Hydrology Report for Swanville

General Information

Swanville Bridge #5282 in Swanville is located on East Side Lake Road, which is a local road just off route 141. The structure crosses Goose River which is made by a small dam directly upstream of the bridge about 100 feet. Swan Lake is on the opposite side of the dam and goes into Goose River. The river flows into Smith Pond, Upper Mason Pond, Mason Pond, and into Belfast Bay.

The dam determines the flow of the river; it is a spill over dam so that the height of the water in Swan Lake will stay relatively constant with respect to the spill over elevation. The drainage area and amount of rain will determine the amount of flow going into the lake and flow leaving the Lake and into Goose River.

The Flow into Goose River at a 50 year flood event is 432 cfs, while the flow is approximately 500 cfs at the 100 year flood event. The average yearly high flow during spring time is 88 cfs.

Hydrology

The drainage area and wetlands area are 28.1 and 6.22 kilometers squared, respectively. These numbers can also be found in the hydraulic information.

Hydraulics

The existing pipe and alternatives were analyzed using HY8. All the alternatives were found to be acceptable in terms of hydraulics, except for the single medium sized pipe arch (Q_{50} and Q_{100}). The input for HY8 can be found in the Hydrology & Hydraulics data.

Scour can also be checked from a Q_{50} velocity. As a scour countermeasure plain rip-rap along with bedding material can be put down on the new downstream side. The velocity of the water is about 10 feet per second during the 50 year flood event. Plain rip-rap will be used for this project, and will go up to the elevation of the 50 year flood event and extend five feet beyond the structure in both directions.

The different alternatives that were looked at was the existing two 6 foot high by 9 feet wide pipe arches, two concrete boxes, one single 7.42 feet high by 11.62 feet wide pipe arch, and finally a single 8.77 feet high by 14.12 feet wide pipe arch.

For pipe type structures the BDG (2-30) states that the headwater depth versus structure depth (HW/D) should be approximately equal to or less than 0.9 during a Q50 flood event. According to HY8 the existing conditions meet the requirement of a 0.9, with HW=4.69 feet and structure depth is 6.11 feet. This gives a HW/D to be 0.76 which is significantly lower than a 0.9 so the existing condition is conservative. The concrete box had a HW height to be 4.33 feet at Q50 and a structure depth of six feet. HW/D is 0.72 which is low but it was asked to meet or exceed the current hydraulic capacity. The single medium sized (7.42 by 11.62) pipe arch had a HW height of 6.84 feet, and the largest depth structure that could fit into the existing conditions without raising the roadway was 7.42 feet. The HW/D value is 0.92 which was close to the 0.9 value needed at Q50 flood. This structure also does not meet the change in headwater elevation at Q100 flood event. The existing condition at Q100 flood has a headwater elevation of 79.92 feet while the single medium pipe head water elevation at Q100 flood event is 81.85 feet, given that the bottom of the pipe at the upstream side is at an elevation of 74.30 feet. This is close to two feet of difference in head water elevation (1.92 feet) between the existing conditions and the alternative single medium pipe (BDG 2.3.10.4). The maximum difference, without a lot more paper work, is one foot. Even though this requirement is set to keep peoples houses from flooding and there are no houses between the road and the dam it would still mean doing a very extensive hydrology analysis. The alternative of a single medium sized pipe arch will no longer be looked at. The large pipe arch (8.77’ by 14.12’) has a HW=5.98 feet while the structure height is 8.77 feet. This gives a HW/D to be 0.68 which is also conservative. The one foot difference between the existing head water elevation and the new head water elevation just barely makes the restriction at 0.95 feet. This was again the controlling factor when a single pipe is used.

Another requirement states that there be a minimum of 1 foot of freeboard at the edge of the pavement at Q100 or the flood of record when outlet conditions control. After talking to the dam owner he indicated that when the dam lets out as much water as it can, tailwater conditions do occur because of the swamp area directly after the bridge. He also said that the river does not drop by more than a foot or two over the next three miles. He said that the water does back up into the culvert at high water but does not get within one foot of the pavement when the dam is wide open.

Dams need to be analyzed hydraulically for the following two situations, with the existing dam in place and when the existing dam is removed. The flood flows are done as if the dam was not present. It is very unlikely that this dam would ever be taken out because people have their homes on Swan Lake, but if it is taken out then the structure would still be able to handle the flow.

If the dam ever broke because of a high water event then the pipes would see significant water flows, and would probably fill up the little volume between the dam and roadway rather quickly. There are precautionary measures that can be taken so that the pipes will be less likely to be washed downstream. This is done by making the low point in the roadway away from the pipes, and rip-rapping the bank that is below this area according to the fall lines. This accomplishes two tasks; one to keep the soil directly above the pipes intact so that the pipes are less likely to float off, and two, the rip-rap does not allow the embankment to be eroded away. Currently the low point of the roadway is away from the pipes at 10+60, while the pipe location is at 10+20. This follows the logic if this unlikely event were to ever occur, as long as the embankment is rip-rapped on the downstream side at 10+60.

A site visit occurred on March 26, 2009 during a period of high water (See Pictures). One problem that is occurring at the site is that the business owner is plowing snow into the area where one culvert discharges the water. This could be plugging up the water and causing the culverts not to function correctly. One thing that we might be able to do to stop this from occurring is to put in a 15 foot radius guard rail around that corner. During the site visit, it was found that there is approximately three feet of cover over the existing pipes.

Environmental situation sometimes arise where the water needs to be constantly flowing during construction. John Perry, of Maine DOT Environmental Office, confirmed that there is no need to keep the river flowing during construction. The dam owner may be able to turn the water down to a minimum low flow of 5 cfs which would help the Contractor during construction.

Two 8 foot plastic pipes were also looked at for this project however the cost of these pipes are typically very high and only justifiable in special situations where the water is so corrosive that it is corroding the aluminum pipe, or an area that DOT does not wish to dig up for another 100 years like the interstate.

In conclusion, three alternatives that can be looked at are raising the road approximately 16” and installing one single large (8.77’ by 14.12’) pipe arch, installing two smaller pipe arches that are approximately the same size as the existing pipes, or two concrete boxes (8’ by 6’).

Hydraulic Summary:

	One large 8.77' high by 14.12' wide Pipe Arch	Existing two 8'-10" wide by 6'-1" high Pipe Archs	Two Concrete boxes (8' wide x 6' high)
Area of Opening (ft2)	96	86	96
Headwater El. @Q50 (ft)	196.58	195.69	195.33
Headwater El. @Q100 (ft)	197.07	196.18	195.78
Velocity @ Q50 (ft/s)	9.14	9.14	9.14
Velocity @ Q100 (ft/s)	9.57	9.57	9.57
Ordinary High Water El. @ Q1.1	193.41 ft	193 ft	192.62 ft
Design velocity @ Q1.1 (ft/s)	5.59	5.5	5.59