
Improved Alpine Culvert Design

Compared to Kuparuk & Prudhoe Bay Culvert Design

Submitted to



Submitted by



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October 25, 2004
103680-MBJ-RPT-004

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The primary difference between the culverts that have been installed in Kuparuk and Prudhoe Bay compared to those installed and proposed in the Colville Delta, is that the culverts in the Colville Delta are located in a major flood delta. The Kuparuk and Prudhoe Bay culverts convey surface water flow for a variety of flow conditions (Photos 1 – 5). Those conditions include spring breakup floods, flow equalization across roads, and meteorological induced flood events. The culverts at Alpine CD-2 and CD-4 roads are mostly limited to spring breakup flood flows. This is the case because at any time other than spring breakup, the culverts are situated well above the normal water levels of the lakes and channels in the direct vicinity of the CD-2 and CD-4 roads.

The significance of the differences in the hydraulic conditions subjected on the Alpine culverts cannot be overstated. First, unlike the Kuparuk and Prudhoe Bay culverts, the only time that surface water flows contact the Alpine culverts is during spring breakup when the gravel road prism is frozen. This assures that the road prism can provide structural resistance to culvert failure and eliminate the potential for water migration through the road prism that could lead to a culvert wash out.

An additional significant difference is that the 48” CD-2 and proposed CD-4 culverts are steel pipe (Photo 6) rather than CMP, as is the case in much of Prudhoe Bay and Kuparuk. This provides increased strength and structural integrity reducing the potential for failure.

Finally, the hydraulic conditions in the Colville Delta consist of a relatively slow moving overland flood water flow caused by delta wide distribution of spring breakup (Photos 7 – 9). In Kuparuk and Prudhoe Bay, surface water flow is often concentrated in drainages with greater topographical relief than is found near Alpine. The result is higher velocities and increased hydraulic forces subjected onto these culvert systems than the Alpine culverts are subjected to.

Another difference between the installations is that selected Alpine culverts downstream exits are armored with concrete mat with geotextile underlayment on the tundra (Photo 10). In addition, the Alpine culvert entrances and exits are armored with Rip Rap side slope protection (Photo 11). At Alpine, road sideslope protection includes jute mat, and revegetation (Photo 12). These erosion control systems are not typical in the Kuparuk and Prudhoe Bay area and provide further protection against wash out or failure.

Additionally, midpoint steel seepage rings have been installed on selected CD-2 culverts in order to protect the culvert and road from water migration and piping along the culvert. Installation of culvert bedding and insulation beneath each Alpine culvert provides for a sound culvert foundation. In order to assure successful performance during spring breakup, plywood culvert end caps are installed to prevent snow and ice accumulation in the culvert. Finally, extensive construction quality control and spring breakup monitoring services assure that the design improvements are constructed within specification, and that the performance of the culvert system is within project requirements.

In conclusion, twenty-six culverts have been in place in the CD-2 road since the summer of 1999 based on improved design, construction, and monitoring techniques. The culverts have withstood five spring breakup floods without a single culvert failure or any significant sign of culvert degradation or erosion. The CD-4 culverts will be subjected to similar conditions and will perform with similar success.



Photo 1 Culverts located in the East Creek in the Spine Road. (6/8/01)



Photo 2 Culverts located in the Prudhoe Bay Unit (WOA) near W pad. (6/16/00)



Photo 3 Culverts located in the Prudhoe Bay Unit (WOA) near W pad. (6/16/00)



Photo 4 Downstream end of culverts located in the Prudhoe Bay Unit (WOA) near W pad. (6/16/00)



Photo 5 Culverts located in the West Fork of Central Creek in the Spine Road. (8/23/00)



Photo 6 Looking east at south side of the CD-2 road near culvert #15. (6/02/04)



Photo 7 Flow conditions on the south (upstream) side of the CD-2 access road for culverts 4, 5, 6, and 7. (5/28/04)



Photo 8 Looking west on south (upstream) side of road at culverts 4, 5, 6 and 7. Picture taken approximately 24 hours after peak stage was observed in the Alpine infield. (5/28/04)



Photo 9 Looking northeast on north (downstream) side of road at culverts 4, 5, 6 and 7. Picture taken approximately 24 hours after peak stage was observed in the Alpine infield. (5/28/04)



Photo 10 Looking south at the north end of culvert #2. (6/18/00)



Photo 11 Looking north at the south end of culvert #4. (6/18/00)



Photo 12 Facing east along the south side of the CD-2 access road from culvert #22. Looking at culverts #23 and #24. (5/31/02)