Project: 3505  
Fir Island Farm Ecosystem Restoration  

Date: 07/13/2015  

Title: Submittal: FIF Subm 037, 31700 Dewatering Plan - Tidegates & Pump Station  
Type: Required Submittal  

To: WDFW  
600 Capitol Way N.  
Olympia, WA 98501  

Attention: Ray Berg, Project Manager  

Re: Dewatering Plan - Tidegates & Pump Station  

Please review one copy of the electronically submitted Dewatering Plan – Tidegates & Pump Station submittal in accordance with the contract specifications Section 31700 – Dewatering.  

Return to the attention of Jamie Howard at address above.  

<table>
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<th>Date</th>
<th>Copies</th>
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Jamie Howard  
IMCO General Construction
DEWATERING PLAN

The following Dewatering Plan includes the following information for construction of the tidegates and the pump station:

1. Middour Consulting Dewatering Plan
   a. This document is attached and includes; an introduction, conceptual groundwater control approach, dewatering system design calculations, and dewatering system construction recommendations.

2. Dewatering Well Drilling Subcontractor

3. Submersible Pumps

4. Execution
1. MIDDOUR CONSULTING DEWATERING PLAN

Please see the attached Middour Consulting plan.
Supplemental Groundwater Control Plan
Fir Island Farm Ecosystem Restoration
Skagit County, Washington

July 10, 2015

Prepared for
IMCO General Construction
2116 Buchanan Loop
Ferndale, WA 98248

MIDDOUR CONSULTING LLC
14241 NE Woodinville Duvall Rd, PMB 226
Woodinville, WA 98072
(425) 864-2719
TABLE OF CONTENTS

INTRODUCTION 1
CONCEPTUAL GROUNDWATER CONTROL APPROACH 1
DEWATERING SYSTEM DESIGN CALCULATIONS 2
  Drawdown Analysis 2
DEWATERING SYSTEM CONSTRUCTION RECOMMENDATIONS 3
  Dewatering System Components 4
  General System Requirements 5
LIMITATIONS 6

LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Summary of Excavation Dimensions, Elevations, and Discharge Rates</td>
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</table>

LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dry Slough – Slough to Skagit Bay Drawdown Profiles</td>
</tr>
<tr>
<td>2</td>
<td>No Name Slough Dewatering System Layout Plan</td>
</tr>
<tr>
<td>3</td>
<td>Pump Station Dewatering System Layout Plan</td>
</tr>
<tr>
<td>4</td>
<td>Dry Slough – Pond to Slough Dewatering System Layout Plan</td>
</tr>
<tr>
<td>5</td>
<td>Dry Slough – Slough to Skagit Bay Dewatering System Layout Plan</td>
</tr>
<tr>
<td>6</td>
<td>Dewatering System Construction Details</td>
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</table>
INTRODUCTION

This report serves a supplement to our Groundwater Control Plan (GWCP) dated June 11, 2015 which provides a summary of the project and subsurface conditions. This supplemental plan only provides the groundwater control approach and design calculations for construction of the No Name Slough tide gate, Dry Slough tide gates, and pump station at the Drainage Storage Pond which is currently under construction. A summary of the subgrade and pipeline invert elevations for the various structure excavations are listed on Table 1. Construction of the tide gates will require constructing coffer dams within the sloughs to isolate the excavation from the surface water. IMCO has prepared coffer dam construction plans which will be submitted under a separate plan.

CONCEPTUAL GROUNDWATER CONTROL APPROACH

The excavations for the tide gates and pump station will encounter a partially confined aquifer with a groundwater elevation of about 3 feet and will require 6 to 12 feet of drawdown to lower groundwater 2 feet below the various structures. Based on our interpretation of the hydrogeologic data, controlling groundwater in the Ha deposits is the primary focus to successfully dewater the structures as the permeability of the underlying He deposits is a few orders of magnitude lower. Based on our interpretation of the slug test and grain size data, we estimate hydraulic conductivity of the bulk of the Ha soils to be between $1 \times 10^{-1}$ to $4 \times 10^{-2}$ ft/min.

Based on the relatively clean soils comprising the Ha deposits which appear to be continuous across the project site either a vacuum wellpoint system or a system of large diameter dewatering wells is appropriate. Due to the relatively narrow construction footprint for the tide gates and pump station, we understand that IMCO would prefer to use a system of deep wells to allow better access to the excavation. As such, we have designed dewatering systems for the various structures using a system of deep wells and the design assumes there are no beneficial effects from the dewatering efforts at the Drainage Storage Pond. However, if construction of the tide gates and/or pump station that are proximate to the Drainage Storage Pond coincide with active dewatering for the pond construction then some of the dewatering wells may not be required. The Dewatering System Construction Recommendations section provides further details about determining if some of the dewatering wells can be eliminated.
DEWATERING SYSTEM DESIGN CALCULATIONS

Dewatering system design calculations were performed to evaluate the number of wells and discharge rates to lower groundwater levels 2 feet below the deepest subgrade. Dewatering calculations were performed using a computer spreadsheet model that accounts for well interference among multiple pumping wells and aquifer boundary conditions using the principle of superposition and image well theory. The spreadsheet model calculates the net drawdown from all pumping and image wells through a predetermined section of the aquifer or area of interest by solving the Theis non-equilibrium equation for drawdown using the radius associated with each pumping and image well.

Soil and groundwater parameters used in the dewatering design calculations were derived from the geotechnical and hydrogeological reports or were estimated from previous experience if not contained in the project reports and are listed below:

- The aquifer is initially partially confined but converts to unconfined conditions as dewatering progresses.
- Maximum groundwater elevation of 3 feet (about 3 to 4 ft below ground surface)
- Minimum Ha aquifer thickness; 12 feet near the pond and 20 feet near Skagit Bay
- Ha soil hydraulic conductivity: $5 \times 10^{-2}$ ft/min near the pond and $1 \times 10^{-1}$ ft/min near Skagit Bay; we feel the hydraulic conductivity values on Table B-1 estimated by the Butler method are skewed
- Subgrade elevation; varies, see Table1
- Specific yield is 0.15 (unitless)

Design calculations using the soil and groundwater parameters listed above indicate operating a system wells at each of the various excavations for a period of 7 to 10 days will lower groundwater levels 2 feet below subgrade. The Table 1 provides a summary of the number of wells and projected discharge rates for the various structure excavations. For demonstrative purposes, the output from the spreadsheet model for one of the excavations is shown on Figure 1 which displays the estimated drawdown cone of depression parallel and perpendicular to the Dry Slough to Skagit Bay tide gate excavation.

DRAWDOWN ANALYSIS

As a result of operating the dewatering system, drawdown of the water table may extend beneath subsurface and above ground structures. The cone of depression will continue to expand with time however, predicting the distance and amount of drawdown becomes increasingly difficult as the cone of depression encounters undocumented soils and aquifer conditions. Middour Consulting has not estimated the potential range of settlement nor has Middour Consulting or IMCO implemented any
engineering controls to limit the amount of drawdown. Middour Consulting’s scope of work did not include these evaluations and Middour Consulting assumes no liability for impacts due to lowering of groundwater levels.

DEWATERING SYSTEM CONSTRUCTION RECOMMENDATIONS

Depending on the sequence of work, some of the excavations covered in this plan may coincide with active dewatering for the Drainage Storage Pond construction as such, we recommend determining the current groundwater level at the structures proximate to the pond prior to installing the proposed dewatering systems. Potholing near the proposed excavation and surveying the water level is the recommended approach for determining the cone of depression created by the pond dewatering system. If the proposed excavation is partially dewatered by the pond dewatering system, IMCO should consult with Middour Consulting to determine if any of the proposed dewatering wells can be eliminated otherwise the proposed dewatering systems listed below should be implemented.

- **No Name Slough**: the dewatering system consists of two dewatering wells at each headwall; the proposed locations are shown on Figure 2. The dewatering wells should be installed to an elevation of -15 feet and consist of a minimum of 15 feet of well screen.

- **Pump Station**: the dewatering system consists of two dewatering wells at the trash rack and two dewatering wells within the sheet pile cells for the pump station excavation; the proposed locations are shown on Figure 3. The dewatering wells at the trash rack should be installed to an elevation of -15 feet and consist of a minimum of 15 feet of well screen. The dewatering wells within the sheet pile cell should be installed to a depth of 2 feet less than the depth of the sheet piles.

- **Dry Slough – pond to slough**: the dewatering system consists of two dewatering wells at each headwall; the proposed locations are shown on Figure 4. The dewatering wells should be installed to an elevation of -15 feet and consist of a minimum of 15 feet of well screen.

- **Dry Slough – slough to Skagit Bay**: the dewatering system consists of two dewatering wells at each headwall; the proposed locations are shown on Figure 5. The dewatering wells should be installed to an elevation of -20 feet and consist of a minimum of 20 feet of well screen.

General construction details for the dewatering wells are shown on Figure 6.
DEWATERING SYSTEM COMPONENTS

**Dewatering Wells:** Boreholes should be drilled using bucket auger drilling methods and should be 30- to 36-inch-diameter. Well casings and screen should be 12-inch diameter Schedule 40 PVC. Based on the grain size data from the soil borings, well screens should consist of 30-slot screen size. A typical schematic of a dewatering well and construction details is shown on Figure 6. For well screen lengths and bottom completion elevations refer the dewatering systems listed on page 3.

We recommend that Middour Consulting monitor the initial drilling, well construction, and well development to verify site conditions. Subsequent wells should be logged and sampled by the driller/dewatering subcontractor. The dewatering subcontractor and/or IMCO should notify Middour Consulting if subsurface conditions differ from those described in this report and/or those observed during drilling the initial dewatering wells in each area.

**Sand Pack:** Sand pack material should be similar to the gradation of a 16 x 30 to 12 x 20 sand pack or something in between. The sand pack should extend above the static water level with a bentonite seal on top of the sand pack. Well and seal construction should be consistent with WAC 173-160.

**Development:** Development is important to improve the hydraulic connection with the aquifer and provide a clean dewatering effluent with time. We recommend that each dewatering well be developed immediately upon completion. Development methods should utilize flow-surging and over-pumping until the discharge requirement is achieved. Development data should be documented to demonstrate that additional development would produce limited improvement.

**Pumps:** Pumps that are capable of operating in dry well conditions should be provided in each well. The dewatering wells should have pumps capable of providing up to 75 gpm under 40 feet of total dynamic head (TDH).

**Header and Conveyance Piping:** The header and conveyance piping should be constructed of PVC or HDPE pipe of the appropriate diameters listed on Figure 6.

**Operation:** The dewatering systems should operate a minimum of 7 to 10 days prior to excavation below the static groundwater level. The dewatering wells should be inspected daily by the dewatering contractor or other personnel trained to operate the dewatering system. Visual observations of the discharge should be made several times a day during excavation, to monitor for increased turbidity levels. Middour Consulting should be contacted if there is anomalous dewatering system performance. This may include pumping rates that differ significantly from rates presented in this report, the occurrence of a sudden change in pumping rates or groundwater levels, or the occurrence of turbidity levels that exceed discharge limits.
**Well Decommissioning:** The dewatering wells should be decommissioned in accordance with WAC 173-160 upon completion of dewatering activities.

**GENERAL SYSTEM REQUIREMENTS**

**Sumps:** One or more sumps may be required inside the excavation. Sumps should be cased with 12-inch-diameter, 30-slot well screen to avoid pumping of fines. The sand pack used to construct the wellpoints should be placed around the sump casing/screen.

**Power Supply:** A continuous main power supply from portable generators or line power is required for all wellpoint systems and dewatering well pumps. We recommend that a backup power source is available on site in the event of a power failure from the main power supply.

**Water Level Monitoring:** Water levels in the dewatering wells should be measured and recorded prior to starting up the dewatering system and daily until the performance of the system has been assessed, approximately 1 week after startup of the system.

**Discharge Water Quality:** Based on the anticipated pumping rates, discharge from the dewatering system(s) should be routed to a settling tank for settlement of suspended solids, prior to discharge to the outfall location. Water quality sampling, performed by others, should be collected from the discharge piping prior to entering the tank and at the outfall location.
LIMITATIONS

This Groundwater Control Plan has been prepared for the exclusive use of IMCO General Construction for their proposed work on the Fir Island Farm Ecosystem Restoration project. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of Middour Consulting LLC. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Middour Consulting, shall be at the user’s sole risk. Middour Consulting warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

MIDDOUR CONSULTING LLC

Robert O. Middour, L.HG.
Principal Hydrogeologist
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NOTES
Hydraulic conductivity = 0.1 ft/min
Operation time = 7 days
Combined Discharge rate = 240 gpm
NOTES

1) Determine current groundwater levels by potholing prior to installing dewatering wells. Contact Middour Consulting if the pond dewatering system has dewatered any part of the proposed excavation(s).

2) The dewatering wells should be installed to an elevation of -15 feet and consist of a minimum of 15 feet of well screen.

3) Refer to Figure 6 for dewatering well construction details.

4) Dewatering well locations are approximate and can be adjusted in the field within 5 feet of proposed locations.
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Operation: The dewatering systems should operate a minimum of 7 to 10 days prior to excavation below the static groundwater level. The dewatering wells should be inspected daily by the dewatering contractor or other personnel trained to operate the dewatering system. Visual observations of the discharge should be made several times a day during excavation, to monitor for increased turbidity levels. Middour Consulting should be contacted if there is anomalous dewatering system performance. This may include pumping rates that differ significantly from rates presented in this report, the occurrence of a sudden change in pumping rates or groundwater levels, or the occurrence of turbidity levels that exceed discharge limits.

Well Decommissioning: The dewatering wells should be decommissioned in accordance with WAC 173-160 upon completion of dewatering activities.
2. **DEWATERING WELL DRILLING SUBCONTRACTOR**

IMCO will be utilizing the experience and expertise of Glacier Drilling and Dewatering (Glacier) on a subcontractor basis for all DOE NOI start cards, well drilling, decommissioning, and DOE NOI decommissioning reports of the dewatering wells. IMCO’s own labor forces, under the direction of Glacier, a licensed driller, will assist Glacier’s driller in the work.

Middour Consulting will be available as needed to review and sign off on drilling logs.
3. **SUBMERSIBLE PUMPS**

The dewatering well system will include the use of Flygt submersible drainage pumps, Model B2720. The data on these pumps including the pump curve is included in this plan.
Find the right model for your needs

Drainage pumps for corrosive applications
The Flygt BS 2720.390, 2740.390 and 2750.390 pumps handle water that contains abrasive particles and particles in suspensions up to 1" × ¼" in size. Available in both high head and high flow versions.

Sludge pumps for corrosive applications
The Flygt DS 2720.280, 2730.280 and 2740.280 pumps handle light slurry, different types of mud and sludge, and heavily contaminated water that contains abrasive particles, particles in suspensions up to 3" in size.

Performance curves

Dimensions and capacities

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4. EXECUTION

The dewatering wells will be installed per Middour’s Figure 6 and the contract specifications section 31700 Dewatering.

Approximate Schedule of Work:

- Dewatering Well Installation –
  o Slough Tidegates: Pending Water Control Plan and upcoming Pre-Cast Headwall Plan approvals
  o Pump Station: Cofferdam and well point installation slated to begin the week of 7/27/15
- Drawdown Period – approximately 7-10 days as needed for dewatering to take effect. Water levels will be monitored and verified during the draw down period. Once ample draw down is achieved, tide gate or pump station construction can begin, and the wells will be continuously monitored.

Dewatering well sequence of construction includes; well drilling and casing installation, slotted well screen installation, sand filter pack installation, bentonite surface seal, pump installation, and connection to the header piping.

During dewatering well development, discharge water will be routed to the adjacent fields within the construction limits where silt and sediment can be filtered prior to entry into the waterways. After wellpoint development, water that is clear and free of turbidity will be discharged directly into the nearest adjacent slough. At the discharge locations, a slated energy dissipation device may be utilized as necessary to prevent erosion. These discharge locations will be monitored per the Turbidity Monitoring Plan.

Notification of wellpoint decommissioning will occur within 1 week of anticipated removal. The wellpoints will be decommissioned per all applicable WAC codes and DOE NOI reports will be completed.