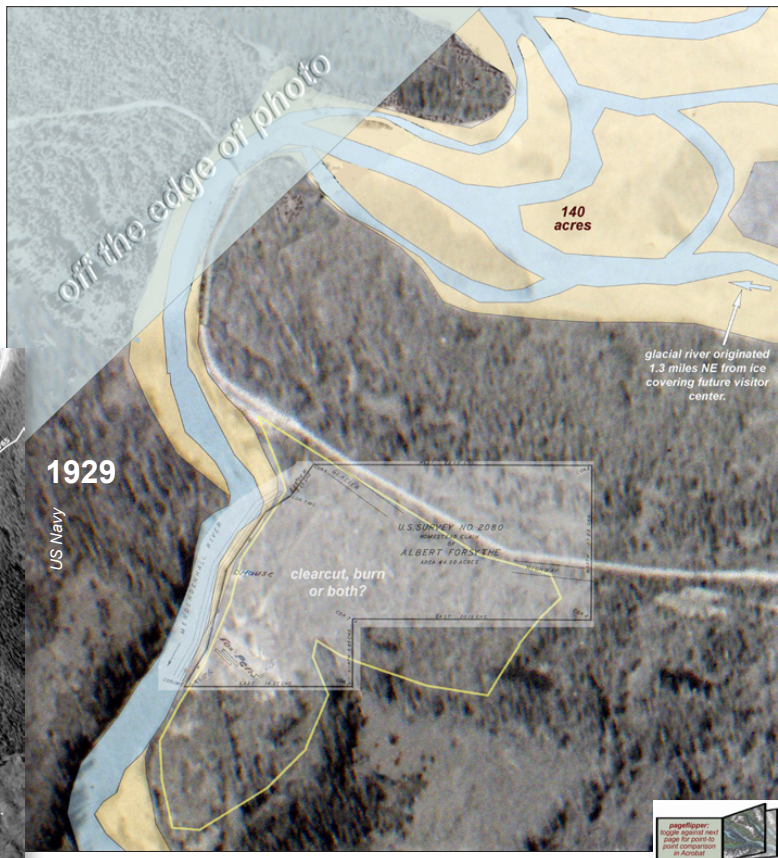
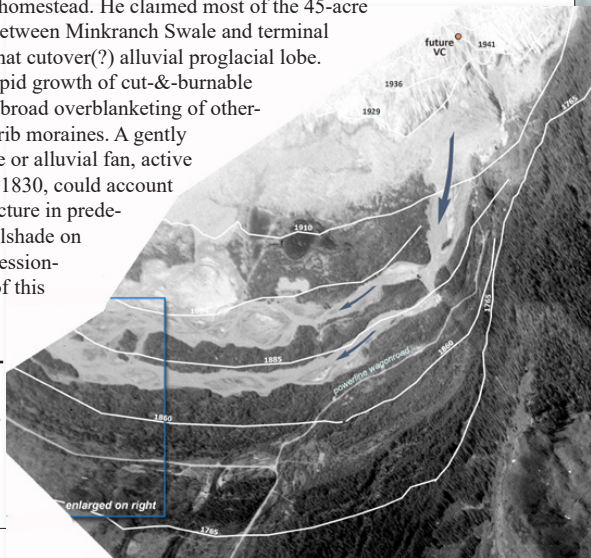
The good news is that to the northeast, we *can* trace bifurcating glacial rivers on Navy 1929s to their source at the downwasting icefront (photo below). They ran down the present corridor of our Visitor Center spur road. The tri-lens aerials, shaped like butterfly bandages, are not individually dated to month and day, but river stage must have been fairly high because it's unusual for a river to spit in half in the downstream direction. At lower stage, it'd have to choose one channel or the other. And we're not just talking braids here; that's a tall moraine—the 1885—separating them.

Annotations for the [Stereogram series](#) describe a clearcut, or burn, or both, on the 1931 Albert Forsythe homestead. He claimed most of the 45-acre yellow-border patch between Minkranch Swale and terminal moraine, and part of that cutover(?) alluvial proglacial lobe.

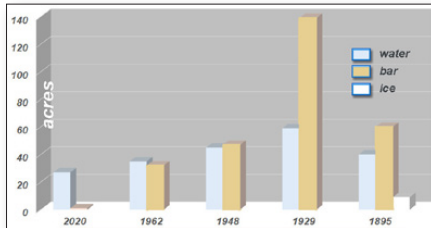
One way to explain rapid growth of cut-&-burnable timber here is a fairly broad overblanketing of otherwise valley-spanning rib moraines. A gently inclining outwash lobe or alluvial fan, active between, say, 1780 & 1830, could account for lack of ribbed structure in pre-development aerials. Hillshade on next page has an impressionistic rubberstamping of this hypothesis.

<sup>1</sup> Or maybe they did, but the photos were lost? If you know of tri-lens 1929s, northwest from this image, please let me know.

### 1929 scale-out



**1895 Crossvalley flows** This one's really winging it. We of course don't have a nadir air photo to trace, and the blowup of Ogilvie's oblique from M-word Mtn ' is pretty grainy and laid-over. Because I didn't trust myself to eyeball a map from it, I juxtaposed the [1948 arcpro simulation](#) before starting.

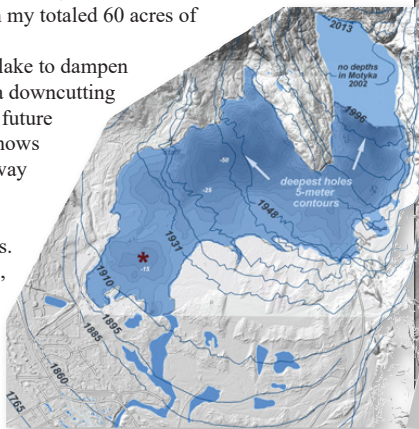


A number of us have been saying that Sit'.áa (M-word Lake) formed around the turn of the century. Motyka *et al* (2002) give a later formation date, saying it "didn't exist before 1930; it was formed as the glacier retreated from 1931 to the present."

What could be taken for a proglacial "lake" on Ogilvie's oblique was probably just seasonal high water (~September image?) over what would subside onto a braided, cobbly foreplain. I've tinted it paler blue for overflow cover, but at low flow it would rightfully have belonged in my totaled 60 acres of riverbar surface.

Perhaps it's true that the ability of the lake to dampen sediment delivery and flip the river into a downcutting century had to await recession out of the future lake's deepest holes. But Roman's map shows a secondary hole 15m(50ft) deep \*, halfway between 1910 & 1931 surface ages.

This bathymetry from 2002 will be interesting to compare to updated surveys. Presumably, if it really *is* a sediment trap, those holes should be shallower. And to what depths do jökulhlaups remobilize material off that soupy bottom?



1 Same as the name of a beer.

**Above:** cover of water and exposed marginal outwash over this historical series. **Below:** bathymetry from Motyka *et al* (2002). Hood and colleagues are remapping lake bottom this summer.

