St. Mary River Irrigation District

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Gabion Wall Infiltration Systems
Aquatic Weed & Algae Control Structures (2010): IRP #2192
Yellow Lake Lateral 4: IRP #2052
Performance Update

Monitoring of the performance Gabion Wall Infiltration Systems installed in fall 2009/winter 2010 was completed over the 2010 irrigation season.

The sites include:

Aquatic Weed & Algae Control Structures (2010): IRP #2192

1. Site 3: Chin Lateral 7 Settling Pond
2. Site 4: Yellow Lake Pump Structure Inlet
3. Site 5: West Medicine Hat Lateral 18&20 Settling Pond

Yellow Lake Lateral 4: IRP #2052

1. Yellow Lake Lateral 4 Settling Pond

All sites involve retrofit of a gabion wall infiltration system upstream of an existing pipeline or pump inlet for the purpose of excluding macrophytic aquatic weeds and filamentous algae mats. The aquatic weeds and algae are intended to be retained in the upstream pond/bay while filtered irrigation water flows through/around the mass, through the pore spaces of gabion rock and into the inlet structure. Periodic removal of excessive buildup with a hydraulic excavator can be done during the irrigation season if operation of the system is affected. Residual organics are expected to be decomposed during the off-season.

Notes on 2010 Irrigation Season

The 2010 irrigation season was not typical as it was unusually cool and wet with much lower than normal irrigation demand and much higher than normal runoff. The growth of aquatic weeds and algae was generally later and less vigorous than normal throughout the district. This resulted in significantly less than design loading for all sites except the Yellow Lake Pump Structure Inlet for aquatic weed and algae exclusion and hydraulics, and Chin Lateral 7 for hydraulics. All sites were evaluated for structural components and future design considerations.

2010 Monitoring

The monitoring involved site inspection at various times during and following the irrigation season to determine whether this technology is meeting the intended purpose of **aquatic weed and algae exclusion**, to assess **hydraulic performance**, to evaluate suitability of the **structural components** of the system and to identify **lessons learned** and opportunities for improvement or refinement of the **design**. Additionally, Water Coordinators were asked to consult their irrigators with respect to their observations following installation of the gabion wall infiltration system.

Aquatic Weed & Algae Exclusion

Accumulations of aquatic weeds and algae were found on the upstream side of all systems except Yellow Lake Lateral 4. The region downstream of all systems was free of suspended aquatic weeds and algae. The following described photos summarize the observations at each site:

CHIN LATERAL 7 SETTLING POND

The Chin Lateral 7 Settling Pond was observed July 22, August 6 and August 11 during the irrigation season. The highest loading is shown in these photographs and was observed on August 11th. Both aquatic weed and filamentous algae mats are present on the upstream side. The Water Coordinator indicated that the total growth of aquatic weeds and algae was similar to previous years, but lower than normal flows through most of the irrigation season meant that less migrated toward the pipeline inlet.

In this second photo the distinct change in presence of aquatic weeds and algae on either side of the wall is observed. The fine screen on the inlet structure was in place during the entire irrigation season with no accumulation. Irrigators reported to the Water Coordinator that the gabion wall "is a blessing to them" and that they are not needing to clean their on-farm pressure filters very often compared to previous years.

YELLOW LAKE PUMP STRUCTURE INLET

The Yellow Lake Pump Structure Inlet was observed June 29, July 22, August 5 and August 18. Screened sampling and qualitative analysis of the upstream and downstream water were completed once significant aquatic weed and algae loading entered the inlet bay. This photo shows the general configuration of the gabion wall infiltration system relative to the inlet.

This second photo shows the results of a double deep sweep (approx. 2 m) along the inside of the wall approximately 10 m from the inlet on the east side (photo is facing south). The organics collected in the screened material include short filaments of algae and freshwater shrimp.

This third photo shows a sample of weeds (primarily coontail) retrieved in a single pass shallow sweep opposite the sample take on the inside of the wall. Probing indicated that the weed mat was quite deep, possibly accumulating to the bed of the bay. Note the higher cloudiness of the upstream water, indicating that at least a portion of the algal filaments are being filtered by the upstream aquatic weed mass.

WEST MEDICINE HAT LATERAL 18&20 SETTLING POND

The West Medicine Hat Lateral 18&20 Settling Pond was observed July 22, August 6 and August 18. Although the primary historic problem in this dead-end canal is filamentous algae mats, this photo shows that long-stemmed submerged weeds are an additional problem that was excluded by the gabion wall infiltration system.

This second photo shows that the trash rack on the pipeline inlet structure remained clear of aquatic weeds and algae.

YELLOW LAKE LATERAL 4 SETTLING POND

The Yellow Lake Lateral 4 Settling Pond was observed June 29, July 22, August 5 and August 18.

Very low irrigation demand and negligible aquatic weed and algae loading were typical of this system for the 2010 irrigation season.

Hydraulic Performance

Only two of the four gabion wall infiltration systems experienced design flows during the 2010 irrigation season. An assessment of their hydraulic performance is provided below:

CHIN LATERAL 7 SETTLING POND

There were two days of during the 2010 irrigation season during which the Chin Lateral 7 system was operating near design flows. The Water Coordinator indicated that during this time aquatic weeds and algae that were growing in the canal was being transported to the gabion wall. There was no measurable difference in the water level on either side of the wall, indicating negligible hydraulic restriction with low weed loading.

YELLOW LAKE PUMP STRUCTURE INLET

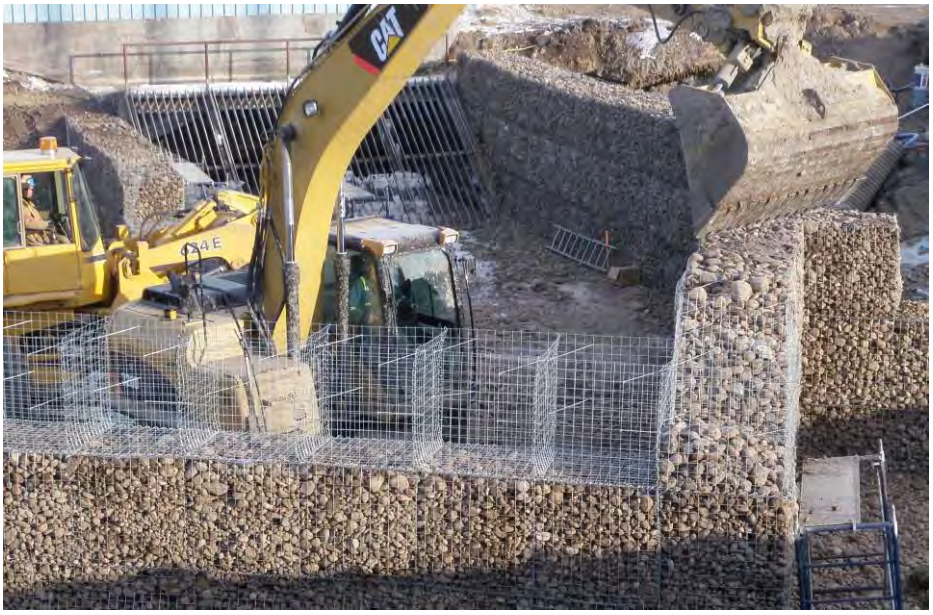
Due to high runoff, both pumps were operated through the entire 2010 irrigation season. At maximum weed loading, there was no measurable difference in water level on either side of the wall. A careful inspection along the wall revealed that inflow was relatively uniform, indicating that flow was maintained through the weed mat. A high factor of safety was used in setting the design

velocity at this site due to low accessibility for maintenance. The low velocity through the wall ensured that entrainment against the structure was avoided. Maintaining velocities below the entrainment velocity avoids compression of the weed mat, permitting infiltration of water throughout. The self-compensating nature of the infiltration system aids in maintaining uniform flow such that a small change in resistance in one area results in a small increase in flow in another such that the magnitude of the restriction is limited. This will continue to be valid so long as entrainment velocities are not reached such that zones of complete blockage are not formed. Ongoing evaluation of the hydraulic performance of these systems will permit refinement of design principles to avoid failure and to improve economics based on site specific conditions as well as expand applicability to a greater number of existing sites.

Structural Components

All systems were constructed from Atlantic Industries Limited welded wire gabions assembled and installed by SMRID forces from 11 gauge galvanized roll stock, 12 gauge galvanized spirals and 9 gauge galvanized corner stiffeners. Baskets were custom cut and pre-assembled in the shop and transported to site for placement, joining, filling and in some cases topping. Pre-assembly included lifting, joining and stabilizing (with corner stiffeners) of the side panels as well as the intermediate panels that form the 1 m long cells.

This system was preferred over the conventional double twisted mesh (typical of chain-



link fence) for the ability to lay flat, hold their shape and be easily joined by twisting a spiral wire instead of hand lacing. This system was easy for the crews to learn, minimized outdoor exposure and allowed most of the joining to be done with gloves on. Additionally the corner stiffener system allowed the baskets to be filled without adding cross-members. This allowed a length of wall to be completed before moving on and minimized worker and excavator interaction. The only condition for uninterrupted filling is that a low gradient of fill be maintained along the section of wall being filled to equalize the forces between cells. Equalization is required to ensure straight side walls by preventing alternating bulging/contracting.

The galvanized coating was preferred over PVC coating as a heavier gauge of wire could be used for the same price, improving stiffness, and the life expectancy was the same. Also, SMRID has many galvanized steel structures, including the intake trash rack at this site, that have held up well.

Any settlement/bulging occurred during and in the first few days following installation. The lack of any significant live load on the wall minimizes shifting that can cause loss or further settlement of the fill rock. No broken welds were found on any of the structures during a fall post-season inspection.

There was only one area of the Chin Lateral 7 structure that had excessive bulging due to a longer than 1m long cell used on a custom fit to the bank.

A small swale is noticeable, but the forces seem to have been distributed throughout with no breakage of strands or welds. The inclusion of freeboard height ensures this structure will not be overtopped during high demand.

The gabion walls were built level and straight for the most part. Leaning of structures are within design tolerances, with no apparent advancement of initial leaning. The placement of buttresses ensures that 8 m is the longest reach of self-supporting wall. The nature of the welded-wire basket system makes straight lines relatively easy so long as the base is prepared well, centerlines are followed and connections are tightened. Base preparation was a challenge for the Yellow Lake Pump Structure Inlet site and the West Medicine Hat Lateral 18 & 20 site. Over-excavation of unstable foundation materials was replaced with heavy rock (YLP) or pit run (WMH 18 & 20). Replacement with heavy rock was found to be more successful as the WMH 18 & 20 structure experienced more initial leaning. Care was also required in Yellow Lake Lateral 4 to protect the underlying PVC membrane liner. This construction was completed following freezing of the underlying ground, but during temperatures that were above the point that the liner becomes brittle. The primary protection was use of the gabion fill rock as a temporary base for the track hoe to walk on during base preparation and basket filling. There was no evidence of liner leakage during the subsequent irrigation season.

Lessons Learned and Future Refinements to the Design

The following lessons have been learned and ideas generated for refinement of designs for Gabion Wall Infiltration Systems for IRP # 2177 – Aquatic Weed & Algae Control Structures (2011) and beyond:

- Ensure the surface area is adequate to prevent entrainment of weeds where significant loading is expected.
- Increasing the length of the wall by running along the length of the bed improves performance by reducing infiltration velocity and by directing accumulated debris to a potential collection point. Consider wind direction when designing the shape.
- Use of gabion wall infiltration systems in canals has potential as a reduced length is possible due to self-cleaning flows similar to wind clearing (above).
- Ensure foundation is solid and base is level and uniform.
- Pull all spirals tight to improve rigidity and straight lines, to minimize bulging and to improve the alignment with overlying rows.
- Add a third set of stiffeners to the bottom row of walls exceeding 2 metres high to reduce bulging.
- Ensure stiffeners are placed over both intersecting wires to reduce stress on the weld.
- Ensure ends of stiffeners are well crimped with no gap to ensure ends don't disengage during basket filling.
- Mimimize use of gabion fill materials smaller than 75 mm and larger than 150 mm. Small materials will be contained within the baskets if sufficient mid-size materials plug the openings. Use of some smaller materials will improve filtering. Larger rocks are more difficult to control when filling baskets and can damage the stiffeners and cause excessive pressure on internal panels, deforming the cell.
- Minor hand sorting and light (foot) tamping of gabion fill improves the tightness of the fit in each cell and will reduce settlement potential.
- When custom cutting for slopes, ensure cell length does not exceed 1 m and sufficient stiffeners and internal panels are in place to retain the shape.
- The low profile buttress design of Chin 7 is preferred over the stepped buttresses in minimizing obstruction during construction and future pond maintenance.
- Cover the top of the wall with wire mesh where operation, maintenance or inspections require.
- Where free-floating or short filaments of algae (Yellow Lake Pump Structure Inlet) are passing through the wall, supplemental filtering could be obtained by installing temporary organic filter mats on the upstream side of the wall. Products such as erosion control blankets may be tested at this site to reduce the potential downstream "seeding" of the North Grassy and North Burdett canal systems.

- Alternatives to the welded wire gabion basket system will be investigated further. The concept of a twin parallel fence system could reduce the thickness of the wall and eliminate the basket pre-assembly time. The major issues to solve include design of a suitable frame/anchor system and internal supports for controlling bulging during filling. Other concepts will be considered where they may reduce costs or improve performance.

Conclusions and Recommendations for Future Use

Initial monitoring of the Gabion Wall Infiltration System has shown that where appropriately sized and aligned for the specific site conditions, this technology is able to successfully exclude macrophytic aquatic weeds and filamentous algae mats with negligible hydraulic effects. Some exclusion of short algal filaments occurs when a sufficient buildup of upstream debris is present. The welded wire gabion system is suitable for this application where the foundation and base is solid, uniform and level, the unsupported wall length is limited to eight metres, stiffeners are located and installed properly and baskets are joined with spirals and pulled tight.

SMRID recommends continued use of this system with improvements where appropriate. Should you have any questions, feedback or concerns, please contact me at the office or on my cell (403-332-3111) or e-mail: cgallagher@smrid.ab.ca

Sincerely,

Christopher Gallagher, P. Eng.
Design Engineer

cc: T. Helwig; D. Joachim; J. Tamminga; C. Orr; T. Crooks