H. Noel Duckworth
Consultant
Duckworth Pipeline Integrity Services, Inc.
1911 Quarterpath Drive
Richmond, Texas 77469
Tel 281/342-6118 hnduck@houston.rr.com Fax 281/342-3180

To: Peter Katchmar
Fm: H. Noel Duckworth
Date: August 26, 2002

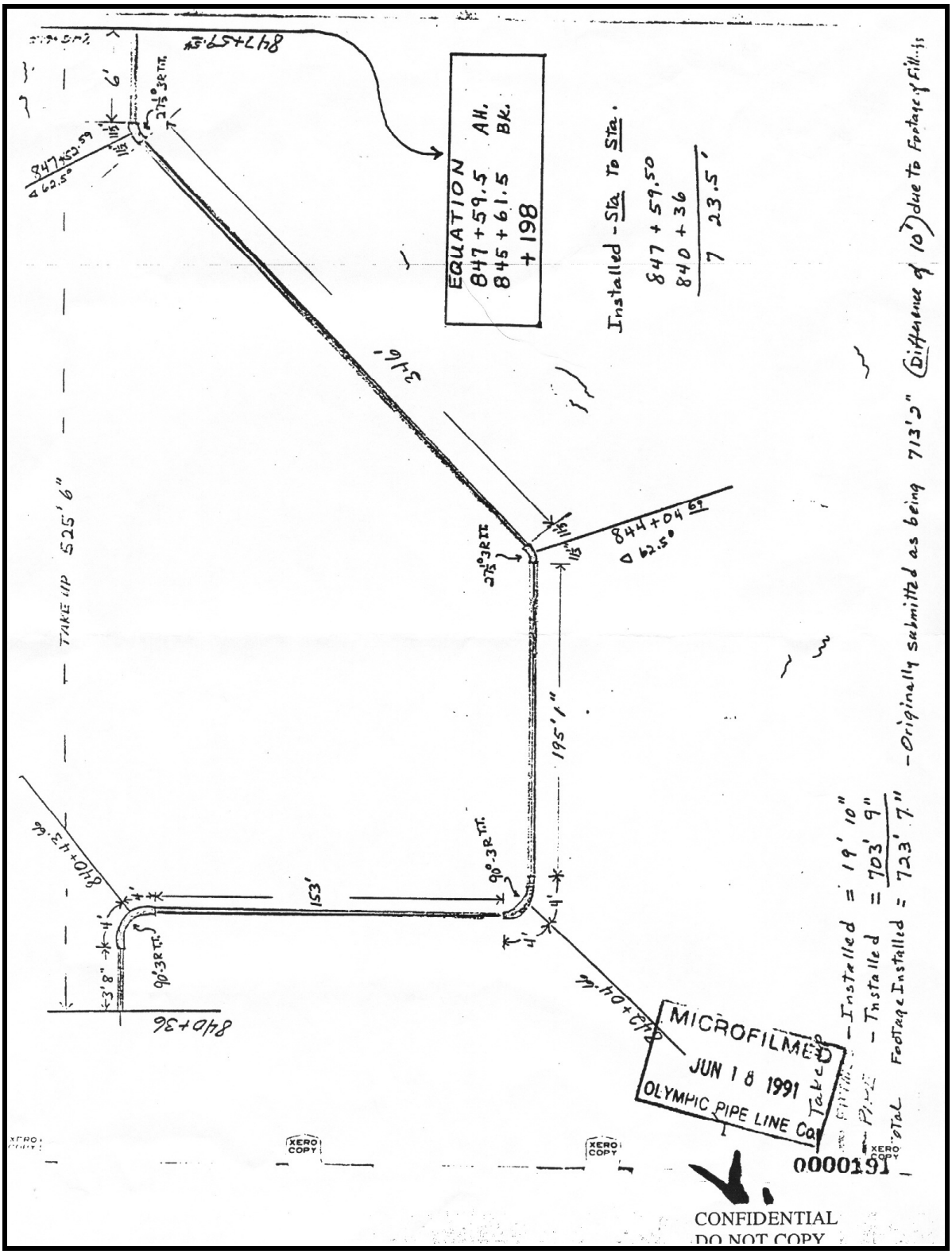
Ref: Olympic Pipeline – Bellingham, WA

Peter –

OPL/BP states in their letter to the NTSB dated 7/17/02 that they relied upon the written reports provided by the vendors and implies that they did not utilize the log data presentations. My final report dated 1/24/00 was developed from the facts as I saw them by analyzing the raw data without technical input from the vendors. In fact, evaluating the vendors' technical performance was one of my tasks. It would not be appropriate to assume that OPL had the capability to develop the in-depth understanding that I developed. Thus, I have re-evaluated the data provided to OPL by the vendors from the viewpoint of a pipeline operations technician who has no skills to interpret raw ILI data. Developing methodologies for communicating, in a form that would provide optimum benefit, to operating companies that are not expert in data interpretation has always been a challenge. Some are well versed in ILI technology and some have very limited capability.

Even though I can't comment on specifically what Richard Klasen, as an individual, knew or did not know, prior to the failure, I can comment on what information was provided to OPL by the vendors or was otherwise in their possession.

First, OPL knew exactly where the pipeline route was located in the area because they had relocated it for the proposed expansion at the City of Bellingham water treatment plant (Figure 1). At the conclusion of this relocation, OPL prepared an "as-built" drawing showing great detail as to the relocated position of the pipeline. This "as-built" drawing shows: a 3'8" pup joint beginning at OPL Station 840+36, a 90° 3R bend 8' long (*designated as "bend a" by HND for this report*) centered at OPL Station 840+43.66, a 153' straight run of pipe, another 90° 3R bend 8' long (*designated as "bend b" by HND for this report*) centered at OPL Station 842+04.66, a 195' 1" straight run of pipe, a 27.5° 3R bend 1' 11" long (*designated as "bend c" by HND for this report*) centered at OPL Station 844+04.69, a 346' straight run of pipe, another 27.5° 3R bend 1' 11" long (*designated as "bend d" by HND for this report*) centered at OPL Station 847+52, and another pup joint 6' long before the downstream tie-in point at OPL Station 847+59.54. The welds between the bends were not identified or located, so therefore, the only welds for which we know the locations are the tie-ins on each end of the relocation and the welds on either side of the four bends within the relocation. The length of each bend



As-Built Drawing of Relocation at Bellingham Water Treatment Plant
Figure 1.

is shown as measured along it's arc length. The radius of curvature for the four bends is erroneously shown to be 3D (3 pipeline diameters). In 16" pipe, it would take an 8D bend to produce an arc length of 8' in a 90° bend.

The correlation of ILI data to this OPL-generated "as-built" will provide evidence as to the linear accuracy of the ILI systems employed. It will also provide confidence that the log location area corresponds to the failure location area due to the unique lengths of the bends, the approximate angle of the bends, the bend sequence, and the unique distances between the bends.

Second, the 1991 Linalog survey database "report of features and anomalies" only showed there to be a "Tap" (WC 84486) within the entire relocation. There was no mention of any other welds, bends, sleeves, other features, mechanical damage, or metal-loss defects. Thus, there is nothing to correlate from this written data set. (*For the record, my analysis of the raw data also confirmed that there were no indications in the 1991 Linalog data except as reported in the written report and there was good correlation at each bend and at the welds.*).

Third, the 1996 Linalog survey database "report of features and anomalies" correlates to the OPL "as-built" drawing as it relates to the tie-in welds and the bends except, the Tuboscope analyst erroneously identified the bends as being sleeves. These are clearly bends and not sleeves. It is obvious that OPL concluded that these were bends and they included them as such on their dig sheet (Bates # 0000082). I consider this to be a reasonable deduction on the part of OPL and it is not one that would be prudently made without looking back in the records to confirm the presence of bends and the lack of evidence that there were sleeves at those locations. This 1996 survey also confirmed the Tap found in the 1991 survey.

In addition to the four bends and tie-in welds defined in this report and correlating to the as-built survey, three other items were included. They were: a "Possible Wrinkle Bend" at WC 84402' 6.6", a 23% metal loss noted to be "Possible Mill/Mechanical" at WC 84416' 9.4", and a "Possible Mash" at WC 84416' 9.6". None of these three items were noted in the 1991 Linalog report. (*Again for the record, in my analysis of the 1991 Linalog raw data, I found no signals other than those related to the tap, the bends, and the welds.*)

The ASME B31.4 code, 451.6.2.2.b states that a dent (*Possible Mash* in this case), containing a scratch, gouge, or groove (*Possible Mill/Mechanical* in this case), shall be removed or repaired. The 23% Possible Mill/Mechanical metal loss reported by Linalog to be 0.4" long and centered at WC 84416' 9.4", is clearly coincident with the Possible Mash centered at 84416' 9.6", only 0.2" downstream. If OPL had dug this location with the intent to "remove or repair" as per B31.4, they would have found the 3rd party mechanical damage at that location and, prudently, would have been impelled to pursue the Possible Wrinkle Bend at WC 84402' 6.6".

Fourth, the 1997 Enduro survey located the four bends and referenced them as Bend A at Enduro Station 840+43, Bend B at Enduro Station 842+03, Bend C at Enduro Station 844+05, and Bend D at Enduro Station 847+58. Also, Enduro noted a 0.45" "Total

Sharp" point of deformation at Enduro Station 843+72 (Bates # OPL 1026535). These station numbers are not derived from an accumulated odometer count as is done with the Linalog devices. At a linear scale of 1" of paper = 250 feet of pipe (1::3000), this would be impossible. Instead, Enduro correlates identifiable features on their log along the pipeline such as at bench marks (pig markers), valves, bends, tees, and wall thickness changes to those features identified by the pipeline operator by station number either in tabular form or on alignment sheets. It is not clear in this case specifically how Enduro correlated the OPL station numbers to their logs. On the bends, it could have been to the upstream weld, the center, or the downstream weld. In any case, the Enduro data does not correlate very well to the as-built survey or to the 1996 Linalog survey which is known to be very accurate.

In Scenario 1., attached, I have aligned the station at Bend A on Enduro to the upstream weld of the same bend on the 1996 Linalog and in that case, the 0.45" Total Sharp reasonably aligns with the Possible Wrinkle Bend at WC 84402' 6.6" which we know to be the origin of failure. In Scenario 2., attached, I have aligned the station at Bend A on Enduro to the downstream weld of the same bend on the 1996 Linalog and in that case, the 0.45" Total Sharp reasonably aligns with the 23% metal loss at WC 84416' 9.4". Note how closely the Linalog data correlates to the "as-built" survey and how poorly, relatively speaking, the Enduro data correlates to the "as-built" data, regardless of which scenario you choose.

In the text accompanying the chart at the failure location (Final Report, page 35 of 80, Bates # OPL 1026535), the downstream bend is located at station 844+05 for both the Enduro station and the OPL station. The 0.45" Total Sharp is located at 843+72 Enduro station that makes it 33' upstream of Bend C. We know from the 1996 Linalog report that the joint upstream of Bend C is 23' 5.8" long and Bend C is 2' 0.5" long. That would place the 0.45" Total Sharp 8' 6" into the joint of pipe containing the origin of failure at the Possible Wrinkle Bend (upstream of the downstream weld). The Possible Wrinkle Bend is defined by the 1996 Linalog survey as being 12' 9.0" upstream of that same weld so this would make the 0.45" Total Sharp fall approximately 4' 3" downstream of the Possible Wrinkle bend.

In another location within Enduro's Final report (Bates # OPL 1026464) the 0.45" Total Sharp is located at 843+69 Enduro Station that makes it 36' upstream of Bend C. Again, we know from the 1996 Linalog report that the joint upstream of Bend C is 23' 5.8" long and Bend C is 2' 0.5" long. That would place the 0.45" Total Sharp 11' 6" into the joint of pipe (upstream of the downstream weld) containing the origin of failure at the Possible Wrinkle Bend. The Possible Wrinkle Bend is defined by the 1996 Linalog survey as being 12' 9.0" upstream of that same weld so this would make the 0.45" Total Sharp fall only 1' 3" downstream of the Possible Wrinkle bend.

In another location (Bates # OPL 1026628), Enduro describes the location of the 0.45" Total Sharp, once again, as being at Enduro Station 843+72.

In yet another location (Bates # OPL 1026630), the 0.45" Total Sharp is located at Enduro Station 843+69. This sheet additionally describes the location of the 0.45" Total Sharp as being

25’ upstream of the downstream weld and 15’ downstream of the upstream weld. This location would put it 1’ 6.2” upstream of the downstream weld in the failure joint but 11’ 2.8” downstream of the Possible Wrinkle Bend and 3’ 0.2” upstream of the 23% metal loss.

In the Enduro hand-written field notes (Bates # OPL 1026461) the 0.45” Total Sharp is described to be at Enduro Station 843+72. It is further stated that the 0.45” Total Sharp is 20’ upstream of Bend C located at “844+04(843+92)”. A measurement 20’ upstream of the bend would place the 0.45 Total Sharp 3’ 8.2” downstream of the 23% metal loss.

In yet another hand-written sheet provided to OPL by Enduro (Bates # OPL 1206454), they describe Bend C as being at Enduro Station 843+90 and the 0.45 Total Sharp as being at Enduro Station 843+69. This places the 0.45” Total Sharp 21’ upstream of Bend C, 2’ 8.2” downstream of the 23% metal loss.

My conclusion is that the written data provided to OPL by Enduro has so many discrepancies in the relocation area that its integrity is highly questionable. In my opinion, a significant portion of the discrepancies can be attributed to Enduro’s attempt to be extremely precise in linear location which simply cannot be done when the data is recorded at a scale of 1::3000. At this scale, a foot of pipe is only 0.004” long on the log paper. The width of the line on the chart is wider than that. It is well understood in the pipeline industry that this class of caliper devices, while providing a good new-construction audit service, does not provide the linear accuracy required for operational applications when precision of location is important.

OPL, at this point had two options available to them that would serve to clarify the situation. They could call the experts at Tuboscope and Enduro and ask them to reconcile the issue, which is done frequently, or they could excavate the location and reconcile it themselves. In either case, it is my opinion that the results would be the same and the mechanical damage would have been found.

When you have reported mechanical damage, no matter how severe, identified on two different surveys by two independent sources in the same general location and you have an additional survey run 5 years earlier that showed nothing, you must be concerned because a rather concentrated change has taken place over a relatively short period of time.

Additionally, OPL had knowledge that a contractor for the City of Bellingham had made modifications to the water treatment plant in the same location as the reported mechanical damage after the survey in 1991 and before the1996/1997 surveys, which required extensive excavation over and around OPL’s pipeline. It is my opinion that it would be prudent for OPL to conclude that the mechanical damage reported by the ILI vendors could have been inflicted to the pipeline by that City contractor. All third party inflicted mechanical damage is considered to be serious and the prudent action would be to excavate the location and confirm that the integrity of their pipeline had not been compromised.

OPL has said that they did not have confidence in the Linalog data for mechanical damage as a result of their experience at the Ebey Slough release. Per the attached Tuboscope “CUSTOMER FEEDBACK REPORT” (Bates # Tubo 000591), OPL contacted Tuboscope

immediately after the Ebey Slough release and Tuboscope confirmed that their equipment did detect the mechanical damage at the release point and further confirmed that it was in the correct orientation and had the correct circumferential extent. (For the record, I have since confirmed the signal presence in the raw data and I concur with Tuboscope's opinion.) It is my opinion that the lesson learned from the Ebey Slough release is quite the opposite of that taken by OPL. Rather than disregard the data, the lesson should be that even though the Linalog conventional MFL pig will not evaluate mechanical damage correctly, if it does see it, it is real and it will be located accurately. Thus, at Bellingham, when a point of mechanical damage was detected, located and reported from the Linalog data, very close attention must be taken because there has already been one release in Ebey Slough due to mechanical damage that was seen by that equipment. Additionally, this release at Ebey Slough was in a buckle (*wrinkle*) adjacent to a *bend* and therefore, OPL should have been even more sensitive to the stated presence of a *Possible Wrinkle Bend* (Linalog 1996).

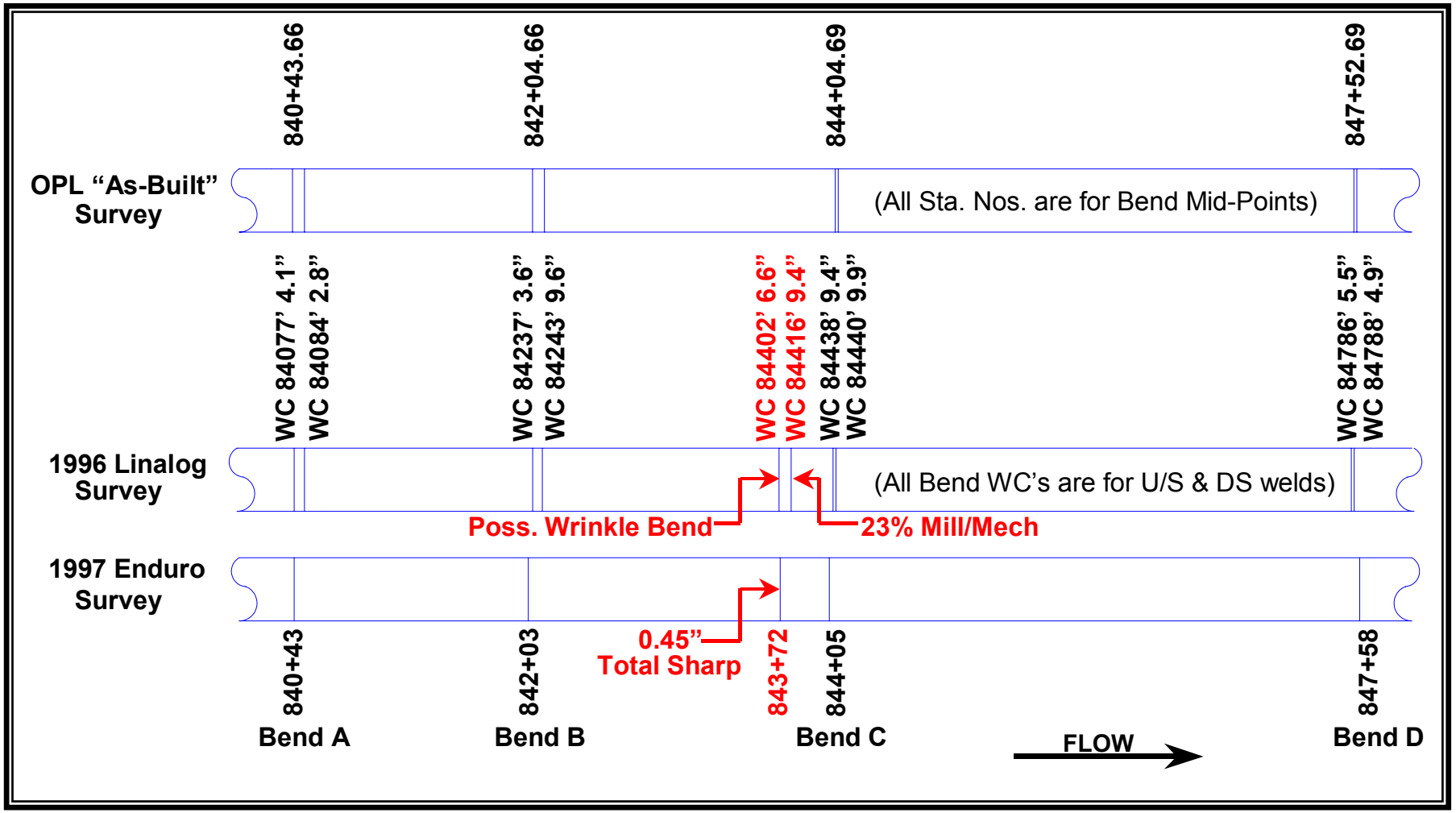
Finally, if you set aside all arguments regarding alignment of the 0.45" Total Sharp, you still have the 23% metal loss coincident with deformation at the possible mash as mentioned earlier, and B31.4 states that you must "replace or repair".

If this is not clear, please advise ASAP.

OPL Failure – Bellingham, WA.

Data Comparison

Scenario 1

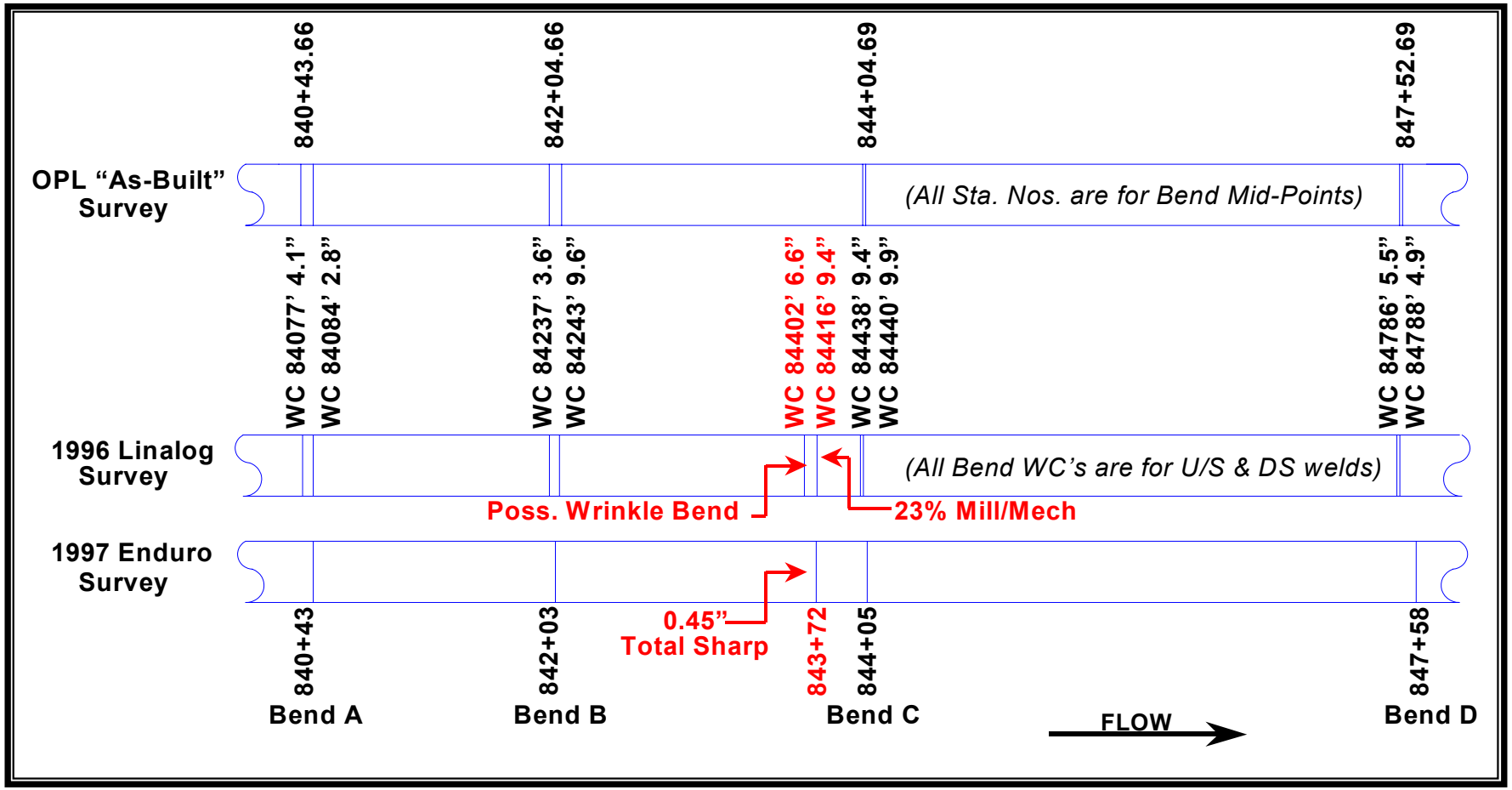


* Assumption: The Enduro Station # for Bend A is aligned with the upstream weld of Bend A on the Linalog Survey.

OPL Failure – Bellingham, WA.

Data Comparison

Scenario 2



* Assumption: The Enduro Station # for Bend A is aligned with the <u>downstream</u> weld of Bend A on the Linalog Survey.