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August 25, 2014

Jane Clark
Spokane Co Engineers Office
1026 W. Broadway
Spokane, WA 99260-0170

Dear Jane-

Attached please find report of, and an invoice for, dive inspection of the Newman Lake oxygenation and alum systems conducted in earlier this August.

Overall, things looked in very good shape, but I do suggest we address the oxygen/water ratio issue. Looking back through my notes, this was suggested previously as well. Paul has some recommendations for options that should make adjustments easier in the future, so that may be one way we can go. I hope to get more details from him and a specific proposal, so look forward to discussing that with you soon.

Thanks for your help,

Barry Moore
General Manager

Newman Lake Hypolimnetic Oxygenation/ Alum Injection Systems Inspection Report to the Newman Lake Flood Control Zone District August 2014

Barry C. Moore

Multiple dive inspections, followed by video documentation, were performed on August 13, 2014 on in-lake portions of the Newman Lake hypolimnetic oxygenation and alum injection systems. Per applicable regulations, two divers performed the inspection and video dives, with a third safety diver ready on the support boat. A summary of findings is as follows:

Intake pump housing was in place and secure with no signs of mechanical damage. The intake screens were in place and good condition; there are no signs of breakage, but were covered in filamentous algae and bacteria. This is not an issue and should only minimally restrict water flow.

Electrical lines were in place and intact with no signs of wear or mechanical disturbance.

Intake piping to Speece Cone was in good shape. Flanges and joining bolts were in good shape, no sign of corrosion or leakage between joints evident as seen several years ago.

Oxygen inlet line was is in place and secure with no signs of mechanical displacement.

Speece Cone itself is in good shape, with no signs of mechanical damage. Flanges and jointing bolts were secure, with no leakage evident in any portion of the cone. The vent riser at the cone outlet was in place and secure, and appeared to be functioning well, although the riser is of insufficient size to handle all excess gas that appeared to be exiting the cone.

The piping and flanges that loop upward, connecting the cone to the manifold were in good shape, secure, with no sign of mechanical twisting that led to the previous failure.

The manifold itself was in good condition. Repairs performed on the manifold about 7 or 8 years ago resulted in the first two ports being installed so that they discharge upward, rather than to the side. A right angle fitting was installed on one of these ports to divert the flow horizontally, as it should be oriented. However, the other port discharges directly vertically, and is the source for a significant portion of bubbling that can be observed at the surface. This is certainly not enough to contribute to destabilization of the thermocline, but likely produces a mounding effect of colder water around the bubble plume. At some point, it would be worthwhile to install a right angle port as on the other vertically-oriented port. This might be done during the regular inspection next year to minimize additional costs for mobilization and diver time.

All joints along the manifold were secure without any evidence of separation. All of the piers, banding straps that connect the piers to the manifold pipe, and associated bolts were in good condition, with no signs of breakage or movement.

Alum injectors were in good shape, with no sign of mechanical disturbance. As typical, there was substantial crust of precipitated alum on the insides of the injectors, but this should not alter their function. As noted in previous inspections, the alum lines have been pulled up and over the manifold, but were still connected. Fishing line wrapped around the lines indicates that the lines are still being snagged. As long as this is just by fishermen, there is likely no serious risk of pulling the alum lines out of the injectors. However, if an anchor catches a line, then this could result in the substantial damage to the system. As in previous reports, this could be addressed by having a diving contractor reroute the alum lines and better secure them to the manifold so the offer less risk of snagging. The current "no anchor zone" does provide some protection if boaters observe the warning.

At the time of the inspection, there seems to have been an increase in bubbles plumes that reach the water surface, downstream of the cone and along the axis of the manifold, compared to previous years. These bubbles may be due to "burping" as un-dissolved oxygen builds up in the cone to the point where the cone volume is exceeded, and a large bubble is swept out to exit the riser and along manifold ports. Such burping greatly reduces the oxygen transfer efficiency, and likely puts mechanical stress on the riser and connective piping to the manifold.

Another source of bubbles was cavitation bubbles that form due to reduction in gas solubility due to low pressure in the high velocity outlet stream of each port as water exits the manifold. This phenomenon has been observed since the cone was first installed, but our impression from this year's inspection is that the cavitation phenomenon has moved further downstream from the cone. Cavitation could be observed more than halfway down the length of the manifold.

The overall increase in bubbles likely is due to an increase in the oxygen/water ratio. Since the water pumping rate is constant, there may have been a change in oxygen delivery. Graphs of oxygen transfer efficiency in Speece Cones display a very pronounced inverted-V shape. This indicates there is a distinct "sweet spot" of maximum transfer efficiency that should be the operative target for oxygen/water in these systems. Past adjustments seemed to have been somewhat successful in reducing the surface bubbling, but the respective rates appear to have been altered, potentially through mechanical wear or vibrational changes that have altered settings and adjustments.

Currently, there is a rotometer that controls oxygen delivery rate. This is a relatively crude control device and provides only rough guidance of oxygen flow rate. I am unclear if this device has been calibrated to the system. One option that the district should consider is installation of a more accurate oxygen flow controller and meter. Coordinated with in-lake measurement of oxygen output in the manifold, such a controller could provide the ability to adjust oxygen/water ratios each year to optimize transfer efficiency and actual delivery of oxygen to the hypolimnion.

Our work has definitively shown that the Newman system can maintain oxic conditions in the hypolimnion, and that phosphorus release is effectively controlled when that is the case. However, we have also learned that hypolimnion responds very quickly to removal of oxygen whenever the system is shutdown. Therefore, maximizing efficiency of oxygen delivery will provide best and most economic use of the system in terms of phosphorus control and water quality protection.

Overall, the systems were observed to be in good to excellent mechanical condition, with only minor potential repairs or alterations needed. These suggested alterations are not critical and can be postponed until other work or inspections are needed to minimize costs. However, it is recommended that the District strongly consider the oxygen metering and controller upgrade, as this will likely improve overall oxygen delivery to the hypolimnion and thus to improved ability to maintain oxic conditions.

Business Invoice

CLEARWATER COMPANY, LLC

Invoice number: NL201401
Invoice date: 25-Aug-13

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Pullman, WA 99163
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Client name: Newman Lk Flood Ctr Zone District
Address: 1026 W Broadway
City, state, postal code: Spokane WA 99260-0170

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PO number: deliver

Date	Persons	Activity	Hours	Rate	note:	Cost
8/12/14	1	Mobilzation fee		75.00		75.00
8/13/14	3	Diver time	6.0	125.00	<30ft rate/min 6 hrs	2,250.00
8/24/14	1	Video archive/report	2.0	35.00		70.00

Total activity cost: $2,395.00

Total billing: $2,395.00