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August 14, 2019 Project 171.05027

Mr. Kevin Martin
Compliance & Procedures Specialist
Maine Department of Environmental Protection
112 Canco Road
Portland, Maine 04103

RE: Response to Review Comments
Nordic Aquafarms Inc., Land-based Aquaculture Facility
Belfast, Maine
L-28319-26-A-N

Dear Mr. Martin:

This letter provides responses to the Department of Environmental Protection letter from Kevin Martin to Elizabeth Ransom dated July 31, 2019. For clarity, the entire comment from the letter has been copied below and italicized. Responses are in regular text, and on the attached plans and figures as referenced below.

The Department is requesting the following information to further characterize the discharge from the proposed Nordic Aquafarms site in Belfast:

1. The location of the outfall, its configuration, and what the associated acute and chronic dilution factors will be and provide modeling details as to how they were derived.

As noted on EPA Form 2D, submitted as page 204 of the application, the proposed location of the outfall is at a latitude of 44 degrees, 23 minutes, 40 seconds, and a longitude of 68 degrees, 58 minutes, and 25 seconds. The outfall configuration is shown on the diagram in **Attachment A**.

The CORMIX modeling presented in our September 27, 2018 memorandum that was included with permit application evaluated a single port outfall as well as a multi-port diffuser outfall. The modeling evaluated single port and multi-port diffuser configurations for two different locations described by their depth and approximate distance from the shoreline. These included a deep location assuming 15 meters depth at Mean Lower Low Water (MLLW) as well as a shallow location assuming 8 meters depth at MLLW. After completion of the September 27, 2018 memorandum it was decided to go forward with the multi-port diffuser as described in the memorandum but located at an intermediate location with a depth of 11.5 meters.

CORMIX modeling has since been performed to simulate the final diffuser configuration and location assuming a depth 11.5 meters. With exception to the assumed depth at the outfall, the methods and inputs are the same as described in our September 27, 2018 memorandum. The results are qualitatively similar to results for the multi-port diffuser described in the memo. A table summarizing dilution at 15 minutes travel time for the two current speeds and 4 seasons simulated are provided in **Attachment B** along with CORMIX session and prediction files for the simulations. The results show dilution at 15 minutes travel time ranging from 15.7 to 282.6, with median value of 52.5 and mean of 78.6. The lowest values for dilution at 15 minutes travel time are expected to occur during slack tides when stratification is stronger in the spring and summer and the MS4 flow classification is predicted.

The modeling indicates minimum dilution occurs during times with strong ambient stratification in the springtime. In those cases, CORMIX predicts the MS4 flow class during slack tide when the buoyancy dominates the cross flow, and the MS1 flow class during mid tide when ambient currents more strongly deflect the discharge. Both flow classes predict that the buoyant effluent becomes trapped as the effluent rises in the ambient stratification. For slack tide a dilution of 10.1 is reached at the terminal trapping level, and for mid-tide a dilution of 15.0 is reached at the terminal trapping level. Thus, according to 06-096 CMR 530 4.A.(2)(a) the acute and chronic dilution factors should be 10.1 and 15.0, respectively.

2. The final far-field dilution, which models were used, why they were used and substantial details about all assumptions used to develop the model(s)

Unlike the preliminary CORMIX analysis presented in our September 27, 2018 memorandum, the far-field analysis described in our October 2, 2018 memo is representative of the final discharge location and outfall configuration as described above.

The far-field modeling approach used a 2-dimensional vertically averaged finite element hydrodynamic model to simulate 15-minute snapshots of the tidal current field. Output from the hydrodynamic simulation was then used drive an offline particle tracking model to simulate mixing and dispersion of the effluent. The particle tracking model was configured to release particles randomly along a 50 m line at the diffuser location consistent with the results of the near-field discharge from CORMIX. Particles were released at regular intervals so that each particle represents an equal mass of effluent. Dilution was then calculated by counting particles within control volumes defined by the finite element grid and dividing the total volume in the control volume by the volume of effluent determined from the particle count. These methods were employed to evaluate far-field dilution because they allow for a dynamic assessment of mixing and dispersion of the effluent that is influenced by cyclic and residual tidal currents. In tidal environments a dynamic analysis is necessary to accurately account for re-circulation of the effluent past the outfall that can tend to increase effective background concentrations, which cannot be simulated by a steady-state model such as CORMIX.

The hydrodynamic model employed uses the ADvanced CIRCulation (ADCIRC) model code. The physics and numerical discretization of the ADCIRC model is well described in the literature (e.g. Luettich et al. 1992, see footnote in the October 2, 2018 memorandum). Details describing ADCIRC model input parameters and output files can be found in the online user's manual at www.adcirc.org. The particular ADCIRC model used for the far-field dilution analysis was initially developed for coastal flood hazard studies in the larger Penobscot Bay region. A report describing the development of the ADCIRC model for Penobscot Bay, including sources of topographic and bathymetric data, frictional parameterization, grid resolution, and model validation, has been prepared for the Town of Islesboro and can be provided upon request. The model was adapted for far-field dilution modeling in Belfast Bay by turning on convective acceleration terms in the model parameterization and implementing the horizontal Smagorinsky turbulence closure scheme to improve physical accuracy of the velocity field simulation for dilution analysis (note, the original model application of simulating tide and storm surge water levels ignored these terms in favor of numerical stability). The Smagorinsky turbulence closure feature became available in version 53 of the ADCIRC model code and is not well documented in the user manual. An additional model validation comparison for the modified model was performed by comparing modeled water levels to NOAA's observed tides at Fort Point and NOAA's harmonic predicted tides at Belfast for the representative time period that was simulated and used for the dilution analysis. An annotated run control file for the ADCIRC simulation (fort.15) that describes the various model input parameters is provided in **Attachment C**. Model input and output files, and instructions for running the model code can be provided upon request.

Particle tracking was performed using the Maureparticle model, which has been developed to perform offline particle tracking given velocity field output from the ADCIRC model. Development of the Maureparticle code was originally described in a report to the Louisiana Department of Natural Resources[1], with further development described in the master's thesis referenced in the footnote in our October 2, 2018 memorandum. An annotated run control file (particles.inp) for the Maureparticle simulation used in the far-field dilution analysis, which describes the model input parameters, is provided in **Attachment C**. Maureparticle is a relatively simple Fortran90 program that is available on github[2]. The specific version of the code used for the far-field analysis and additional detail and instructions on running the program can be provided upon request.

3. The far-field modeling information needs to include an analysis of the discharge's influence on ambient water quality relative to dissolved oxygen and total nitrogen. This analysis should be based on expected permit limits for BOD (technology-based limit for BOD (technology-based limit for BOD is expected to be 30 mg/l as a monthly average, and 50 mg/L as a daily maximum), and proposed loading for total nitrogen and discharge flow. The applicant's water quality monitoring contained DO values that were below the percent saturation criterion for the SB waterbody classification.

We understand that near-bottom observations in the vicinity of the proposed outfall have shown DO concentrations that are below saturation criteria for SB water classification, and that such conditions may occur as a result of natural processes, particularly when strong density stratification prevents mixing of the surface waters into bottom layers. The CORMIX modeling indicates the discharge is positively buoyant during all seasons due to density differences between the effluent and ambient water. Positive buoyancy will tend to keep higher total Nitrogen and BOD concentrations from the effluent within the upper layers of the water column where they will have limited effect on near bottom DO. In the winter season when ambient stratification

[1] URS, 2006. Mississippi River Reintroduction into Maurepas Swamp Project PO-29, Volume VII of VII Diversion Modeling. Final Report to the Louisiana Department of Natural Resources, December 2006. Online at: https://lacoast.gov/reports/project/Vol_VII_Diversion%20Modeling%20Report-Dec%208-FINAL.pdf
[2] https://github.com/natedill/maureparticle/tree/lose_wetdry

becomes weaker and the effluent is expected to become fully vertically mixed the colder water temperatures and full vertical ambient mixing will tend to prevent low near-bottom DO concentrations.

The far-field dilution analysis shows relatively low Total N and BOD concentrations given the proposed nitrogen loading (5.55 mg/l) and technology based daily limit for BOD (50 mg/l). Images showing time medial total N and BOD concentrations for those effluent concentrations based on the far-field dilution estimated in our October 2, 2018 memorandum are provided in **Attachment D**.

Nordic Aquafarms understand the concern raised by observed DO concentrations that do not meet SB water classification and intends to closely monitor DO and other water quality variables as the facility is developed and discharges increase to permitted rates.

4. A detailed list of all drugs, pesticides, and chemicals that may be used in the facility, their concentration, and an estimate of the amount used annually.

A detailed list of all drugs, pesticides, and chemicals that may be used in the facility, including their concentration and an estimate of the amount use annually, was included as Attachment 3 to the Fish Rearing Facility Form, Questions 10 and 11, submitted as pages 216 through 219 of the MEPDES application. An updated list is attached to this letter as **Attachment E**.

Nordic Aquafarms has removed methanol from the list of chemicals included in the initial submission of the company's MEPDES permit (October 19, 2019). The process of denitrification, which Nordic Aquafarms is using to reduce nitrogen in its discharge, requires the addition of a carbon source. Methanol is traditionally used as a carbon source in this application. Since the initial MEPDES submission, Nordic Aquafarms staff have identified and vetted a more favorable alternative to methanol that is USDA certified as a Biobased Product. This product, MicroC 2000, should replace Methanol on the chemical list included as part of NAF's MEPDES application. Use of MicroC 2000 is further described on the attached list of chemicals, as well as the SDS and technical data sheets included.

5. Information regarding the temperature or thermal component of the discharge to the receiving water.

Temperature of the effluent is expected to be constant at 13 degrees centigrade. Ambient temperatures range from 0 centigrade to 22 centigrade (Normandeau, 1978). **Attachment F** shows estimated effluent temperatures that bracket the range of high and low ambient temperatures based on the far-field dilution estimated in our October 2, 2018 memorandum. Overall the far-field temperature anomaly is expected to be less than 0.2 degrees centigrade in either season based on this analysis.

Please contact me with any questions or comments.

Sincerely,

RANSOM CONSULTING, INC.

Digitally signed by Elizabeth M. Ransom, P.G.
Date: 2019.08.14 13:46:58 -04'00'

Elizabeth M. Ransom, P.G.
Senior Project Manager

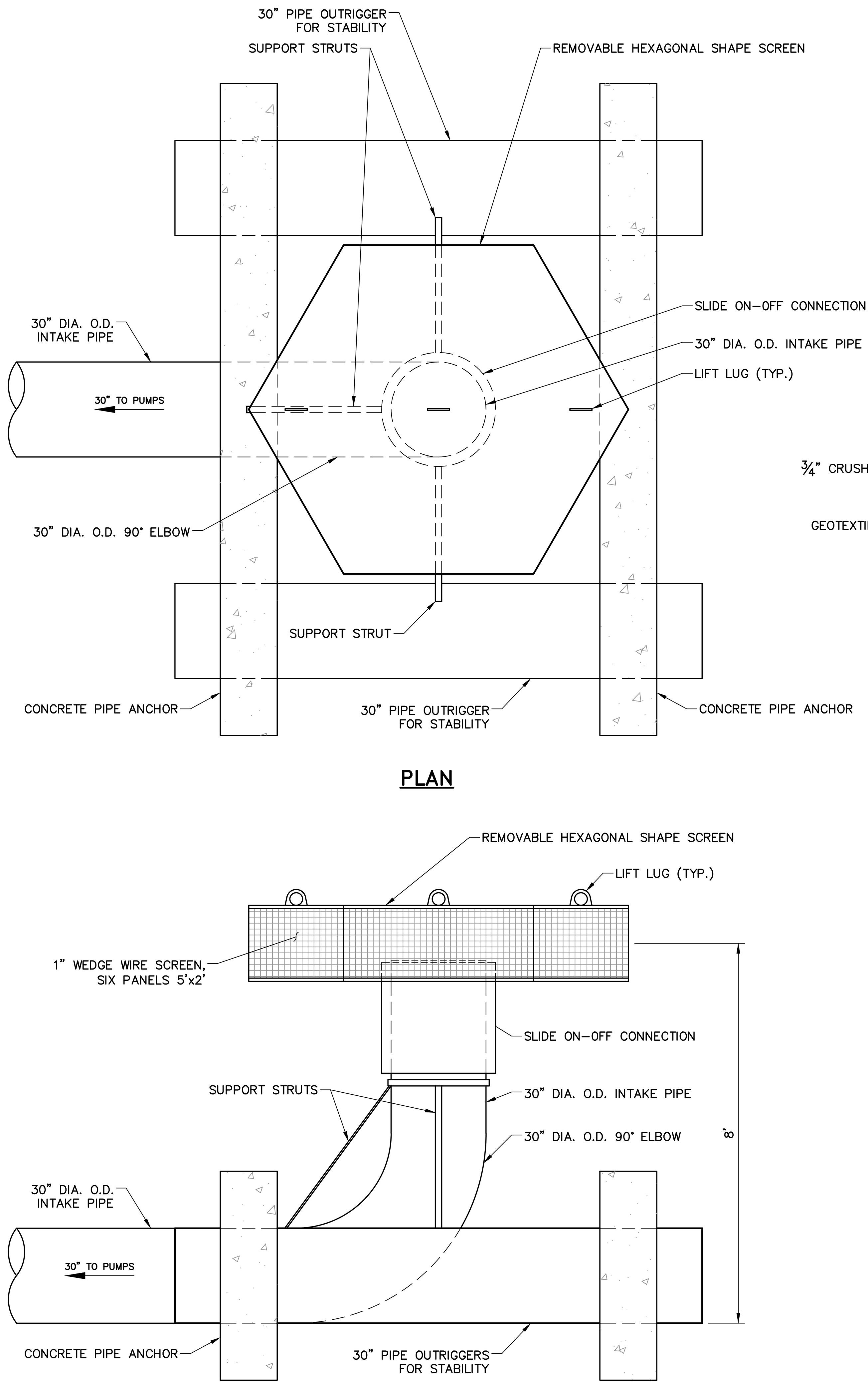
EMR:jar

ATTACHMENT A

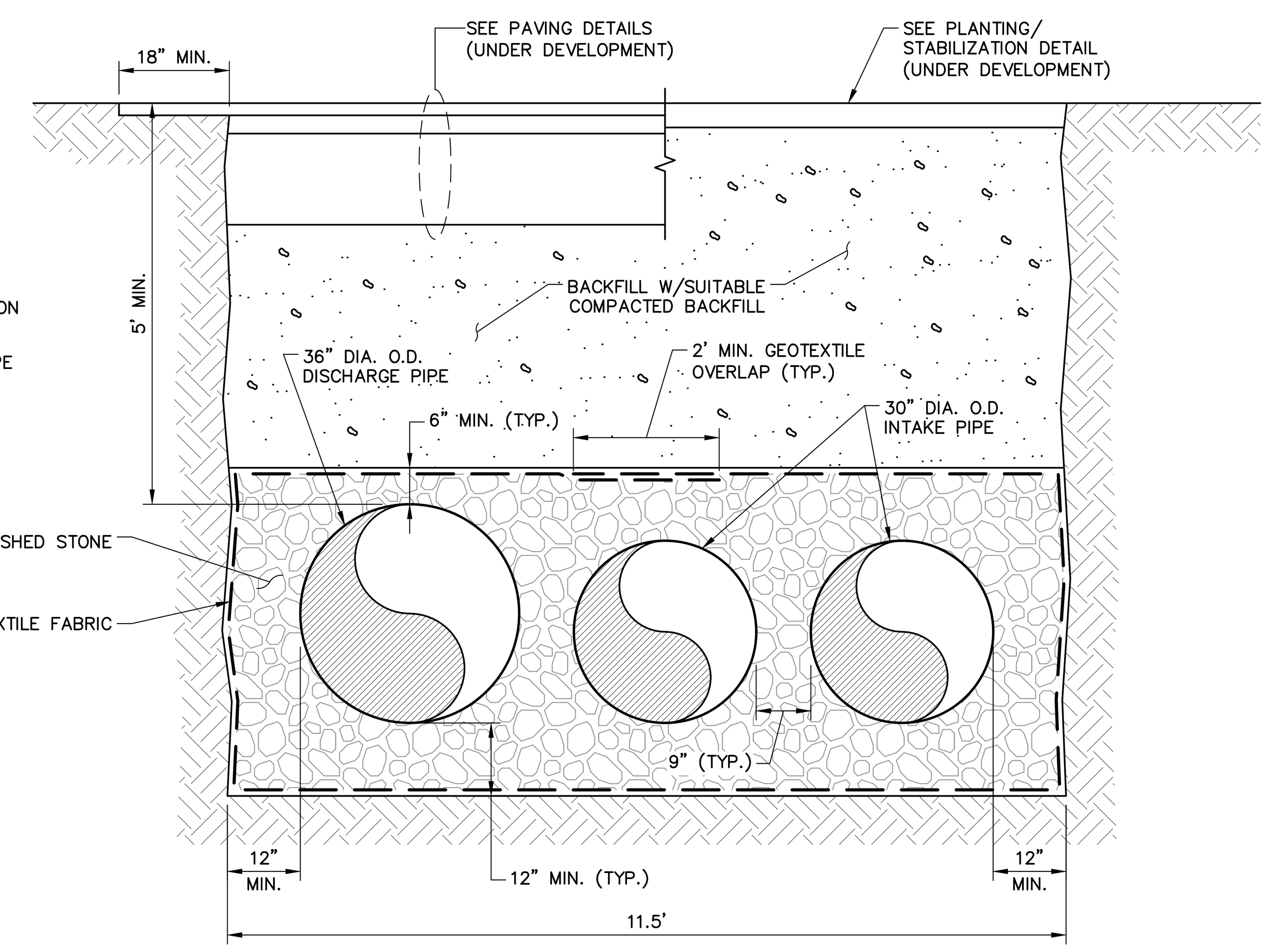
Discharge Diffuser Detail Drawing CS503

Response to Review Comments
Nordic Aquafarms Inc., Land-based Aquaculture Facility
Belfast, Maine
L-28319-26-A-N

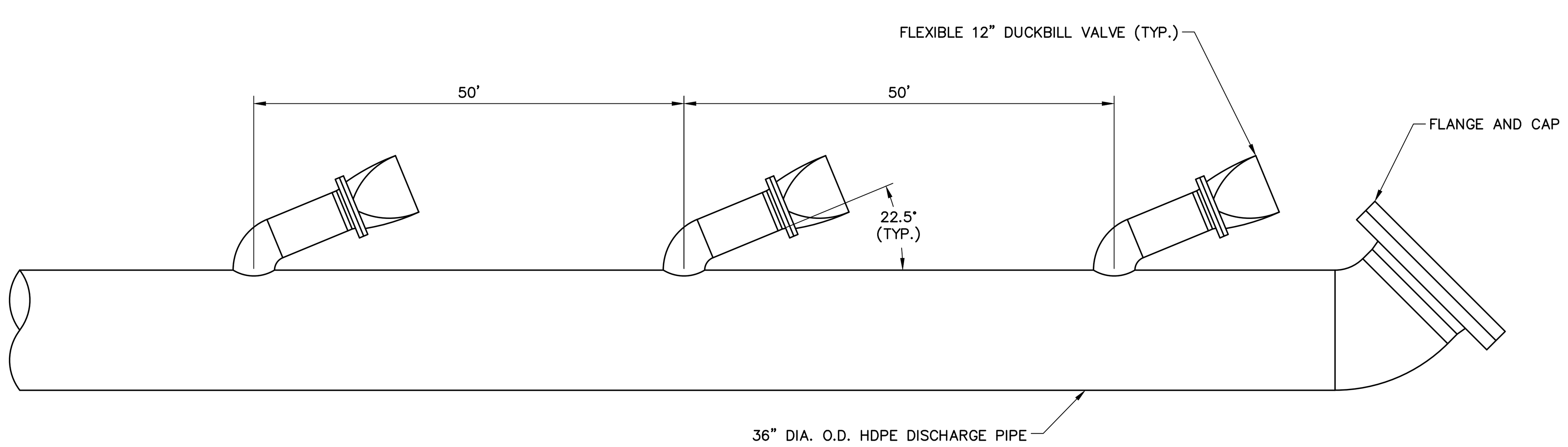
Ransom Consulting, Inc.
Project 171.05027.008



6 CS503 INTAKE STRUCTURE DETAIL
SCALE: NOT TO SCALE



5 CS503 BURIED 3-PIPE TRENCH DETAIL (LAND)
SCALE: 1" = 2'



7 CS503 DISCHARGE DIFFUSER DETAIL
SCALE: NOT TO SCALE

RANSOM Consulting Engineers and Scientists

WOODARD & CURRAN
41 Hutchins Drive
Portland, Maine 04102
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COMMITMENT & INTEGRITY DRIVE RESULTS

REV	DESCRIPTION	DATE

ISSUED FOR PERMIT
05-02-19
CURRENT ISSUE STATUS:

TRUE NORTH:

SMRT Architects and Engineers
144 Fore Street, PO Box 618
Portland, Maine 04104
ARCHITECTURE | ENGINEERING | PLANNING | INTERIORS | ENERGY
SMRT

NORDIC AQUAFARMS

BELFAST, MAINE

CIVIL DETAILS - 3

PROJECT MANAGER:
PROJECT NO: 18076
JOB CAPTAIN:

CS503

NOT FOR CONSTRUCTION

24x36

ATTACHMENT B

CORMIX Summary Table and Results

Response to Review Comments
Nordic Aquafarms Inc., Land-based Aquaculture Facility
Belfast, Maine
L-28319-26-A-N

Ransom Consulting, Inc.
Project 171.05027.008

Summary of CORMIX Results at Intermediate Depth location for Diffuser at 15 minutes Travel Time

Location	Current (m/s)	Season	CORMIX Flow Class	Distance From Port* (m)	Dilution	% Initial Conc. Excess
Intermediate	**0.2**	**Winter**	MU6	180.4	282.6	0.4
Intermediate	**0.2**	**Spring**	MS1	191.6	54.0	1.9
Intermediate	**0.2**	**Summer**	MS1	195.1	69.4	1.5
Intermediate	**0.2**	**Fall**	MS1	197.7	82.3	1.2
Intermediate	**0.05**	**Winter**	MU6	45.8	51.1	2.0
Intermediate	**0.05**	**Spring**	MS4	54.7	15.7	6.4
Intermediate	**0.05**	**Summer**	MS4	58.1	22.3	4.5
Intermediate	**0.05**	**Fall**	MU6	45.8	51.1	2.0

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0G
                       HYDRO2:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                BelfastBay
  DESIGN CASE:
  FILE NAME:                    C:\0 PROJECTS\171.05027-NordicAquaFarms\Modeling\CORMIX\Sim
ulations\diffuser\32-int-fast-winter-diff.prd
  Using subsystem CORMIX2:     Multiport Diffuser Discharges
  Start of session:             07/31/2018--08:00:14
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                          = unbounded
  Average depth                 HA       = 11.5 m
  Depth at discharge            HD       = 11.5 m
  Ambient velocity              UA       = 0.2 m/s
  Darcy-Weisbach friction factor F       = 0.1
  Wind velocity                 UW       = 1 m/s
  Stratification Type           STRCND = U
  Surface density               RHOAS  = 1025 kg/m^3
  Bottom density                RHOAB  = 1025 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:           Submerged Multiport Diffuser Discharge
  Diffuser type                 DITYPE = staged perpendicular
  Diffuser length               LD     = 30 m
  Nearest bank                         = right
  Diffuser endpoints            YB1    = 735 m;    YB2 = 765 m
  Number of openings            NOPEN  = 3
  Number of Risers              NRISER = 3
  Ports/Nozzles per Riser       NPPERR  = 1
  Spacing between risers/openings SPAC = 15 m
  Port/Nozzle diameter          D0     = 0.305 m
    with contraction ratio             = 1
  Equivalent slot width         B0     = 0.004871 m
  Total area of openings        TA0    = 0.2192 m^2
  Discharge velocity            U0     = 1.54 m/s
  Total discharge flowrate      Q0     = 0.337 m^3/s
  Discharge port height         H0     = 2 m
  Nozzle arrangement            BETYPE = staged
  Diffuser alignment angle      GAMMA  = 90 deg
  Vertical discharge angle      THETA  = 22 deg
  Actual Vertical discharge angle THEAC = 22 deg
  Horizontal discharge angle    SIGMA  = 90 deg
  Relative orientation angle    BETA   = 0 deg
  Discharge density             RHO0   = 1014.8100 kg/m^3
  Density difference            DRHO   = 10.1900 kg/m^3
  Buoyant acceleration          GP0    = 0.0975 m/s^2
  Discharge concentration       C0     = 100 deg.C
  Surface heat exchange coeff.  KS     = 0 m/s
  Coefficient of decay          KD     = 0 /s
-----------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)       q0     = 0.011233 m^2/s
  Momentum flux
      (based on slot width B0)    m0 =U0^2*B0   = 0.011514 m^3/s^2
      (based on volume flux q0)   m0 =U0*q0     = 0.017271 m^3/s^2
  Buoyancy flux
      (based on slot width B0)    j0 =U0*GP0*B0 = 0.000730 m^3/s^3
      (based on volume flux q0)   j0 =q0*GP0    = 0.001095 m^3/s^3
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.01 m          Lm  = 0.43 m          LM  = 1.42 m
  lm' = 99999 m         Lb' = 99999 m         La  = 99999 m
```

```
  (These refer to the actual discharge/environment length scales.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number              FR0    = 70.56
  Port/nozzle Froude number       FRD0   = 8.92
  Velocity ratio                  R      = 7.69
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                          = no
  Water quality standard specified         = no
  Regulatory mixing zone                   = no
  Region of interest                       = 1000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = MU6 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 11.5 m
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    750 m from the right bank/shore.
  Number of display steps NSTEP = 20 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 0.4841 deg.C
  Dilution at edge of NFR              s = 206.6
  NFR Location:                        x = 57.5 m
    (centerline coordinates)           y = 0.56 m
                                       z = 11.5 m
  NFR plume dimensions:  half-width (bh) = 15.13 m
                          thickness (bv) = 11.5 m
Cumulative travel time:       287.5 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
-----------------------------------------------------------------------------
Near-field instability behavior:
  The diffuser flow will experience instabilities with full vertical mixing
  in the near-field.
  There may be benthic impact of high pollutant concentrations.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume is vertically fully mixed WITHIN NEAR-FIELD (or a fraction thereof),
  but RE-STRATIFIES LATER.
  Plume becomes vertically fully mixed again at 997.74 m downstream.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section does not contact bank in this simulation.
*********************** TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************* REGULATORY MIXING ZONE SUMMARY ***********************
No RMZ and no ambient water quality standard have been specified.
******************** FINAL DESIGN ADVICE AND COMMENTS **********************
```

CORMIX2 uses the TWO-DIMENSIONAL SLOT DIFFUSER CONCEPT to represent the actual three-dimensional diffuser geometry. Thus, it approximates the details of the merging process of the individual jets from each port/nozzle.

In the present design, the spacing between adjacent ports/nozzles (or riser assemblies) is of the order of, or less than, the local water depth so that the slot diffuser approximation holds well.

Nevertheless, if this is a final design, the user is advised to use a final CORMIX1 (single port discharge) analysis, with discharge data for an individual diffuser jet/plume, in order to compare to the present near-field prediction.

REMINDER: The user must take note that HYDRODYNAMIC MODELING by any known technique is NOT AN EXACT SCIENCE.

Extensive comparison with field and laboratory data has shown that the CORMIX predictions on dilutions and concentrations (with associated plume geometries) are reliable for the majority of cases and are accurate to within about +-50% (standard deviation).

As a further safeguard, CORMIX will not give predictions whenever it judges the design configuration as highly complex and uncertain for prediction.

```
CORMIX2 PREDICTION FILE:
22222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
2222
                       CORMIX MIXING ZONE EXPERT SYSTEM
               Subsystem CORMIX2: Multiport Diffuser Discharges
                             CORMIX Version 11.0G
                     HYDRO2 Version 11.0.0.0 April 2018
-----------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------
---
CASE DESCRIPTION
 Site name/label:   BelfastBay
 Design case:
 FILE NAME:         C:\...\Simulations\diffuser\32-int-fast-winter-diff.prd
 Time stamp:        07/31/2018--08:00:14

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA    =     11.50  HD    =     11.50
 UA    =      0.200 F     =      0.100 USTAR =0.2236E-01
 UW    =      1.000 UWSTAR=0.1071E-02
 Uniform density environment
 STRCND=  U         RHOAM = 1025.0000

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:     DITYPE= staged_perpendicular
 BANK  =  RIGHT     DISTB =    750.00  YB1   =    735.00  YB2   =    765.00
 LD    =     30.00  NOPEN =    3       NRISER=    3       SPAC  =     15.00    NPPERR =
1
 D0    =      0.305 A0    =      0.073 H0    =      2.00  SUB0  =      9.50
 D0INP =      0.305 CR0   =      1.000 B0    =0.4871E-02
 Nozzle/port arrangement:   staged
 GAMMA =     90.00  THETA =     22.00  SIGMA =     90.00  BETA  =      0.00
 U0    =      1.538 Q0    =      0.337 Q0A   =0.3370E+00
 RHO0  = 1014.8100  DRHO0 =0.1019E+02  GP0   =0.9749E-01
 C0    =0.1000E+03  CUNITS=  deg.C
 IPOLL =  1         KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0    =0.1123E-01         SIGNJ0=      1.0
 m0 =U0^2*B0 =0.1151E-01   j0 =U0*GP0*B0 =0.7301E-03   (based on slot width B0)
 m0 =U0*q0   =0.1727E-01   j0 =q0*GP0    =0.1095E-02   (based on volume flux q0)
 Associated 2-d length scales (meters)
 lQ=B  =      0.007 lM    =      1.42  lm    =      0.43
 lmp   =  99999.00  lbp   =  99999.00  la    =  99999.00

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0    =0.3370E+00  M0    =0.3454E+00  J0    =0.2190E-01
 Associated 3-d length scales (meters)
 LQ    =      0.27  LM    =      3.04  Lm    =      3.60  Lb    =      4.11
                                       Lmp   =  99999.00  Lbp   =  99999.00

NON-DIMENSIONAL PARAMETERS
 FR0   =     70.56  FRD0  =      8.92  R     =      7.69  PL    =  136.30
 (slot)             (port/nozzle)


FLOW CLASSIFICATION
 222222222222222222222222222222222222222222
 2  Flow class (CORMIX2)      =    MU6    2
 2  Applicable layer depth HS =    11.50  2
 222222222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.1000E+03  CUNITS=  deg.C
```

```
 NTOX  =  0
 NSTD  =  0
 REGMZ =  0
 XINT  =   1000.00  XMAX  =   1000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
       750.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  20 display intervals per module
-----------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------
---
BEGIN MOD202: DISCHARGE MODULE (STAGED DIFFUSER)

 Due to complex near-field motions:  EQUIVALENT SLOT DIFFUSER (2-D) GEOMETRY

 Profile definitions:
   BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory
   BH = Gaussian 1/e (37%) half-width in horizontal plane normal to trajectory
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)
   Uc = Local centerline excess velocity (above ambient)
   TT = Cumulative travel time

       X        Y       Z        S        C       BV       BH       Uc        TT
      0.00     0.00    2.00     1.0 0.100E+03   0.00    15.00     1.538   .00000E+00

END OF MOD202: DISCHARGE MODULE (STAGED DIFFUSER)
-----------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------
---
BEGIN MOD275: STAGED PERPENDICULAR DIFFUSER IN STRONG CURRENT

 Because of the strong ambient current the diffuser plume of this crossflowing
   discharge gets RAPIDLY DEFLECTED.
 A near-field zone is formed that is VERTICALLY FULLY MIXED over the entire
   layer depth.  Full mixing is achieved at a downstream distance of about
   five (5) layer depths.

 Profile definitions:
   BV = layer depth (vertically mixed)
   BH = top-hat half-width, measured horizontally in Y-direction
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

       X        Y       Z        S        C       BV       BH         TT
      0.00     0.00    2.00     1.0 0.100E+03   0.00    15.00 .00000E+00
      2.88     0.03    2.19    47.0 0.213E+01   0.58    15.01 .14375E+02
      5.75     0.06    2.38    66.0 0.151E+01   1.15    15.01 .28750E+02
      8.62     0.08    2.56    80.6 0.124E+01   1.73    15.02 .43125E+02
     11.50     0.11    2.75    92.9 0.108E+01   2.30    15.03 .57500E+02
     14.38     0.14    2.94   103.8 0.964E+00   2.88    15.03 .71875E+02
     17.25     0.17    3.12   113.6 0.880E+00   3.45    15.04 .86250E+02
     20.12     0.20    3.31   122.6 0.816E+00   4.03    15.05 .10062E+03
     23.00     0.23    3.50   131.0 0.763E+00   4.60    15.05 .11500E+03
     25.88     0.25    3.69   138.9 0.720E+00   5.18    15.06 .12938E+03
     28.75     0.28    3.88   146.4 0.683E+00   5.75    15.07 .14375E+03
     31.62     0.31    4.06   153.5 0.652E+00   6.33    15.07 .15812E+03
     34.50     0.34    4.25   160.2 0.624E+00   6.90    15.08 .17250E+03
     37.38     0.37    4.44   166.7 0.600E+00   7.48    15.09 .18688E+03
     40.25     0.39    4.62   173.0 0.578E+00   8.05    15.09 .20125E+03
     43.12     0.42    4.81   179.0 0.559E+00   8.63    15.10 .21562E+03
```

```
     46.00     0.45    5.00    184.9 0.541E+00   9.20    15.11 .23000E+03
     48.88     0.48    5.19    190.5 0.525E+00   9.78    15.11 .24438E+03
     51.75     0.51    5.38    196.0 0.510E+00  10.35    15.12 .25875E+03
     54.62     0.54    5.56    201.4 0.497E+00  10.93    15.13 .27312E+03
     57.50     0.56    5.75    206.6 0.484E+00  11.50    15.13 .28750E+03
 Cumulative travel time =         287.5000 sec  (    0.08 hrs)
   Plume centerline may exhibit slight discontinuities in transition
     to subsequent far-field module.

END OF MOD275: STAGED PERPENDICULAR DIFFUSER IN STRONG CURRENT
-----------------------------------------------------------------------------------------
---
** End of NEAR-FIELD REGION (NFR) **
-----------------------------------------------------------------------------------------
---
BEGIN MOD241: BUOYANT AMBIENT SPREADING

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

 Plume Stage 1 (not bank attached):
       X        Y       Z        S        C       BV       BH      ZU      ZL       TT
     57.50     0.56   11.50    206.6 0.484E+00  11.50    15.13   11.50    0.00   .28750E+03
    104.51     0.56   11.50    239.8 0.417E+00   7.86    25.70   11.50    3.64   .52253E+03
    151.51     0.56   11.50    266.2 0.376E+00   6.52    34.38   11.50    4.98   .75756E+03
    198.52     0.56   11.50    293.2 0.341E+00   5.87    42.07   11.50    5.63   .99259E+03
    245.52     0.56   11.50    323.3 0.309E+00   5.55    49.11   11.50    5.95   .12276E+04
    292.53     0.56   11.50    358.0 0.279E+00   5.42    55.67   11.50    6.08   .14626E+04
    339.53     0.56   11.50    398.3 0.251E+00   5.42    61.86   11.50    6.08   .16977E+04
    386.54     0.56   11.50    444.6 0.225E+00   5.53    67.76   11.50    5.97   .19327E+04
    433.55     0.56   11.50    497.7 0.201E+00   5.71    73.40   11.50    5.79   .21677E+04
    480.55     0.56   11.50    557.8 0.179E+00   5.96    78.84   11.50    5.54   .24028E+04
    527.56     0.56   11.50    625.5 0.160E+00   6.27    84.09   11.50    5.23   .26378E+04
    574.56     0.56   11.50    700.9 0.143E+00   6.62    89.19   11.50    4.88   .28728E+04
    621.57     0.56   11.50    784.5 0.127E+00   7.02    94.14   11.50    4.48   .31078E+04
    668.58     0.56   11.50    876.4 0.114E+00   7.46    98.97   11.50    4.04   .33429E+04
    715.58     0.56   11.50    977.0 0.102E+00   7.94   103.68   11.50    3.56   .35779E+04
    762.59     0.56   11.50   1086.5 0.920E-01   8.45   108.28   11.50    3.05   .38129E+04
    809.59     0.56   11.50   1205.1 0.830E-01   9.00   112.79   11.50    2.50   .40480E+04
    856.60     0.56   11.50   1333.0 0.750E-01   9.58   117.22   11.50    1.92   .42830E+04
    903.60     0.56   11.50   1470.4 0.680E-01  10.19   121.56   11.50    1.31   .45180E+04
    950.61     0.56   11.50   1617.6 0.618E-01  10.83   125.83   11.50    0.67   .47531E+04
    997.62     0.56   11.50   1774.6 0.563E-01  11.50   130.02   11.50    0.00   .49881E+04
 Cumulative travel time =        4988.0820 sec  (    1.39 hrs)

END OF MOD241: BUOYANT AMBIENT SPREADING
-----------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------
---
BEGIN MOD261: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

  Vertical diffusivity (initial value)   = 0.515E-01 m^2/s
  Horizontal diffusivity (initial value) = 0.988E+00 m^2/s

 Profile definitions:
   BV = Gaussian s.d.*sqrt(pi/2) (46%) thickness, measured vertically
      = or equal to layer depth, if fully mixed
   BH = Gaussian s.d.*sqrt(pi/2) (46%) half-width,
        measured horizontally in Y-direction
```

ZU = upper plume boundary (Z-coordinate)
ZL = lower plume boundary (Z-coordinate)
S = hydrodynamic centerline dilution
C = centerline concentration (includes reaction effects, if any)
TT = Cumulative travel time

Plume Stage 1 (not bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
997.62	0.56	11.50	1774.6	0.563E-01	11.50	130.02	11.50	0.00	.49881E+04

Plume interacts with BOTTOM.
The passive diffusion plume becomes VERTICALLY FULLY MIXED within this prediction interval.

997.74	0.56	11.50	1774.9	0.563E-01	11.50	130.03	11.50	0.00	.49887E+04
997.85	0.56	11.50	1775.0	0.563E-01	11.50	130.03	11.50	0.00	.49893E+04
997.97	0.56	11.50	1775.1	0.563E-01	11.50	130.04	11.50	0.00	.49899E+04
998.09	0.56	11.50	1775.2	0.563E-01	11.50	130.05	11.50	0.00	.49905E+04
998.21	0.56	11.50	1775.2	0.563E-01	11.50	130.06	11.50	0.00	.49911E+04
998.33	0.56	11.50	1775.3	0.563E-01	11.50	130.06	11.50	0.00	.49917E+04
998.45	0.56	11.50	1775.4	0.563E-01	11.50	130.07	11.50	0.00	.49923E+04
998.57	0.56	11.50	1775.5	0.563E-01	11.50	130.08	11.50	0.00	.49928E+04
998.69	0.56	11.50	1775.6	0.563E-01	11.50	130.08	11.50	0.00	.49934E+04
998.81	0.56	11.50	1775.7	0.563E-01	11.50	130.09	11.50	0.00	.49940E+04
998.93	0.56	11.50	1775.8	0.563E-01	11.50	130.10	11.50	0.00	.49946E+04
999.05	0.56	11.50	1775.9	0.563E-01	11.50	130.11	11.50	0.00	.49952E+04
999.17	0.56	11.50	1776.0	0.563E-01	11.50	130.11	11.50	0.00	.49958E+04
999.29	0.56	11.50	1776.1	0.563E-01	11.50	130.12	11.50	0.00	.49964E+04
999.40	0.56	11.50	1776.2	0.563E-01	11.50	130.13	11.50	0.00	.49970E+04
999.52	0.56	11.50	1776.3	0.563E-01	11.50	130.13	11.50	0.00	.49976E+04
999.64	0.56	11.50	1776.4	0.563E-01	11.50	130.14	11.50	0.00	.49982E+04
999.76	0.56	11.50	1776.5	0.563E-01	11.50	130.15	11.50	0.00	.49988E+04
999.88	0.56	11.50	1776.6	0.563E-01	11.50	130.16	11.50	0.00	.49994E+04
1000.00	0.56	11.50	1776.7	0.563E-01	11.50	130.16	11.50	0.00	.50000E+04

Cumulative travel time = 5000.0000 sec (1.39 hrs)

Simulation limit based on maximum specified distance = 1000.00 m.
This is the REGION OF INTEREST limitation.

END OF MOD261: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

CORMIX2: Multiport Diffuser Discharges   End of Prediction File

22222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0G
                       HYDRO2:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                BelfastBay
  DESIGN CASE:
  FILE NAME:                    C:\0 PROJECTS\171.05027-NordicAquaFarms\Modeling\CORMIX\Sim
ulations\diffuser\34-int-fast-spring-diff.prd
  Using subsystem CORMIX2:     Multiport Diffuser Discharges
  Start of session:             07/31/2018--08:02:07
****************************************************************************
SUMMARY OF INPUT DATA:
----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                            = unbounded
  Average depth                   HA       = 11.5 m
  Depth at discharge              HD       = 11.5 m
  Ambient velocity                UA       = 0.2 m/s
  Darcy-Weisbach friction factor  F        = 0.1
  Wind velocity                   UW       = 1 m/s
  Stratification Type             STRCND = A
  Surface density                 RHOAS  = 1013 kg/m^3
  Bottom density                  RHOAB  = 1022 kg/m^3
----------------------------------------------------------------------------
DISCHARGE PARAMETERS:             Submerged Multiport Diffuser Discharge
  Diffuser type                   DITYPE = staged perpendicular
  Diffuser length                 LD     = 30 m
  Nearest bank                           = right
  Diffuser endpoints              YB1    = 735 m;    YB2 = 765 m
  Number of openings              NOPEN  = 3
  Number of Risers                NRISER = 3
  Ports/Nozzles per Riser         NPPERR  = 1
  Spacing between risers/openings SPAC   = 15 m
  Port/Nozzle diameter            D0     = 0.305 m
    with contraction ratio               = 1
  Equivalent slot width           B0     = 0.004871 m
  Total area of openings          TA0    = 0.2192 m^2
  Discharge velocity              U0     = 1.54 m/s
  Total discharge flowrate        Q0     = 0.337 m^3/s
  Discharge port height           H0     = 2 m
  Nozzle arrangement              BETYPE = staged
  Diffuser alignment angle        GAMMA  = 90 deg
  Vertical discharge angle        THETA  = 22 deg
  Actual Vertical discharge angle THEAC  = 22 deg
  Horizontal discharge angle      SIGMA  = 90 deg
  Relative orientation angle      BETA   = 0 deg
  Discharge density               RHO0   = 1014.8100 kg/m^3
  Density difference              DRHO   = 5.6248 kg/m^3
  Buoyant acceleration            GP0    = 0.0541 m/s^2
  Discharge concentration         C0     = 100 deg.C
  Surface heat exchange coeff.    KS     = 0 m/s
  Coefficient of decay            KD     = 0 /s
----------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)         q0     = 0.011233 m^2/s
  Momentum flux
      (based on slot width B0)    m0 =U0^2*B0   = 0.011514 m^3/s^2
      (based on volume flux q0)   m0 =U0*q0     = 0.017271 m^3/s^2
  Buoyancy flux
      (based on slot width B0)    j0 =U0*GP0*B0 = 0.000405 m^3/s^3
      (based on volume flux q0)   j0 =q0*GP0    = 0.000607 m^3/s^3
----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.01 m         Lm  = 0.43 m         LM  = 2.10 m
  lm' = 1.32 m         Lb' = 0.98 m         La  = 2.31 m
```

```
  (These refer to the actual discharge/environment length scales.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number              FR0    = 94.75
  Port/nozzle Froude number       FRD0   = 11.97
  Velocity ratio                  R      = 7.69
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = no
  Water quality standard specified       = no
  Regulatory mixing zone                 = no
  Region of interest                     = 1000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = MS1 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the linearly
  stratified density layer at the discharge site.
  Applicable layer depth = water depth = 11.5 m
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    750 m from the right bank/shore.
  Number of display steps NSTEP = 20 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 4.5378 deg.C
  Dilution at edge of NFR              s = 22.0
  NFR Location:                        x = 24.07 m
    (centerline coordinates)           y = 1.25 m
                                       z = 3.23 m
  NFR plume dimensions:  half-width (bh) = 16.40 m
                          thickness (bv) = 1.13 m
Cumulative travel time:       62.7086 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
-----------------------------------------------------------------------------
Stratification assessment:
  The specified ambient density stratification is dynamically important.
  The discharge near field flow is trapped within the linearly stratified
  ambient density layer.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section does not contact bank in this simulation.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY **********************
No RMZ and no ambient water quality standard have been specified.
********************* FINAL DESIGN ADVICE AND COMMENTS *********************
CORMIX2 uses the TWO-DIMENSIONAL SLOT DIFFUSER CONCEPT to represent
  the actual three-dimensional diffuser geometry.  Thus, it approximates
  the details of the merging process of the individual jets from each
  port/nozzle.
In the present design, the spacing between adjacent ports/nozzles
```

(or riser assemblies) is of the order of, or less than, the local water depth so that the slot diffuser approximation holds well.

Nevertheless, if this is a final design, the user is advised to use a final CORMIX1 (single port discharge) analysis, with discharge data for an individual diffuser jet/plume, in order to compare to the present near-field prediction.

REMINDER: The user must take note that HYDRODYNAMIC MODELING by any known technique is NOT AN EXACT SCIENCE.

Extensive comparison with field and laboratory data has shown that the CORMIX predictions on dilutions and concentrations (with associated plume geometries) are reliable for the majority of cases and are accurate to within about +-50% (standard deviation).

As a further safeguard, CORMIX will not give predictions whenever it judges the design configuration as highly complex and uncertain for prediction.

```
CORMIX2 PREDICTION FILE:
2222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
2222
                       CORMIX MIXING ZONE EXPERT SYSTEM
               Subsystem CORMIX2: Multiport Diffuser Discharges
                             CORMIX Version 11.0G
                         HYDRO2 Version 11.0.0.0 April 2018
---------------------------------------------------------------------------------------------
---
---------------------------------------------------------------------------------------------
---
CASE DESCRIPTION
 Site name/label:   BelfastBay
 Design case:
 FILE NAME:         C:\...\Simulations\diffuser\34-int-fast-spring-diff.prd
 Time stamp:        07/31/2018--08:02:07

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA    =     11.50  HD    =     11.50
 UA    =      0.200 F     =      0.100 USTAR =0.2236E-01
 UW    =      1.000 UWSTAR=0.1071E-02
 Density stratified environment
 STRCND=  A         RHOAM = 1017.5000
 RHOAS = 1013.0000  RHOAB = 1022.0000  RHOAH0= 1020.4348  E     =0.7510E-02

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:     DITYPE= staged_perpendicular
 BANK  =  RIGHT     DISTB =    750.00  YB1   =    735.00  YB2   =    765.00
 LD    =     30.00  NOPEN =    3       NRISER=    3       SPAC  =     15.00    NPPERR =
1
 D0    =      0.305 A0    =      0.073 H0    =      2.00  SUB0  =      9.50
 D0INP =      0.305 CR0   =      1.000 B0    =0.4871E-02
 Nozzle/port arrangement:   staged
 GAMMA =     90.00  THETA =     22.00  SIGMA =     90.00  BETA  =      0.00
 U0    =      1.538 Q0    =      0.337 Q0A   =0.3370E+00
 RHO0  = 1014.8100  DRHO0 =0.5625E+01  GP0   =0.5406E-01
 C0    =0.1000E+03  CUNITS=  deg.C
 IPOLL =  1         KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0    =0.1123E-01         SIGNJ0=      1.0
 m0 =U0^2*B0 =0.1151E-01   j0 =U0*GP0*B0 =0.4048E-03   (based on slot width B0)
 m0 =U0*q0   =0.1727E-01   j0 =q0*GP0    =0.6072E-03   (based on volume flux q0)
 Associated 2-d length scales (meters)
 lQ=B  =      0.007 lM    =      2.10  lm    =      0.43
 lmp   =      1.32  lbp   =      0.98  la    =      2.31

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0    =0.3370E+00  M0    =0.3454E+00  J0    =0.1214E-01
 Associated 3-d length scales (meters)
 LQ    =      0.27  LM    =      4.09  Lm    =      3.60  Lb    =      2.28
                                       Lmp   =      2.88  Lbp   =      2.30

NON-DIMENSIONAL PARAMETERS
 FR0   =     94.75  FRD0  =     11.97  R     =      7.69  PL    =  111.98
 (slot)             (port/nozzle)


FLOW CLASSIFICATION
 222222222222222222222222222222222222222222
 2  Flow class (CORMIX2)      =    MS1    2
 2  Applicable layer depth HS =    11.50  2
 222222222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
```

```
 C0    =0.1000E+03  CUNITS=  deg.C
 NTOX  =  0
 NSTD  =  0
 REGMZ =  0
 XINT  =   1000.00  XMAX  =   1000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
       750.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  20 display intervals per module
-----------------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------------
---
BEGIN MOD101: DISCHARGE MODULE (SINGLE PORT AT DIFFUSER CENTER)
```

X	Y	Z	S	C	BV	BH	Uc	TT
0.00	0.00	2.00	1.0	0.100E+03	0.15	0.15	1.538	.00000E+00

```
END OF MOD101: DISCHARGE MODULE (SINGLE PORT AT DIFFUSER CENTER)
-----------------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------------
---
BEGIN CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

 Jet-like motion in linear stratification with strong crossflow.

 Zone of flow establishment:             THETAE=     21.97  SIGMAE=     86.67
  LE    =      0.89  XE    =      0.02  YE    =      0.82  ZE    =      2.33

 Profile definitions:
   BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory
   BH = before merging: Gaussian 1/e (37%) half-width in horizontal plane
                        normal to trajectory
        after merging:  top-hat half-width in horizontal plane
                        parallel to diffuser line
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)
   Uc = Local centerline excess velocity (above ambient)
   TT = Cumulative travel time
```

Individual jet/plumes before merging:

X	Y	Z	S	C	BV	BH	Uc	TT
0.02	0.82	2.33	1.0	0.100E+03	0.15	0.15	1.538	.00000E+00
0.02	0.82	2.33	1.0	0.100E+03	0.15	0.15	1.538	.20073E-02
0.98	1.15	2.48	1.7	0.581E+02	0.27	0.27	0.905	.78249E+00
2.06	1.21	2.54	2.5	0.405E+02	0.36	0.36	0.642	.19223E+01
3.15	1.24	2.61	3.2	0.309E+02	0.45	0.45	0.500	.33437E+01
4.23	1.25	2.67	4.0	0.249E+02	0.52	0.52	0.409	.50105E+01
5.31	1.25	2.74	4.8	0.208E+02	0.59	0.59	0.347	.68943E+01
6.40	1.25	2.80	5.6	0.178E+02	0.66	0.66	0.301	.89793E+01
7.48	1.25	2.86	6.4	0.156E+02	0.72	0.72	0.266	.11227E+02
8.56	1.25	2.91	7.2	0.139E+02	0.78	0.78	0.239	.13628E+02
9.64	1.25	2.96	8.0	0.125E+02	0.83	0.83	0.217	.16165E+02
10.73	1.25	3.01	8.8	0.114E+02	0.88	0.88	0.199	.18826E+02
11.81	1.25	3.05	9.6	0.105E+02	0.93	0.93	0.184	.21598E+02
12.89	1.25	3.08	10.3	0.970E+01	0.97	0.97	0.171	.24472E+02
13.98	1.25	3.12	11.1	0.905E+01	1.02	1.02	0.160	.27450E+02
15.06	1.25	3.15	11.8	0.850E+01	1.06	1.06	0.151	.30501E+02
16.15	1.25	3.17	12.5	0.802E+01	1.09	1.09	0.143	.33629E+02
17.23	1.25	3.19	13.1	0.761E+01	1.13	1.13	0.136	.36826E+02
18.31	1.25	3.21	13.8	0.725E+01	1.16	1.16	0.129	.40086E+02
19.40	1.25	3.22	14.4	0.694E+01	1.19	1.19	0.124	.43405E+02
20.48	1.25	3.23	15.0	0.666E+01	1.22	1.22	0.119	.46776E+02

```
  Maximum jet height has been reached.
     21.57     1.25    3.23    15.6 0.642E+01   1.25     1.25     0.115   .50195E+02
  Terminal level in stratified ambient has been reached.
 Cumulative travel time =          50.1949 sec  (    0.01 hrs)
  Merging of individual jet/plumes not found in this module, but interaction
    will occur in following module.  Overall jet/plume interaction dimensions:
     21.57     1.25    3.23    15.6 0.642E+01   1.25    15.15     0.115   .50195E+02

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION
------------------------------------------------------------------------------------------
---
------------------------------------------------------------------------------------------
---
BEGIN MOD235: LAYER/BOUNDARY/TERMINAL LAYER APPROACH

  Control volume inflow:
       X        Y       Z        S        C       BV       BH        TT
     21.57     1.25    3.23    15.6 0.642E+01   1.25    15.15   .50195E+02

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

       X        Y       Z        S        C       BV       BH      ZU      ZL        TT
     20.31     1.25    3.23    15.6 0.642E+01   0.00     0.00    3.23    3.23   .50195E+02
     21.06     1.25    3.23    15.6 0.642E+01   0.84     7.34    3.65    2.81   .50195E+02
     21.82     1.25    3.23    15.8 0.631E+01   0.99    16.36    3.72    2.73   .51446E+02
     22.57     1.25    3.23    18.6 0.537E+01   1.07    16.38    3.76    2.69   .55200E+02
     23.32     1.25    3.23    21.1 0.473E+01   1.12    16.39    3.79    2.67   .58954E+02
     24.07     1.25    3.23    22.0 0.454E+01   1.13    16.40    3.79    2.66   .62709E+02
 Cumulative travel time =          62.7086 sec  (    0.02 hrs)

END OF MOD235: LAYER/BOUNDARY/TERMINAL LAYER APPROACH
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---
** End of NEAR-FIELD REGION (NFR) **
------------------------------------------------------------------------------------------
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BEGIN MOD242: BUOYANT TERMINAL LAYER SPREADING

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

 Plume Stage 1 (not bank attached):
       X        Y       Z        S        C       BV       BH      ZU      ZL        TT
     24.07     1.25    3.23    22.0 0.454E+01   1.13    16.40    3.79    2.66   .62709E+02
     72.86     1.25    3.23    28.9 0.346E+01   0.80    30.48    3.63    2.83   .30669E+03
    121.66     1.25    3.23    37.8 0.265E+01   0.75    42.15    3.61    2.85   .55067E+03
    170.46     1.25    3.23    48.6 0.206E+01   0.77    53.51    3.61    2.85   .79466E+03
    219.25     1.25    3.23    61.1 0.164E+01   0.79    65.05    3.62    2.83   .10386E+04
    268.05     1.25    3.23    74.8 0.134E+01   0.82    76.90    3.64    2.82   .12826E+04
    316.85     1.25    3.23    89.7 0.111E+01   0.85    89.08    3.65    2.80   .15266E+04
    365.64     1.25    3.23   105.7 0.946E+00   0.88   101.57    3.67    2.79   .17706E+04
    414.44     1.25    3.23   122.7 0.815E+00   0.90   114.37    3.68    2.78   .20146E+04
    463.24     1.25    3.23   140.6 0.711E+00   0.93   127.45    3.69    2.76   .22586E+04
```

512.03	1.25	3.23	159.5	0.627E+00	0.95	140.80	3.71	2.75	.25025E+04
560.83	1.25	3.23	179.2	0.558E+00	0.98	154.39	3.72	2.74	.27465E+04
609.63	1.25	3.23	199.7	0.501E+00	1.00	168.21	3.73	2.73	.29905E+04
658.42	1.25	3.23	221.1	0.452E+00	1.02	182.25	3.74	2.72	.32345E+04
707.22	1.25	3.23	243.2	0.411E+00	1.04	196.49	3.75	2.71	.34785E+04
756.02	1.25	3.23	266.1	0.376E+00	1.06	210.92	3.76	2.70	.37225E+04
804.81	1.25	3.23	289.8	0.345E+00	1.08	225.53	3.77	2.69	.39664E+04
853.61	1.25	3.23	314.1	0.318E+00	1.10	240.31	3.78	2.68	.42104E+04
902.41	1.25	3.23	339.2	0.295E+00	1.12	255.25	3.79	2.67	.44544E+04
951.20	1.25	3.23	364.9	0.274E+00	1.14	270.34	3.80	2.66	.46984E+04
1000.00	1.25	3.23	391.3	0.256E+00	1.15	285.58	3.81	2.65	.49424E+04

Cumulative travel time = 4942.3687 sec (1.37 hrs)

Simulation limit based on maximum specified distance = 1000.00 m.
This is the REGION OF INTEREST limitation.

END OF MOD242: BUOYANT TERMINAL LAYER SPREADING

CORMIX2: Multiport Diffuser Discharges   End of Prediction File
2222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0G
                       HYDRO2:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                 BelfastBay
  DESIGN CASE:
  FILE NAME:                     C:\0 PROJECTS\171.05027-NordicAquaFarms\Modeling\CORMIX\Sim
ulations\diffuser\36-int-fast-summer-diff.prd
  Using subsystem CORMIX2:      Multiport Diffuser Discharges
  Start of session:              07/31/2018--08:04:48
***************************************************************************
SUMMARY OF INPUT DATA:
---------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                             = unbounded
  Average depth                  HA         = 11.5 m
  Depth at discharge             HD         = 11.5 m
  Ambient velocity               UA         = 0.2 m/s
  Darcy-Weisbach friction factor F          = 0.1
  Wind velocity                  UW         = 1 m/s
  Stratification Type            STRCND = A
  Surface density                RHOAS  = 1018 kg/m^3
  Bottom density                 RHOAB  = 1022.6 kg/m^3
---------------------------------------------------------------------------
DISCHARGE PARAMETERS:            Submerged Multiport Diffuser Discharge
  Diffuser type                  DITYPE = staged perpendicular
  Diffuser length                LD         = 30 m
  Nearest bank                              = right
  Diffuser endpoints             YB1        = 735 m;    YB2 = 765 m
  Number of openings             NOPEN  = 3
  Number of Risers               NRISER = 3
  Ports/Nozzles per Riser        NPPERR  = 1
  Spacing between risers/openings SPAC   = 15 m
  Port/Nozzle diameter           D0         = 0.305 m
    with contraction ratio                  = 1
  Equivalent slot width          B0         = 0.004871 m
  Total area of openings         TA0        = 0.2192 m^2
  Discharge velocity             U0         = 1.54 m/s
  Total discharge flowrate       Q0         = 0.337 m^3/s
  Discharge port height          H0         = 2 m
  Nozzle arrangement             BETYPE = staged
  Diffuser alignment angle       GAMMA  = 90 deg
  Vertical discharge angle       THETA  = 22 deg
  Actual Vertical discharge angle THEAC  = 22 deg
  Horizontal discharge angle     SIGMA  = 90 deg
  Relative orientation angle     BETA   = 0 deg
  Discharge density              RHO0   = 1014.8100 kg/m^3
  Density difference             DRHO   = 6.9900 kg/m^3
  Buoyant acceleration           GP0        = 0.0671 m/s^2
  Discharge concentration        C0         = 100 deg.C
  Surface heat exchange coeff.   KS         = 0 m/s
  Coefficient of decay           KD         = 0 /s
---------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)        q0         = 0.011233 m^2/s
  Momentum flux
      (based on slot width B0)   m0 =U0^2*B0   = 0.011514 m^3/s^2
      (based on volume flux q0)  m0 =U0*q0     = 0.017271 m^3/s^2
  Buoyancy flux
      (based on slot width B0)   j0 =U0*GP0*B0 = 0.000502 m^3/s^3
      (based on volume flux q0)  j0 =q0*GP0    = 0.000754 m^3/s^3
---------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.01 m          Lm  = 0.43 m          LM  = 1.82 m
  lm' = 1.65 m          Lb' = 1.47 m          La  = 3.23 m
```

```
  (These refer to the actual discharge/environment length scales.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number              FR0    = 85.06
  Port/nozzle Froude number       FRD0   = 10.75
  Velocity ratio                  R      = 7.69
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                          = no
  Water quality standard specified         = no
  Regulatory mixing zone                   = no
  Region of interest                       = 1000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = MS1 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the linearly
  stratified density layer at the discharge site.
  Applicable layer depth = water depth = 11.5 m
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    750 m from the right bank/shore.
  Number of display steps NSTEP = 20 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 2.9421 deg.C
  Dilution at edge of NFR              s = 34.0
  NFR Location:                        x = 35.99 m
    (centerline coordinates)           y = 1.24 m
                                       z = 3.75 m
  NFR plume dimensions:  half-width (bh) = 16.75 m
                          thickness (bv) = 1.71 m
Cumulative travel time:       104.5347 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
-----------------------------------------------------------------------------
Stratification assessment:
  The specified ambient density stratification is dynamically important.
  The discharge near field flow is trapped within the linearly stratified
  ambient density layer.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section does not contact bank in this simulation.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY **********************
No RMZ and no ambient water quality standard have been specified.
********************* FINAL DESIGN ADVICE AND COMMENTS *********************
CORMIX2 uses the TWO-DIMENSIONAL SLOT DIFFUSER CONCEPT to represent
  the actual three-dimensional diffuser geometry.  Thus, it approximates
  the details of the merging process of the individual jets from each
  port/nozzle.
In the present design, the spacing between adjacent ports/nozzles
```

```
  (or riser assemblies) is of the order of, or less than, the local
  water depth so that the slot diffuser approximation holds well.

Nevertheless, if this is a final design, the user is advised to use a
  final CORMIX1 (single port discharge) analysis, with discharge data
  for an individual diffuser jet/plume, in order to compare to
  the present near-field prediction.
-----------------------------------------------------------------------------
REMINDER:  The user must take note that HYDRODYNAMIC MODELING by any known
  technique is NOT AN EXACT SCIENCE.
Extensive comparison with field and laboratory data has shown that the
  CORMIX predictions on dilutions and concentrations (with associated
  plume geometries) are reliable for the majority of cases and are accurate
  to within about +-50% (standard deviation).
As a further safeguard, CORMIX will not give predictions whenever it judges
  the design configuration as highly complex and uncertain for prediction.
```

```
CORMIX2 PREDICTION FILE:
2222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
2222
                       CORMIX MIXING ZONE EXPERT SYSTEM
               Subsystem CORMIX2: Multiport Diffuser Discharges
                             CORMIX Version 11.0G
                     HYDRO2 Version 11.0.0.0 April 2018
-----------------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------------
---
CASE DESCRIPTION
 Site name/label:   BelfastBay
 Design case:
 FILE NAME:         C:\...\Simulations\diffuser\36-int-fast-summer-diff.prd
 Time stamp:        07/31/2018--08:04:48

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA    =     11.50  HD    =     11.50
 UA    =      0.200 F     =      0.100 USTAR =0.2236E-01
 UW    =      1.000 UWSTAR=0.1071E-02
 Density stratified environment
 STRCND=  A         RHOAM = 1020.3000
 RHOAS = 1018.0000  RHOAB = 1022.6000  RHOAH0= 1021.8000  E     =0.3836E-02

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:     DITYPE= staged_perpendicular
 BANK  =  RIGHT     DISTB =    750.00  YB1   =    735.00  YB2   =    765.00
 LD    =     30.00  NOPEN =    3       NRISER=    3       SPAC  =     15.00    NPPERR =
1
 D0    =      0.305 A0    =      0.073 H0    =      2.00  SUB0  =      9.50
 D0INP =      0.305 CR0   =      1.000 B0    =0.4871E-02
 Nozzle/port arrangement:   staged
 GAMMA =     90.00  THETA =     22.00  SIGMA =     90.00  BETA  =      0.00
 U0    =      1.538 Q0    =      0.337 Q0A   =0.3370E+00
 RHO0  = 1014.8100  DRHO0 =0.6990E+01  GP0   =0.6709E-01
 C0    =0.1000E+03  CUNITS=  deg.C
 IPOLL =  1         KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0    =0.1123E-01         SIGNJ0=      1.0
 m0 =U0^2*B0 =0.1151E-01   j0 =U0*GP0*B0 =0.5024E-03   (based on slot width B0)
 m0 =U0*q0   =0.1727E-01   j0 =q0*GP0    =0.7536E-03   (based on volume flux q0)
 Associated 2-d length scales (meters)
 lQ=B  =      0.007 lM    =      1.82  lm    =      0.43
 lmp   =      1.65  lbp   =      1.47  la    =      3.23

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0    =0.3370E+00  M0    =0.3454E+00  J0    =0.1507E-01
 Associated 3-d length scales (meters)
 LQ    =      0.27  LM    =      3.67  Lm    =      3.60  Lb    =      2.83
                                       Lmp   =      3.41  Lbp   =      3.12

NON-DIMENSIONAL PARAMETERS
 FR0   =     85.06  FRD0  =     10.75  R     =      7.69  PL    =  120.34
 (slot)             (port/nozzle)


FLOW CLASSIFICATION
 222222222222222222222222222222222222222222
 2  Flow class (CORMIX2)      =    MS1    2
 2  Applicable layer depth HS =    11.50  2
 222222222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
```

```
 C0    =0.1000E+03  CUNITS=  deg.C
 NTOX  =  0
 NSTD  =  0
 REGMZ =  0
 XINT  =   1000.00  XMAX  =   1000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
       750.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  20 display intervals per module
-----------------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------------
---
BEGIN MOD101: DISCHARGE MODULE (SINGLE PORT AT DIFFUSER CENTER)

       X        Y       Z        S       C       BV       BH       Uc        TT
      0.00     0.00    2.00     1.0 0.100E+03   0.15     0.15     1.538   .00000E+00

END OF MOD101: DISCHARGE MODULE (SINGLE PORT AT DIFFUSER CENTER)
-----------------------------------------------------------------------------------------------
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-----------------------------------------------------------------------------------------------
---
BEGIN CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

 Jet-like motion in linear stratification with strong crossflow.

 Zone of flow establishment:            THETAE=     21.97  SIGMAE=     86.67
  LE    =      0.89  XE    =      0.02  YE    =      0.82  ZE    =      2.33

 Profile definitions:
   BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory
   BH = before merging: Gaussian 1/e (37%) half-width in horizontal plane
                        normal to trajectory
        after merging:  top-hat half-width in horizontal plane
                        parallel to diffuser line
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)
   Uc = Local centerline excess velocity (above ambient)
   TT = Cumulative travel time

       X        Y       Z        S       C       BV       BH       Uc        TT
  Individual jet/plumes before merging:
      0.02     0.82    2.33     1.0 0.100E+03   0.15     0.15     1.538   .00000E+00
      0.02     0.82    2.33     1.0 0.100E+03   0.15     0.15     1.538   .20072E-02
      1.54     1.19    2.52     2.1 0.472E+02   0.32     0.32     0.746   .13340E+01
      3.18     1.23    2.63     3.3 0.304E+02   0.45     0.45     0.495   .34000E+01
      4.83     1.24    2.75     4.5 0.221E+02   0.57     0.57     0.371   .60429E+01
      6.47     1.24    2.86     5.8 0.173E+02   0.67     0.67     0.297   .91481E+01
      8.12     1.24    2.97     7.1 0.141E+02   0.76     0.76     0.249   .12652E+02
      9.76     1.24    3.06     8.4 0.120E+02   0.85     0.85     0.215   .16473E+02
     11.41     1.24    3.16     9.7 0.104E+02   0.93     0.93     0.189   .20586E+02
     13.05     1.24    3.24    10.9 0.915E+01   1.00     1.00     0.170   .24931E+02
     14.70     1.24    3.32    12.2 0.820E+01   1.07     1.07     0.154   .29500E+02
     16.34     1.24    3.40    13.4 0.744E+01   1.14     1.14     0.141   .34244E+02
     17.99     1.24    3.46    14.7 0.682E+01   1.20     1.20     0.130   .39168E+02
     19.63     1.24    3.52    15.9 0.630E+01   1.26     1.26     0.121   .44228E+02
     21.28     1.24    3.58    17.0 0.587E+01   1.31     1.31     0.113   .49421E+02
     22.92     1.24    3.62    18.1 0.551E+01   1.36     1.36     0.106   .54749E+02
     24.57     1.24    3.66    19.2 0.520E+01   1.41     1.41     0.101   .60172E+02
     26.22     1.24    3.70    20.3 0.493E+01   1.45     1.45     0.096   .65706E+02
     27.86     1.24    3.72    21.3 0.470E+01   1.49     1.49     0.091   .71313E+02
     29.51     1.24    3.74    22.2 0.451E+01   1.53     1.53     0.088   .77013E+02
     31.16     1.24    3.75    23.1 0.433E+01   1.56     1.56     0.084   .82769E+02
```

```
  Maximum jet height has been reached.
     32.80     1.24    3.75    23.9 0.418E+01   1.59     1.59     0.081   .88586E+02
  Terminal level in stratified ambient has been reached.
 Cumulative travel time =          88.5862 sec  (    0.02 hrs)
  Merging of individual jet/plumes not found in this module, but interaction
    will occur in following module.  Overall jet/plume interaction dimensions:
     32.80     1.24    3.75    23.9 0.418E+01   1.59    15.15     0.081   .88586E+02

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION
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-----------------------------------------------------------------------------------------
---
BEGIN MOD235: LAYER/BOUNDARY/TERMINAL LAYER APPROACH

  Control volume inflow:
       X        Y       Z        S       C       BV       BH        TT
     32.80     1.24    3.75    23.9 0.418E+01   1.59    15.15   .88586E+02

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

       X        Y       Z        S       C       BV       BH      ZU      ZL        TT
     31.21     1.24    3.75    23.9 0.418E+01   0.00     0.00    3.75    3.75   .88586E+02
     32.16     1.24    3.75    23.9 0.418E+01   1.27     7.49    4.39    3.12   .88586E+02
     33.12     1.24    3.75    24.3 0.412E+01   1.50    16.72    4.50    3.00   .90181E+02
     34.08     1.24    3.75    28.7 0.349E+01   1.62    16.73    4.56    2.94   .94966E+02
     35.03     1.24    3.75    32.6 0.307E+01   1.69    16.74    4.60    2.91   .99750E+02
     35.99     1.24    3.75    34.0 0.294E+01   1.71    16.75    4.61    2.90   .10453E+03
 Cumulative travel time =         104.5347 sec  (    0.03 hrs)

END OF MOD235: LAYER/BOUNDARY/TERMINAL LAYER APPROACH
-----------------------------------------------------------------------------------------
---
** End of NEAR-FIELD REGION (NFR) **
-----------------------------------------------------------------------------------------
---
BEGIN MOD242: BUOYANT TERMINAL LAYER SPREADING

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

 Plume Stage 1 (not bank attached):
       X        Y       Z        S       C       BV       BH      ZU      ZL        TT
     35.99     1.24    3.75    34.0 0.294E+01   1.71    16.75    4.61    2.90   .10453E+03
     84.19     1.24    3.75    42.8 0.234E+01   1.15    31.48    4.33    3.18   .34554E+03
    132.39     1.24    3.75    52.8 0.189E+01   1.03    43.10    4.27    3.24   .58654E+03
    180.59     1.24    3.75    65.1 0.154E+01   1.02    54.02    4.26    3.25   .82754E+03
    228.79     1.24    3.75    79.4 0.126E+01   1.03    64.88    4.27    3.24   .10685E+04
    276.99     1.24    3.75    95.3 0.105E+01   1.06    75.89    4.28    3.22   .13095E+04
    325.19     1.24    3.75   112.5 0.889E+00   1.09    87.13    4.30    3.21   .15505E+04
    373.39     1.24    3.75   131.0 0.764E+00   1.12    98.62    4.31    3.19   .17915E+04
    421.59     1.24    3.75   150.6 0.664E+00   1.15   110.37    4.33    3.18   .20326E+04
    469.80     1.24    3.75   171.3 0.584E+00   1.18   122.37    4.34    3.16   .22736E+04
```

518.00	1.24	3.75	193.0	0.518E+00	1.21	134.60	4.36	3.15	.25146E+04
566.20	1.24	3.75	215.8	0.463E+00	1.24	147.06	4.37	3.14	.27556E+04
614.40	1.24	3.75	239.4	0.418E+00	1.26	159.72	4.38	3.12	.29966E+04
662.60	1.24	3.75	264.0	0.379E+00	1.29	172.59	4.40	3.11	.32376E+04
710.80	1.24	3.75	289.5	0.345E+00	1.31	185.65	4.41	3.10	.34786E+04
759.00	1.24	3.75	315.9	0.317E+00	1.34	198.89	4.42	3.08	.37196E+04
807.20	1.24	3.75	343.1	0.291E+00	1.36	212.30	4.43	3.07	.39606E+04
855.40	1.24	3.75	371.1	0.269E+00	1.38	225.88	4.45	3.06	.42016E+04
903.60	1.24	3.75	399.9	0.250E+00	1.41	239.61	4.46	3.05	.44426E+04
951.80	1.24	3.75	429.5	0.233E+00	1.43	253.48	4.47	3.04	.46836E+04
1000.00	1.24	3.75	459.9	0.217E+00	1.45	267.51	4.48	3.03	.49246E+04

Cumulative travel time = 4924.5762 sec (1.37 hrs)

Simulation limit based on maximum specified distance = 1000.00 m.
This is the REGION OF INTEREST limitation.

END OF MOD242: BUOYANT TERMINAL LAYER SPREADING

CORMIX2: Multiport Diffuser Discharges End of Prediction File

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CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0G
                       HYDRO2:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                BelfastBay
  DESIGN CASE:
  FILE NAME:                    C:\0 PROJECTS\171.05027-NordicAquaFarms\Modeling\CORMIX\Sim
ulations\diffuser\38-int-fast-fall-diff.prd
  Using subsystem CORMIX2:     Multiport Diffuser Discharges
  Start of session:             07/31/2018--08:06:17
****************************************************************************
SUMMARY OF INPUT DATA:
----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                                = unbounded
  Average depth                   HA       = 11.5 m
  Depth at discharge              HD       = 11.5 m
  Ambient velocity                UA       = 0.2 m/s
  Darcy-Weisbach friction factor  F        = 0.1
  Wind velocity                   UW       = 1 m/s
  Stratification Type             STRCND = A
  Surface density                 RHOAS  = 1020 kg/m^3
  Bottom density                  RHOAB  = 1023 kg/m^3
----------------------------------------------------------------------------
DISCHARGE PARAMETERS:             Submerged Multiport Diffuser Discharge
  Diffuser type                   DITYPE = staged perpendicular
  Diffuser length                 LD       = 30 m
  Nearest bank                             = right
  Diffuser endpoints              YB1      = 735 m;    YB2 = 765 m
  Number of openings              NOPEN  = 3
  Number of Risers                NRISER = 3
  Ports/Nozzles per Riser         NPPERR  = 1
  Spacing between risers/openings SPAC     = 15 m
  Port/Nozzle diameter            D0       = 0.305 m
    with contraction ratio                 = 1
  Equivalent slot width           B0       = 0.004871 m
  Total area of openings          TA0      = 0.2192 m^2
  Discharge velocity              U0       = 1.54 m/s
  Total discharge flowrate        Q0       = 0.337 m^3/s
  Discharge port height           H0       = 2 m
  Nozzle arrangement              BETYPE = staged
  Diffuser alignment angle        GAMMA  = 90 deg
  Vertical discharge angle        THETA  = 22 deg
  Actual Vertical discharge angle THEAC  = 22 deg
  Horizontal discharge angle      SIGMA  = 90 deg
  Relative orientation angle      BETA   = 0 deg
  Discharge density               RHO0   = 1014.8100 kg/m^3
  Density difference              DRHO   = 7.6683 kg/m^3
  Buoyant acceleration            GP0      = 0.0735 m/s^2
  Discharge concentration         C0       = 100 deg.C
  Surface heat exchange coeff.    KS       = 0 m/s
  Coefficient of decay            KD       = 0 /s
----------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)         q0       = 0.011233 m^2/s
  Momentum flux
      (based on slot width B0)    m0 =U0^2*B0   = 0.011514 m^3/s^2
      (based on volume flux q0)   m0 =U0*q0     = 0.017271 m^3/s^2
  Buoyancy flux
      (based on slot width B0)    j0 =U0*GP0*B0 = 0.000551 m^3/s^3
      (based on volume flux q0)   j0 =q0*GP0    = 0.000826 m^3/s^3
----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.01 m          Lm  = 0.43 m          LM  = 1.71 m
  lm' = 1.90 m          Lb' = 1.88 m          La  = 4.00 m
```

```
  (These refer to the actual discharge/environment length scales.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number              FR0    = 81.23
  Port/nozzle Froude number       FRD0   = 10.27
  Velocity ratio                  R      = 7.69
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = no
  Water quality standard specified       = no
  Regulatory mixing zone                 = no
  Region of interest                     = 1000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = MS1 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the linearly
  stratified density layer at the discharge site.
  Applicable layer depth = water depth = 11.5 m
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    750 m from the right bank/shore.
  Number of display steps NSTEP = 20 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 2.2328 deg.C
  Dilution at edge of NFR              s = 44.8
  NFR Location:                        x = 45.91 m
    (centerline coordinates)           y = 1.24 m
                                       z = 4.18 m
  NFR plume dimensions:  half-width (bh) = 17.00 m
                          thickness (bv) = 2.22 m
Cumulative travel time:       141.5130 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
-----------------------------------------------------------------------------
Stratification assessment:
  The specified ambient density stratification is dynamically important.
  The discharge near field flow is trapped within the linearly stratified
  ambient density layer.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section does not contact bank in this simulation.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY ***********************
No RMZ and no ambient water quality standard have been specified.
********************* FINAL DESIGN ADVICE AND COMMENTS **********************
CORMIX2 uses the TWO-DIMENSIONAL SLOT DIFFUSER CONCEPT to represent
  the actual three-dimensional diffuser geometry.  Thus, it approximates
  the details of the merging process of the individual jets from each
  port/nozzle.
In the present design, the spacing between adjacent ports/nozzles
```

(or riser assemblies) is of the order of, or less than, the local
water depth so that the slot diffuser approximation holds well.

Nevertheless, if this is a final design, the user is advised to use a
final CORMIX1 (single port discharge) analysis, with discharge data
for an individual diffuser jet/plume, in order to compare to
the present near-field prediction.

REMINDER: The user must take note that HYDRODYNAMIC MODELING by any known
technique is NOT AN EXACT SCIENCE.
Extensive comparison with field and laboratory data has shown that the
CORMIX predictions on dilutions and concentrations (with associated
plume geometries) are reliable for the majority of cases and are accurate
to within about +-50% (standard deviation).
As a further safeguard, CORMIX will not give predictions whenever it judges
the design configuration as highly complex and uncertain for prediction.

```
CORMIX2 PREDICTION FILE:
22222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
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                       CORMIX MIXING ZONE EXPERT SYSTEM
               Subsystem CORMIX2: Multiport Diffuser Discharges
                             CORMIX Version 11.0G
                         HYDRO2 Version 11.0.0.0 April 2018
-----------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------
---
CASE DESCRIPTION
 Site name/label:   BelfastBay
 Design case:
 FILE NAME:         C:\...IX\Simulations\diffuser\38-int-fast-fall-diff.prd
 Time stamp:        07/31/2018--08:06:17

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA    =     11.50  HD    =     11.50
 UA    =      0.200 F     =      0.100 USTAR =0.2236E-01
 UW    =      1.000 UWSTAR=0.1071E-02
 Density stratified environment
 STRCND=  A         RHOAM = 1021.5000
 RHOAS = 1020.0000  RHOAB = 1023.0000  RHOAH0= 1022.4783  E     =0.2501E-02

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:     DITYPE= staged_perpendicular
 BANK  =  RIGHT     DISTB =    750.00  YB1   =    735.00  YB2   =    765.00
 LD    =     30.00  NOPEN =    3       NRISER=    3       SPAC  =     15.00    NPPERR =
1
 D0    =      0.305 A0    =      0.073 H0    =      2.00  SUB0  =      9.50
 D0INP =      0.305 CR0   =      1.000 B0    =0.4871E-02
 Nozzle/port arrangement:   staged
 GAMMA =     90.00  THETA =     22.00  SIGMA =     90.00  BETA  =      0.00
 U0    =      1.538 Q0    =      0.337 Q0A   =0.3370E+00
 RHO0  = 1014.8100  DRHO0 =0.7668E+01  GP0   =0.7355E-01
 C0    =0.1000E+03  CUNITS=  deg.C
 IPOLL =  1         KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0    =0.1123E-01         SIGNJ0=      1.0
 m0 =U0^2*B0 =0.1151E-01   j0 =U0*GP0*B0 =0.5508E-03   (based on slot width B0)
 m0 =U0*q0   =0.1727E-01   j0 =q0*GP0    =0.8262E-03   (based on volume flux q0)
 Associated 2-d length scales (meters)
 lQ=B  =      0.007 lM    =      1.71  lm    =      0.43
 lmp   =      1.90  lbp   =      1.88  la    =      4.00

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0    =0.3370E+00  M0    =0.3454E+00  J0    =0.1652E-01
 Associated 3-d length scales (meters)
 LQ    =      0.27  LM    =      3.51  Lm    =      3.60  Lb    =      3.10
                                       Lmp   =      3.79  Lbp   =      3.75

NON-DIMENSIONAL PARAMETERS
 FR0   =     81.23  FRD0  =     10.27  R     =      7.69  PL    =  124.08
 (slot)             (port/nozzle)


FLOW CLASSIFICATION
 222222222222222222222222222222222222222222
 2  Flow class (CORMIX2)      =    MS1    2
 2  Applicable layer depth HS =    11.50  2
 222222222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
```

```
 C0    =0.1000E+03  CUNITS=  deg.C
 NTOX  =  0
 NSTD  =  0
 REGMZ =  0
 XINT  =   1000.00  XMAX  =   1000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
       750.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  20 display intervals per module
-----------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------
---
BEGIN MOD101: DISCHARGE MODULE (SINGLE PORT AT DIFFUSER CENTER)

       X        Y       Z        S       C        BV       BH       Uc        TT
      0.00     0.00    2.00     1.0 0.100E+03   0.15     0.15     1.538   .00000E+00

END OF MOD101: DISCHARGE MODULE (SINGLE PORT AT DIFFUSER CENTER)
-----------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------
---
BEGIN CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

 Jet-like motion in linear stratification with strong crossflow.

 Zone of flow establishment:            THETAE=     21.97  SIGMAE=     86.67
  LE    =      0.89  XE    =      0.02  YE    =      0.82  ZE    =      2.33

 Profile definitions:
   BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory
   BH = before merging: Gaussian 1/e (37%) half-width in horizontal plane
                        normal to trajectory
        after merging:  top-hat half-width in horizontal plane
                        parallel to diffuser line
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)
   Uc = Local centerline excess velocity (above ambient)
   TT = Cumulative travel time

       X        Y       Z        S       C        BV       BH       Uc        TT
  Individual jet/plumes before merging:
      0.02     0.82    2.33     1.0 0.100E+03   0.15     0.15     1.538   .00000E+00
      0.02     0.82    2.33     1.0 0.100E+03   0.15     0.15     1.538   .20072E-02
      2.01     1.21    2.56     2.5 0.408E+02   0.36     0.36     0.651   .18598E+01
      4.13     1.24    2.72     4.0 0.248E+02   0.52     0.52     0.415   .48531E+01
      6.24     1.24    2.87     5.7 0.176E+02   0.66     0.66     0.306   .86929E+01
      8.35     1.24    3.01     7.4 0.136E+02   0.78     0.78     0.244   .13183E+02
     10.47     1.24    3.15     9.1 0.110E+02   0.89     0.89     0.204   .18208E+02
     12.58     1.24    3.28    10.8 0.928E+01   0.99     0.99     0.176   .23666E+02
     14.69     1.24    3.40    12.5 0.800E+01   1.09     1.09     0.155   .29473E+02
     16.81     1.24    3.51    14.2 0.704E+01   1.17     1.17     0.139   .35600E+02
     18.93     1.24    3.62    15.9 0.629E+01   1.25     1.25     0.126   .41978E+02
     21.04     1.24    3.71    17.6 0.570E+01   1.33     1.33     0.115   .48602E+02
     23.16     1.24    3.80    19.2 0.521E+01   1.40     1.40     0.106   .55430E+02
     25.28     1.24    3.88    20.8 0.482E+01   1.46     1.46     0.099   .62426E+02
     27.39     1.24    3.95    22.3 0.448E+01   1.53     1.53     0.093   .69598E+02
     29.51     1.24    4.01    23.8 0.421E+01   1.58     1.58     0.087   .76916E+02
     31.63     1.24    4.06    25.2 0.397E+01   1.64     1.64     0.082   .84348E+02
     33.75     1.24    4.10    26.6 0.377E+01   1.69     1.69     0.078   .91911E+02
     35.87     1.24    4.13    27.8 0.359E+01   1.73     1.73     0.075   .99578E+02
     37.98     1.24    4.16    29.0 0.344E+01   1.77     1.77     0.072   .10732E+03
     40.10     1.24    4.17    30.2 0.332E+01   1.81     1.81     0.069   .11516E+03
```

```
  Maximum jet height has been reached.
     42.22     1.24    4.18    31.2 0.321E+01   1.85     1.85     0.067   .12306E+03
  Terminal level in stratified ambient has been reached.
 Cumulative travel time =         123.0553 sec  (    0.03 hrs)
  Merging of individual jet/plumes not found in this module, but interaction
    will occur in following module.  Overall jet/plume interaction dimensions:
     42.22     1.24    4.18    31.2 0.321E+01   1.85    15.15     0.067   .12306E+03

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION
-----------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------
---
BEGIN MOD235: LAYER/BOUNDARY/TERMINAL LAYER APPROACH

  Control volume inflow:
      X        Y       Z        S       C       BV      BH        TT
     42.22     1.24    4.18    31.2 0.321E+01   1.85    15.15   .12306E+03

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

      X        Y       Z        S       C       BV      BH      ZU      ZL       TT
     40.37     1.24    4.18    31.2 0.321E+01   0.00     0.00    4.18    4.18   .12306E+03
     41.48     1.24    4.18    31.2 0.321E+01   1.66     7.60    5.00    3.35   .12306E+03
     42.59     1.24    4.18    31.7 0.315E+01   1.94    16.97    5.15    3.20   .12490E+03
     43.70     1.24    4.18    37.6 0.266E+01   2.11    16.98    5.23    3.12   .13044E+03
     44.80     1.24    4.18    42.9 0.233E+01   2.19    16.99    5.27    3.08   .13598E+03
     45.91     1.24    4.18    44.8 0.223E+01   2.22    17.00    5.29    3.07   .14151E+03
 Cumulative travel time =         141.5130 sec  (    0.04 hrs)

END OF MOD235: LAYER/BOUNDARY/TERMINAL LAYER APPROACH
-----------------------------------------------------------------------------------------
---
** End of NEAR-FIELD REGION (NFR) **
-----------------------------------------------------------------------------------------
---
BEGIN MOD242: BUOYANT TERMINAL LAYER SPREADING

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

 Plume Stage 1 (not bank attached):
      X        Y       Z        S       C       BV      BH      ZU      ZL       TT
     45.91     1.24    4.18    44.8 0.223E+01   2.22    17.00    5.29    3.07   .14151E+03
     93.62     1.24    4.18    55.4 0.181E+01   1.45    32.15    4.90    3.45   .38004E+03
    141.32     1.24    4.18    66.3 0.151E+01   1.27    43.83    4.81    3.54   .61856E+03
    189.02     1.24    4.18    79.5 0.126E+01   1.23    54.55    4.79    3.56   .85708E+03
    236.73     1.24    4.18    95.0 0.105E+01   1.23    65.04    4.79    3.56   .10956E+04
    284.43     1.24    4.18   112.3 0.891E+00   1.25    75.58    4.80    3.55   .13341E+04
    332.14     1.24    4.18   131.1 0.763E+00   1.28    86.27    4.82    3.54   .15726E+04
    379.84     1.24    4.18   151.2 0.661E+00   1.31    97.17    4.83    3.52   .18112E+04
    427.55     1.24    4.18   172.7 0.579E+00   1.34   108.27    4.85    3.50   .20497E+04
    475.25     1.24    4.18   195.3 0.512E+00   1.38   119.60    4.86    3.49   .22882E+04
```

522.96	1.24	4.18	219.0	0.457E+00	1.41	131.13	4.88	3.47	.25267E+04
570.66	1.24	4.18	243.8	0.410E+00	1.44	142.87	4.89	3.46	.27653E+04
618.36	1.24	4.18	269.6	0.371E+00	1.47	154.81	4.91	3.44	.30038E+04
666.07	1.24	4.18	296.4	0.337E+00	1.50	166.93	4.92	3.43	.32423E+04
713.77	1.24	4.18	324.2	0.308E+00	1.52	179.24	4.94	3.41	.34808E+04
761.48	1.24	4.18	352.9	0.283E+00	1.55	191.71	4.95	3.40	.37193E+04
809.18	1.24	4.18	382.5	0.261E+00	1.58	204.35	4.96	3.39	.39579E+04
856.89	1.24	4.18	413.0	0.242E+00	1.60	217.14	4.98	3.37	.41964E+04
904.59	1.24	4.18	444.4	0.225E+00	1.63	230.08	4.99	3.36	.44349E+04
952.30	1.24	4.18	476.6	0.210E+00	1.65	243.17	5.00	3.35	.46734E+04
1000.00	1.24	4.18	509.6	0.196E+00	1.67	256.39	5.01	3.34	.49120E+04

Cumulative travel time = 4911.9565 sec (1.36 hrs)

Simulation limit based on maximum specified distance = 1000.00 m.
This is the REGION OF INTEREST limitation.

END OF MOD242: BUOYANT TERMINAL LAYER SPREADING

CORMIX2: Multiport Diffuser Discharges End of Prediction File

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CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0G
                       HYDRO2:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                BelfastBay
  DESIGN CASE:
  FILE NAME:                    C:\0 PROJECTS\171.05027-NordicAquaFarms\Modeling\CORMIX\Sim
ulations\diffuser\40-int-slow-winter-diff.prd
  Using subsystem CORMIX2:     Multiport Diffuser Discharges
  Start of session:             07/31/2018--08:07:53
***************************************************************************
SUMMARY OF INPUT DATA:
---------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                               = unbounded
  Average depth                   HA     = 11.5 m
  Depth at discharge              HD     = 11.5 m
  Ambient velocity                UA     = 0.05 m/s
  Darcy-Weisbach friction factor  F      = 0.1
  Wind velocity                   UW     = 1 m/s
  Stratification Type             STRCND = U
  Surface density                 RHOAS  = 1025 kg/m^3
  Bottom density                  RHOAB  = 1025 kg/m^3
---------------------------------------------------------------------------
DISCHARGE PARAMETERS:             Submerged Multiport Diffuser Discharge
  Diffuser type                   DITYPE = staged perpendicular
  Diffuser length                 LD     = 30 m
  Nearest bank                           = right
  Diffuser endpoints              YB1    = 735 m;    YB2 = 765 m
  Number of openings              NOPEN  = 3
  Number of Risers                NRISER = 3
  Ports/Nozzles per Riser         NPPERR  = 1
  Spacing between risers/openings SPAC   = 15 m
  Port/Nozzle diameter            D0     = 0.305 m
    with contraction ratio               = 1
  Equivalent slot width           B0     = 0.004871 m
  Total area of openings          TA0    = 0.2192 m^2
  Discharge velocity              U0     = 1.54 m/s
  Total discharge flowrate        Q0     = 0.337 m^3/s
  Discharge port height           H0     = 2 m
  Nozzle arrangement              BETYPE = staged
  Diffuser alignment angle        GAMMA  = 90 deg
  Vertical discharge angle        THETA  = 22 deg
  Actual Vertical discharge angle THEAC  = 22 deg
  Horizontal discharge angle      SIGMA  = 90 deg
  Relative orientation angle      BETA   = 0 deg
  Discharge density               RHO0   = 1014.8100 kg/m^3
  Density difference              DRHO   = 10.1900 kg/m^3
  Buoyant acceleration            GP0    = 0.0975 m/s^2
  Discharge concentration         C0     = 100 deg.C
  Surface heat exchange coeff.    KS     = 0 m/s
  Coefficient of decay            KD     = 0 /s
---------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)         q0     = 0.011233 m^2/s
  Momentum flux
      (based on slot width B0)    m0 =U0^2*B0   = 0.011514 m^3/s^2
      (based on volume flux q0)   m0 =U0*q0     = 0.017271 m^3/s^2
  Buoyancy flux
      (based on slot width B0)    j0 =U0*GP0*B0 = 0.000730 m^3/s^3
      (based on volume flux q0)   j0 =q0*GP0    = 0.001095 m^3/s^3
---------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.01 m          Lm  = 6.91 m          LM  = 1.42 m
  lm' = 99999 m          Lb' = 99999 m          La  = 99999 m
```

```
  (These refer to the actual discharge/environment length scales.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number              FR0    = 70.56
  Port/nozzle Froude number       FRD0   = 8.92
  Velocity ratio                  R      = 30.75
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                         = no
  Water quality standard specified        = no
  Regulatory mixing zone                  = no
  Region of interest                      = 1000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = MU6 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 11.5 m
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    750 m from the right bank/shore.
  Number of display steps NSTEP = 20 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 1.7331 deg.C
  Dilution at edge of NFR              s = 57.7
  NFR Location:                        x = 57.5 m
    (centerline coordinates)           y = 9.01 m
                                       z = 11.5 m
  NFR plume dimensions:  half-width (bh) = 16.91 m
                          thickness (bv) = 11.5 m
Cumulative travel time:       1150 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
-----------------------------------------------------------------------------
Near-field instability behavior:
  The diffuser flow will experience instabilities with full vertical mixing
  in the near-field.
  There may be benthic impact of high pollutant concentrations.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed WITHIN NEAR-FIELD at 0 m
  downstream, but RE-STRATIFIES LATER and is not mixed in the far-field.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section does not contact bank in this simulation.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************* REGULATORY MIXING ZONE SUMMARY ************************
No RMZ and no ambient water quality standard have been specified.
********************* FINAL DESIGN ADVICE AND COMMENTS **********************
CORMIX2 uses the TWO-DIMENSIONAL SLOT DIFFUSER CONCEPT to represent
```

```
  the actual three-dimensional diffuser geometry.  Thus, it approximates
  the details of the merging process of the individual jets from each
  port/nozzle.
In the present design, the spacing between adjacent ports/nozzles
  (or riser assemblies) is of the order of, or less than, the local
  water depth so that the slot diffuser approximation holds well.

Nevertheless, if this is a final design, the user is advised to use a
  final CORMIX1 (single port discharge) analysis, with discharge data
  for an individual diffuser jet/plume, in order to compare to
  the present near-field prediction.
-----------------------------------------------------------------------------
REMINDER:  The user must take note that HYDRODYNAMIC MODELING by any known
  technique is NOT AN EXACT SCIENCE.
Extensive comparison with field and laboratory data has shown that the
  CORMIX predictions on dilutions and concentrations (with associated
  plume geometries) are reliable for the majority of cases and are accurate
  to within about +-50% (standard deviation).
As a further safeguard, CORMIX will not give predictions whenever it judges
  the design configuration as highly complex and uncertain for prediction.
```

```
CORMIX2 PREDICTION FILE:
2222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
2222
                       CORMIX MIXING ZONE EXPERT SYSTEM
               Subsystem CORMIX2: Multiport Diffuser Discharges
                             CORMIX Version 11.0G
                     HYDRO2 Version 11.0.0.0 April 2018
-----------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------
---
CASE DESCRIPTION
 Site name/label:   BelfastBay
 Design case:
 FILE NAME:         C:\...\Simulations\diffuser\40-int-slow-winter-diff.prd
 Time stamp:        07/31/2018--08:07:53

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA    =     11.50  HD    =     11.50
 UA    =      0.050 F     =      0.100 USTAR =0.5590E-02
 UW    =      1.000 UWSTAR=0.1071E-02
 Uniform density environment
 STRCND=  U         RHOAM = 1025.0000

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:     DITYPE= staged_perpendicular
 BANK  =  RIGHT     DISTB =    750.00  YB1   =    735.00  YB2   =    765.00
 LD    =     30.00  NOPEN =    3       NRISER=    3       SPAC  =     15.00    NPPERR =
1
 D0    =      0.305 A0    =      0.073 H0    =      2.00  SUB0  =      9.50
 D0INP =      0.305 CR0   =      1.000 B0    =0.4871E-02
 Nozzle/port arrangement:   staged
 GAMMA =     90.00  THETA =     22.00  SIGMA =     90.00  BETA  =      0.00
 U0    =      1.538 Q0    =      0.337 Q0A   =0.3370E+00
 RHO0  = 1014.8100  DRHO0 =0.1019E+02  GP0   =0.9749E-01
 C0    =0.1000E+03  CUNITS=  deg.C
 IPOLL =  1         KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0    =0.1123E-01         SIGNJ0=      1.0
 m0 =U0^2*B0 =0.1151E-01   j0 =U0*GP0*B0 =0.7301E-03   (based on slot width B0)
 m0 =U0*q0   =0.1727E-01   j0 =q0*GP0    =0.1095E-02   (based on volume flux q0)
 Associated 2-d length scales (meters)
 lQ=B  =      0.007 lM    =      1.42  lm    =      6.91
 lmp   =  99999.00  lbp   =  99999.00  la    =  99999.00

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0    =0.3370E+00  M0    =0.3454E+00  J0    =0.2190E-01
 Associated 3-d length scales (meters)
 LQ    =      0.27  LM    =      3.04  Lm    =     14.40  Lb    =    262.84
                                       Lmp   =  99999.00  Lbp   =  99999.00

NON-DIMENSIONAL PARAMETERS
 FR0   =     70.56  FRD0  =      8.92  R     =     30.75  PL    =  136.30
 (slot)             (port/nozzle)


FLOW CLASSIFICATION
 222222222222222222222222222222222222222222
 2  Flow class (CORMIX2)      =    MU6    2
 2  Applicable layer depth HS =    11.50  2
 222222222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.1000E+03  CUNITS=  deg.C
```

```
 NTOX  =  0
 NSTD  =  0
 REGMZ =  0
 XINT  =   1000.00  XMAX  =   1000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
       750.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  20 display intervals per module
-----------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------
---
BEGIN MOD202: DISCHARGE MODULE (STAGED DIFFUSER)

 Due to complex near-field motions:  EQUIVALENT SLOT DIFFUSER (2-D) GEOMETRY

 Profile definitions:
   BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory
   BH = Gaussian 1/e (37%) half-width in horizontal plane normal to trajectory
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)
   Uc = Local centerline excess velocity (above ambient)
   TT = Cumulative travel time

       X        Y       Z        S        C       BV       BH       Uc        TT
      0.00     0.00    2.00     1.0 0.100E+03   0.00    15.00     1.538   .00000E+00

END OF MOD202: DISCHARGE MODULE (STAGED DIFFUSER)
-----------------------------------------------------------------------------------------
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-----------------------------------------------------------------------------------------
---
BEGIN MOD275: STAGED PERPENDICULAR DIFFUSER IN STRONG CURRENT

 Because of the strong ambient current the diffuser plume of this crossflowing
   discharge gets RAPIDLY DEFLECTED.
 A near-field zone is formed that is VERTICALLY FULLY MIXED over the entire
   layer depth.  Full mixing is achieved at a downstream distance of about
   five (5) layer depths.

 Profile definitions:
   BV = layer depth (vertically mixed)
   BH = top-hat half-width, measured horizontally in Y-direction
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

       X        Y       Z        S        C       BV       BH         TT
      0.00     0.00    2.00     1.0 0.100E+03   0.00    15.00 .00000E+00
      2.88     0.45    2.19    13.7 0.731E+01   0.58    15.10 .57500E+02
      5.75     0.90    2.38    18.9 0.528E+01   1.15    15.19 .11500E+03
      8.62     1.35    2.56    23.0 0.436E+01   1.73    15.29 .17250E+03
     11.50     1.80    2.75    26.4 0.379E+01   2.30    15.38 .23000E+03
     14.38     2.25    2.94    29.4 0.341E+01   2.88    15.48 .28750E+03
     17.25     2.70    3.12    32.1 0.312E+01   3.45    15.57 .34500E+03
     20.12     3.15    3.31    34.5 0.289E+01   4.03    15.67 .40250E+03
     23.00     3.60    3.50    36.9 0.271E+01   4.60    15.76 .46000E+03
     25.88     4.06    3.69    39.0 0.256E+01   5.18    15.86 .51750E+03
     28.75     4.51    3.88    41.1 0.243E+01   5.75    15.95 .57500E+03
     31.62     4.96    4.06    43.1 0.232E+01   6.33    16.05 .63250E+03
     34.50     5.41    4.25    44.9 0.223E+01   6.90    16.15 .69000E+03
     37.38     5.86    4.44    46.7 0.214E+01   7.48    16.24 .74750E+03
     40.25     6.31    4.62    48.4 0.206E+01   8.05    16.34 .80500E+03
     43.12     6.76    4.81    50.1 0.200E+01   8.63    16.43 .86250E+03
```

```
     46.00     7.21    5.00    51.7 0.193E+01   9.20    16.53 .92000E+03
     48.88     7.66    5.19    53.3 0.188E+01   9.78    16.62 .97750E+03
     51.75     8.11    5.38    54.8 0.183E+01  10.35    16.72 .10350E+04
     54.62     8.56    5.56    56.3 0.178E+01  10.93    16.81 .10925E+04
     57.50     9.01    5.75    57.7 0.173E+01  11.50    16.91 .11500E+04
 Cumulative travel time =        1150.0000 sec  (    0.32 hrs)
   Plume centerline may exhibit slight discontinuities in transition
     to subsequent far-field module.

END OF MOD275: STAGED PERPENDICULAR DIFFUSER IN STRONG CURRENT
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** End of NEAR-FIELD REGION (NFR) **
-----------------------------------------------------------------------------------------------
---
BEGIN MOD241: BUOYANT AMBIENT SPREADING

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

 Plume Stage 1 (not bank attached):
       X        Y       Z        S       C        BV       BH       ZU       ZL        TT
     57.50     9.01   11.50    57.7 0.173E+01  11.50    16.91    11.50     0.00   .11500E+04
    104.62     9.01   11.50    83.7 0.119E+01   3.80    74.31    11.50     7.70   .20925E+04
    151.75     9.01   11.50    93.4 0.107E+01   2.78   113.42    11.50     8.72   .30350E+04
    198.88     9.01   11.50   100.3 0.997E+00   2.31   146.39    11.50     9.19   .39775E+04
    246.00     9.01   11.50   105.9 0.944E+00   2.03   175.78    11.50     9.47   .49200E+04
    293.12     9.01   11.50   111.1 0.900E+00   1.85   202.69    11.50     9.65   .58625E+04
    340.25     9.01   11.50   116.1 0.861E+00   1.72   227.74    11.50     9.78   .68050E+04
    387.38     9.01   11.50   121.1 0.826E+00   1.62   251.32    11.50     9.88   .77475E+04
    434.50     9.01   11.50   126.2 0.792E+00   1.55   273.70    11.50     9.95   .86900E+04
    481.62     9.01   11.50   131.5 0.760E+00   1.50   295.06    11.50    10.00   .96325E+04
    528.75     9.01   11.50   137.1 0.729E+00   1.46   315.56    11.50    10.04   .10575E+05
    575.88     9.01   11.50   143.0 0.699E+00   1.44   335.31    11.50    10.06   .11518E+05
    623.00     9.01   11.50   149.2 0.670E+00   1.42   354.40    11.50    10.08   .12460E+05
    670.12     9.01   11.50   155.8 0.642E+00   1.41   372.91    11.50    10.09   .13402E+05
    717.25     9.01   11.50   162.8 0.614E+00   1.40   390.90    11.50    10.10   .14345E+05
    764.38     9.01   11.50   170.2 0.588E+00   1.40   408.41    11.50    10.10   .15288E+05
    811.50     9.01   11.50   178.1 0.562E+00   1.41   425.51    11.50    10.09   .16230E+05
    858.62     9.01   11.50   186.4 0.536E+00   1.42   442.22    11.50    10.08   .17172E+05
    905.75     9.01   11.50   195.2 0.512E+00   1.43   458.58    11.50    10.07   .18115E+05
    952.88     9.01   11.50   204.6 0.489E+00   1.45   474.62    11.50    10.05   .19058E+05
   1000.00     9.01   11.50   214.4 0.466E+00   1.47   490.37    11.50    10.03   .20000E+05
 Cumulative travel time =       20000.0000 sec  (    5.56 hrs)

 Simulation limit based on maximum specified distance =   1000.00 m.
   This is the REGION OF INTEREST limitation.

END OF MOD241: BUOYANT AMBIENT SPREADING
-----------------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------------
---
CORMIX2: Multiport Diffuser Discharges       End of Prediction File
222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
2222
```

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CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0G
                       HYDRO2:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                  BelfastBay
  DESIGN CASE:
  FILE NAME:                      C:\0 PROJECTS\171.05027-NordicAquaFarms\Modeling\CORMIX\Sim
ulations\diffuser\42-int-slow-spring-diff.prd
  Using subsystem CORMIX2:       Multiport Diffuser Discharges
  Start of session:               07/31/2018--08:09:48
****************************************************************************
SUMMARY OF INPUT DATA:
----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                                = unbounded
  Average depth                     HA         = 11.5 m
  Depth at discharge                HD         = 11.5 m
  Ambient velocity                  UA         = 0.05 m/s
  Darcy-Weisbach friction factor    F          = 0.1
  Wind velocity                     UW         = 1 m/s
  Stratification Type               STRCND = A
  Surface density                   RHOAS  = 1013 kg/m^3
  Bottom density                    RHOAB  = 1022 kg/m^3
----------------------------------------------------------------------------
DISCHARGE PARAMETERS:               Submerged Multiport Diffuser Discharge
  Diffuser type                     DITYPE = staged perpendicular
  Diffuser length                   LD     = 30 m
  Nearest bank                             = right
  Diffuser endpoints                YB1    = 735 m;    YB2 = 765 m
  Number of openings                NOPEN  = 3
  Number of Risers                  NRISER = 3
  Ports/Nozzles per Riser           NPPERR  = 1
  Spacing between risers/openings SPAC   = 15 m
  Port/Nozzle diameter              D0     = 0.305 m
    with contraction ratio                 = 1
  Equivalent slot width             B0     = 0.004871 m
  Total area of openings            TA0    = 0.2192 m^2
  Discharge velocity                U0     = 1.54 m/s
  Total discharge flowrate          Q0     = 0.337 m^3/s
  Discharge port height             H0     = 2 m
  Nozzle arrangement                BETYPE = staged
  Diffuser alignment angle          GAMMA  = 90 deg
  Vertical discharge angle          THETA  = 22 deg
  Actual Vertical discharge angle THEAC  = 22 deg
  Horizontal discharge angle        SIGMA  = 90 deg
  Relative orientation angle        BETA   = 0 deg
  Discharge density                 RHO0   = 1014.8100 kg/m^3
  Density difference                DRHO   = 5.6248 kg/m^3
  Buoyant acceleration              GP0    = 0.0541 m/s^2
  Discharge concentration           C0     = 100 deg.C
  Surface heat exchange coeff.      KS     = 0 m/s
  Coefficient of decay              KD     = 0 /s
----------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)           q0     = 0.011233 m^2/s
  Momentum flux
      (based on slot width B0)      m0 =U0^2*B0   = 0.011514 m^3/s^2
      (based on volume flux q0)     m0 =U0*q0     = 0.017271 m^3/s^2
  Buoyancy flux
      (based on slot width B0)      j0 =U0*GP0*B0 = 0.000405 m^3/s^3
      (based on volume flux q0)     j0 =q0*GP0    = 0.000607 m^3/s^3
----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.01 m          Lm  = 6.91 m          LM  = 2.10 m
  lm' = 1.32 m          Lb' = 0.98 m          La  = 0.58 m
```

```
  (These refer to the actual discharge/environment length scales.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number              FR0    = 94.75
  Port/nozzle Froude number       FRD0   = 11.97
  Velocity ratio                  R      = 30.75
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                         = no
  Water quality standard specified        = no
  Regulatory mixing zone                  = no
  Region of interest                      = 1000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *-------------------------*
  | FLOW CLASS   = MS4 |
  *-------------------------*
  This flow configuration applies to a layer corresponding to the linearly
  stratified density layer at the discharge site.
  Applicable layer depth = water depth = 11.5 m
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    750 m from the right bank/shore.
  Number of display steps NSTEP = 20 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 6.6941 deg.C
  Dilution at edge of NFR              s = 14.9
  NFR Location:                        x = 39.57 m
    (centerline coordinates)           y = 4.09 m
                                       z = 4.13 m
  NFR plume dimensions:  half-width (bh) = 57.45 m
                          thickness (bv) = 0.88 m
Cumulative travel time:       604.5605 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
-----------------------------------------------------------------------------
Stratification assessment:
  The specified ambient density stratification is dynamically important.
  The discharge near field flow is trapped within the linearly stratified
  ambient density layer.
-----------------------------------------------------------------------------
UPSTREAM INTRUSION SUMMARY:
Plume exhibits upstream intrusion due to low ambient velocity or strong
  discharge buoyancy.
  Intrusion length                        =  27.93 m
  Intrusion stagnation point              =  -17.08 m
  Intrusion thickness                     =  1.38 m
  Intrusion half width at impingement     =  57.45 m
  Intrusion half thickness at impingement =  0.88 m
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section does not contact bank in this simulation.
************************ TOXIC DILUTION ZONE SUMMARY ************************
```

```
No TDZ was specified for this simulation.
********************* REGULATORY MIXING ZONE SUMMARY ***********************
No RMZ and no ambient water quality standard have been specified.
******************** FINAL DESIGN ADVICE AND COMMENTS *********************
CORMIX2 uses the TWO-DIMENSIONAL SLOT DIFFUSER CONCEPT to represent
  the actual three-dimensional diffuser geometry.  Thus, it approximates
  the details of the merging process of the individual jets from each
  port/nozzle.
In the present design, the spacing between adjacent ports/nozzles
  (or riser assemblies) is of the order of, or less than, the local
  water depth so that the slot diffuser approximation holds well.

Nevertheless, if this is a final design, the user is advised to use a
  final CORMIX1 (single port discharge) analysis, with discharge data
  for an individual diffuser jet/plume, in order to compare to
  the present near-field prediction.
-----------------------------------------------------------------------------
REMINDER:  The user must take note that HYDRODYNAMIC MODELING by any known
  technique is NOT AN EXACT SCIENCE.
Extensive comparison with field and laboratory data has shown that the
  CORMIX predictions on dilutions and concentrations (with associated
  plume geometries) are reliable for the majority of cases and are accurate
  to within about +-50% (standard deviation).
As a further safeguard, CORMIX will not give predictions whenever it judges
  the design configuration as highly complex and uncertain for prediction.
```

```
CORMIX2 PREDICTION FILE:
222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
2222
                       CORMIX MIXING ZONE EXPERT SYSTEM
               Subsystem CORMIX2: Multiport Diffuser Discharges
                             CORMIX Version 11.0G
                     HYDRO2 Version 11.0.0.0 April 2018
-------------------------------------------------------------------------------------------
---
-------------------------------------------------------------------------------------------
---
CASE DESCRIPTION
 Site name/label:   BelfastBay
 Design case:
 FILE NAME:         C:\...\Simulations\diffuser\42-int-slow-spring-diff.prd
 Time stamp:        07/31/2018--08:09:48

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA    =     11.50  HD    =     11.50
 UA    =      0.050 F     =      0.100 USTAR =0.5590E-02
 UW    =      1.000 UWSTAR=0.1071E-02
 Density stratified environment
 STRCND=  A         RHOAM = 1017.5000
 RHOAS = 1013.0000  RHOAB = 1022.0000  RHOAH0= 1020.4348  E     =0.7510E-02

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:     DITYPE= staged_perpendicular
 BANK  =  RIGHT     DISTB =    750.00  YB1   =    735.00  YB2   =    765.00
 LD    =     30.00  NOPEN =    3       NRISER=    3       SPAC  =     15.00    NPPERR =
1
 D0    =      0.305 A0    =      0.073 H0    =      2.00  SUB0  =      9.50
 D0INP =      0.305 CR0   =      1.000 B0    =0.4871E-02
 Nozzle/port arrangement:   staged
 GAMMA =     90.00  THETA =     22.00  SIGMA =     90.00  BETA  =      0.00
 U0    =      1.538 Q0    =      0.337 Q0A   =0.3370E+00
 RHO0  = 1014.8100  DRHO0 =0.5625E+01  GP0   =0.5406E-01
 C0    =0.1000E+03  CUNITS=  deg.C
 IPOLL =  1         KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0    =0.1123E-01         SIGNJ0=      1.0
 m0 =U0^2*B0 =0.1151E-01   j0 =U0*GP0*B0 =0.4048E-03   (based on slot width B0)
 m0 =U0*q0   =0.1727E-01   j0 =q0*GP0    =0.6072E-03   (based on volume flux q0)
 Associated 2-d length scales (meters)
 lQ=B  =      0.007 lM    =      2.10  lm    =      6.91
 lmp   =      1.32  lbp   =      0.98  la    =      0.58

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0    =0.3370E+00  M0    =0.3454E+00  J0    =0.1214E-01
 Associated 3-d length scales (meters)
 LQ    =      0.27  LM    =      4.09  Lm    =     14.40  Lb    =    145.73
                                       Lmp   =      2.88  Lbp   =      2.30

NON-DIMENSIONAL PARAMETERS
 FR0   =     94.75  FRD0  =     11.97  R     =     30.75  PL    =  111.98
 (slot)             (port/nozzle)


FLOW CLASSIFICATION
 222222222222222222222222222222222222222222
 2  Flow class (CORMIX2)      =    MS4    2
 2  Applicable layer depth HS =    11.50  2
 222222222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
```

```
 C0    =0.1000E+03  CUNITS=  deg.C
 NTOX  =  0
 NSTD  =  0
 REGMZ =  0
 XINT  =   1000.00  XMAX  =   1000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
       750.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  20 display intervals per module
---------------------------------------------------------------------------------------------
---
---------------------------------------------------------------------------------------------
---
BEGIN MOD101: DISCHARGE MODULE (SINGLE PORT AT DIFFUSER CENTER)

       X        Y       Z        S       C       BV       BH       Uc        TT
      0.00     0.00    2.00     1.0 0.100E+03   0.15     0.15     1.538   .00000E+00

END OF MOD101: DISCHARGE MODULE (SINGLE PORT AT DIFFUSER CENTER)
---------------------------------------------------------------------------------------------
---
---------------------------------------------------------------------------------------------
---
BEGIN CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

 Jet-like motion in linear stratification with weak crossflow.

 Zone of flow establishment:            THETAE=     22.00  SIGMAE=     89.17
  LE    =      1.37  XE    =      0.01  YE    =      1.27  ZE    =      2.51

 Profile definitions:
   BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory
   BH = before merging: Gaussian 1/e (37%) half-width in horizontal plane
                        normal to trajectory
        after merging:  top-hat half-width in horizontal plane
                        parallel to diffuser line
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)
   Uc = Local centerline excess velocity (above ambient)
   TT = Cumulative travel time

       X        Y       Z        S       C       BV       BH       Uc        TT
  Individual jet/plumes before merging:
      0.01     1.27    2.51     1.0 0.100E+03   0.15     0.15     1.538   .00000E+00
      0.01     1.27    2.51     1.0 0.100E+03   0.15     0.15     1.538   .33790E-02
      0.10     1.82    2.74     1.2 0.813E+02   0.22     0.22     1.473   .34724E+00
      0.38     2.30    2.96     1.7 0.600E+02   0.30     0.30     1.085   .82311E+00
      0.80     2.69    3.16     2.1 0.467E+02   0.37     0.37     0.846   .14389E+01
      1.31     2.99    3.33     2.6 0.379E+02   0.45     0.45     0.690   .22051E+01
      1.86     3.20    3.48     3.1 0.319E+02   0.52     0.52     0.586   .30988E+01
      2.42     3.37    3.61     3.6 0.276E+02   0.59     0.59     0.511   .41223E+01
      3.01     3.50    3.73     4.1 0.242E+02   0.66     0.66     0.453   .52848E+01
      3.60     3.60    3.84     4.6 0.217E+02   0.73     0.73     0.408   .65544E+01
      4.19     3.68    3.95     5.1 0.196E+02   0.79     0.79     0.371   .79406E+01
      4.79     3.75    4.04     5.6 0.179E+02   0.86     0.86     0.341   .94407E+01
      5.39     3.80    4.12     6.1 0.165E+02   0.92     0.92     0.314   .11072E+02
      5.99     3.85    4.18     6.5 0.154E+02   0.98     0.98     0.292   .12793E+02
      6.60     3.89    4.23     7.0 0.144E+02   1.03     1.03     0.274   .14618E+02
      7.21     3.93    4.26     7.4 0.135E+02   1.09     1.09     0.257   .16567E+02
      7.82     3.96    4.27     7.8 0.128E+02   1.14     1.14     0.243   .18589E+02
  Maximum jet height has been reached.
      8.42     3.99    4.27     8.3 0.121E+02   1.19     1.19     0.231   .20702E+02
      9.03     4.02    4.25     8.7 0.115E+02   1.24     1.24     0.220   .22930E+02
      9.64     4.05    4.22     9.2 0.109E+02   1.29     1.29     0.210   .25219E+02
```

```
     10.24     4.07    4.18     9.6 0.104E+02   1.35     1.35     0.201   .27596E+02
     10.85     4.09    4.13    10.1 0.991E+01   1.40     1.40     0.192   .30059E+02
  Terminal level in stratified ambient has been reached.
 Cumulative travel time =          30.0588 sec  (    0.01 hrs)
  Merging of individual jet/plumes not found in this module, but interaction
    will occur in following module.  Overall jet/plume interaction dimensions:
     10.85     4.09    4.13    10.1 0.991E+01   1.40    15.15     0.192   .30059E+02

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION
-----------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------
---
BEGIN MOD237: TERMINAL LAYER INJECTION/UPSTREAM SPREADING

 UPSTREAM INTRUSION PROPERTIES:
        Maximum elevation of jet/plume rise     =      6.58 m
        Layer thickness in impingement region   =      1.38 m
        Upstream intrusion length               =     27.93 m
        X-position of upstream stagnation point =    -17.08 m
        Thickness in intrusion region           =      1.38 m
        Half-width at downstream end            =     57.45 m
        Thickness at downstream end             =      0.88 m

  Control volume inflow:
       X         Y       Z        S        C       BV       BH        TT
     10.85     4.09    4.13    10.1 0.991E+01   1.40    15.15   .30059E+02

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

       X         Y       Z        S        C       BV       BH       ZU      ZL        TT
    -17.08     4.09    4.13  9999.9 0.000E+00   0.00     0.00     4.13    4.13   .58861E+03
    -15.95     4.09    4.13    40.0 0.250E+01   0.35     8.81     4.31    3.96   .56595E+03
    -10.40     4.09    4.13    16.7 0.601E+01   0.84    21.40     4.55    3.71   .45491E+03
     -4.84     4.09    4.13    12.7 0.790E+01   1.10    28.96     4.69    3.58   .34387E+03
      0.71     4.09    4.13    11.0 0.909E+01   1.27    34.92     4.77    3.50   .23283E+03
      6.26     4.09    4.13    10.3 0.974E+01   1.36    40.00     4.81    3.45   .12179E+03
     11.81     4.09    4.13    10.1 0.989E+01   1.38    53.53     4.83    3.44   .49364E+02
     17.36     4.09    4.13    11.0 0.910E+01   1.29    54.43     4.78    3.49   .16040E+03
     22.92     4.09    4.13    12.5 0.797E+01   1.13    55.26     4.70    3.57   .27144E+03
     28.47     4.09    4.13    13.9 0.721E+01   0.99    56.03     4.63    3.64   .38248E+03
     34.02     4.09    4.13    14.6 0.686E+01   0.91    56.76     4.59    3.68   .49352E+03
     39.57     4.09    4.13    14.9 0.669E+01   0.88    57.45     4.57    3.70   .60456E+03
 Cumulative travel time =         604.5605 sec  (    0.17 hrs)

END OF MOD237: TERMINAL LAYER INJECTION/UPSTREAM SPREADING
-----------------------------------------------------------------------------------------
---
** End of NEAR-FIELD REGION (NFR) **
-----------------------------------------------------------------------------------------
---
BEGIN MOD242: BUOYANT TERMINAL LAYER SPREADING

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
```

C = average (bulk) concentration (includes reaction effects, if any)
TT = Cumulative travel time

Plume Stage 1 (not bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
39.57	4.09	4.13	14.9	0.669E+01	0.88	57.45	4.57	3.70	.60456E+03
87.59	4.09	4.13	17.4	0.575E+01	0.60	97.64	4.43	3.83	.15650E+04
135.62	4.09	4.13	19.2	0.521E+01	0.51	127.02	4.39	3.88	.25254E+04
183.64	4.09	4.13	21.1	0.475E+01	0.47	151.82	4.37	3.90	.34858E+04
231.66	4.09	4.13	23.1	0.434E+01	0.45	174.18	4.36	3.91	.44463E+04
279.68	4.09	4.13	25.2	0.396E+01	0.44	195.13	4.35	3.92	.54067E+04
327.70	4.09	4.13	27.6	0.362E+01	0.43	215.23	4.35	3.92	.63671E+04
375.72	4.09	4.13	30.1	0.332E+01	0.43	234.83	4.35	3.92	.73276E+04
423.74	4.09	4.13	32.8	0.305E+01	0.43	254.11	4.35	3.92	.82880E+04
471.76	4.09	4.13	35.5	0.281E+01	0.44	273.21	4.35	3.91	.92484E+04
519.79	4.09	4.13	38.4	0.260E+01	0.44	292.22	4.36	3.91	.10209E+05
567.81	4.09	4.13	41.4	0.241E+01	0.45	311.17	4.36	3.91	.11169E+05
615.83	4.09	4.13	44.5	0.225E+01	0.45	330.12	4.36	3.91	.12130E+05
663.85	4.09	4.13	47.7	0.210E+01	0.46	349.08	4.36	3.90	.13090E+05
711.87	4.09	4.13	50.9	0.196E+01	0.47	368.07	4.37	3.90	.14051E+05
759.89	4.09	4.13	54.2	0.184E+01	0.47	387.09	4.37	3.90	.15011E+05
807.91	4.09	4.13	57.7	0.173E+01	0.48	406.16	4.37	3.89	.15971E+05
855.94	4.09	4.13	61.1	0.164E+01	0.48	425.28	4.38	3.89	.16932E+05
903.96	4.09	4.13	64.7	0.155E+01	0.49	444.45	4.38	3.89	.17892E+05
951.98	4.09	4.13	68.3	0.146E+01	0.50	463.67	4.38	3.89	.18853E+05
1000.00	4.09	4.13	71.9	0.139E+01	0.50	482.95	4.38	3.88	.19813E+05

Cumulative travel time =   19813.1055 sec (5.50 hrs)

Simulation limit based on maximum specified distance =   1000.00 m.
This is the REGION OF INTEREST limitation.

END OF MOD242: BUOYANT TERMINAL LAYER SPREADING

CORMIX2: Multiport Diffuser Discharges   End of Prediction File
22222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
2222

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0G
                       HYDRO2:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                 BelfastBay
  DESIGN CASE:
  FILE NAME:                     C:\0 PROJECTS\171.05027-NordicAquaFarms\Modeling\CORMIX\Sim
ulations\diffuser\44-int-slow-summer-diff.prd
  Using subsystem CORMIX2:      Multiport Diffuser Discharges
  Start of session:              07/31/2018--08:12:33
****************************************************************************
SUMMARY OF INPUT DATA:
----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                            = unbounded
  Average depth                  HA        = 11.5 m
  Depth at discharge             HD        = 11.5 m
  Ambient velocity               UA        = 0.05 m/s
  Darcy-Weisbach friction factor F         = 0.1
  Wind velocity                  UW        = 1 m/s
  Stratification Type            STRCND = A
  Surface density                RHOAS  = 1018 kg/m^3
  Bottom density                 RHOAB  = 1022.6 kg/m^3
----------------------------------------------------------------------------
DISCHARGE PARAMETERS:            Submerged Multiport Diffuser Discharge
  Diffuser type                  DITYPE = staged perpendicular
  Diffuser length                LD        = 30 m
  Nearest bank                             = right
  Diffuser endpoints             YB1       = 735 m;    YB2 = 765 m
  Number of openings             NOPEN  = 3
  Number of Risers               NRISER = 3
  Ports/Nozzles per Riser        NPPERR  = 1
  Spacing between risers/openings SPAC     = 15 m
  Port/Nozzle diameter           D0        = 0.305 m
    with contraction ratio                 = 1
  Equivalent slot width          B0        = 0.004871 m
  Total area of openings         TA0       = 0.2192 m^2
  Discharge velocity             U0        = 1.54 m/s
  Total discharge flowrate       Q0        = 0.337 m^3/s
  Discharge port height          H0        = 2 m
  Nozzle arrangement             BETYPE = staged
  Diffuser alignment angle       GAMMA  = 90 deg
  Vertical discharge angle       THETA  = 22 deg
  Actual Vertical discharge angle THEAC  = 22 deg
  Horizontal discharge angle     SIGMA  = 90 deg
  Relative orientation angle     BETA   = 0 deg
  Discharge density              RHO0   = 1014.8100 kg/m^3
  Density difference             DRHO   = 6.9900 kg/m^3
  Buoyant acceleration           GP0       = 0.0671 m/s^2
  Discharge concentration        C0        = 100 deg.C
  Surface heat exchange coeff.   KS        = 0 m/s
  Coefficient of decay           KD        = 0 /s
----------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)        q0        = 0.011233 m^2/s
  Momentum flux
      (based on slot width B0)   m0 =U0^2*B0   = 0.011514 m^3/s^2
      (based on volume flux q0)  m0 =U0*q0     = 0.017271 m^3/s^2
  Buoyancy flux
      (based on slot width B0)   j0 =U0*GP0*B0 = 0.000502 m^3/s^3
      (based on volume flux q0)  j0 =q0*GP0    = 0.000754 m^3/s^3
----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.01 m         Lm  = 6.91 m         LM  = 1.82 m
  lm' = 1.65 m         Lb' = 1.47 m         La  = 0.81 m
```

```
  (These refer to the actual discharge/environment length scales.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number              FR0    = 85.06
  Port/nozzle Froude number       FRD0   = 10.75
  Velocity ratio                  R      = 30.75
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = no
  Water quality standard specified       = no
  Regulatory mixing zone                 = no
  Region of interest                     = 1000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = MS4 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the linearly
  stratified density layer at the discharge site.
  Applicable layer depth = water depth = 11.5 m
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    750 m from the right bank/shore.
  Number of display steps NSTEP = 20 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 4.6424 deg.C
  Dilution at edge of NFR              s = 21.5
  NFR Location:                        x = 46.31 m
    (centerline coordinates)           y = 3.95 m
                                       z = 5.09 m
  NFR plume dimensions:  half-width (bh) = 62.18 m
                          thickness (bv) = 1.17 m
Cumulative travel time:       671.3911 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
-----------------------------------------------------------------------------
Stratification assessment:
  The specified ambient density stratification is dynamically important.
  The discharge near field flow is trapped within the linearly stratified
  ambient density layer.
-----------------------------------------------------------------------------
UPSTREAM INTRUSION SUMMARY:
Plume exhibits upstream intrusion due to low ambient velocity or strong
  discharge buoyancy.
  Intrusion length                        =  31.41 m
  Intrusion stagnation point              =  -16.19 m
  Intrusion thickness                     =  1.94 m
  Intrusion half width at impingement     =  62.18 m
  Intrusion half thickness at impingement =  1.17 m
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section does not contact bank in this simulation.
************************ TOXIC DILUTION ZONE SUMMARY ************************
```

```
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY ***********************
No RMZ and no ambient water quality standard have been specified.
********************* FINAL DESIGN ADVICE AND COMMENTS **********************
CORMIX2 uses the TWO-DIMENSIONAL SLOT DIFFUSER CONCEPT to represent
  the actual three-dimensional diffuser geometry.  Thus, it approximates
  the details of the merging process of the individual jets from each
  port/nozzle.
In the present design, the spacing between adjacent ports/nozzles
  (or riser assemblies) is of the order of, or less than, the local
  water depth so that the slot diffuser approximation holds well.

Nevertheless, if this is a final design, the user is advised to use a
  final CORMIX1 (single port discharge) analysis, with discharge data
  for an individual diffuser jet/plume, in order to compare to
  the present near-field prediction.
-----------------------------------------------------------------------------
REMINDER:  The user must take note that HYDRODYNAMIC MODELING by any known
  technique is NOT AN EXACT SCIENCE.
Extensive comparison with field and laboratory data has shown that the
  CORMIX predictions on dilutions and concentrations (with associated
  plume geometries) are reliable for the majority of cases and are accurate
  to within about +-50% (standard deviation).
As a further safeguard, CORMIX will not give predictions whenever it judges
  the design configuration as highly complex and uncertain for prediction.
```

```
CORMIX2 PREDICTION FILE:
22222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
2222
                       CORMIX MIXING ZONE EXPERT SYSTEM
               Subsystem CORMIX2: Multiport Diffuser Discharges
                             CORMIX Version 11.0G
                     HYDRO2 Version 11.0.0.0 April 2018
-------------------------------------------------------------------------------------------
---
-------------------------------------------------------------------------------------------
---
CASE DESCRIPTION
 Site name/label:   BelfastBay
 Design case:
 FILE NAME:         C:\...\Simulations\diffuser\44-int-slow-summer-diff.prd
 Time stamp:        07/31/2018--08:12:33

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA    =     11.50  HD    =     11.50
 UA    =      0.050 F     =      0.100 USTAR =0.5590E-02
 UW    =      1.000 UWSTAR=0.1071E-02
 Density stratified environment
 STRCND=  A         RHOAM = 1020.3000
 RHOAS = 1018.0000  RHOAB = 1022.6000  RHOAH0= 1021.8000  E     =0.3836E-02

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:     DITYPE= staged_perpendicular
 BANK  =  RIGHT     DISTB =    750.00  YB1   =    735.00  YB2   =    765.00
 LD    =     30.00  NOPEN =    3       NRISER=    3       SPAC  =     15.00    NPPERR =
1
 D0    =      0.305 A0    =      0.073 H0    =      2.00  SUB0  =      9.50
 D0INP =      0.305 CR0   =      1.000 B0    =0.4871E-02
 Nozzle/port arrangement:   staged
 GAMMA =     90.00  THETA =     22.00  SIGMA =     90.00  BETA  =      0.00
 U0    =      1.538 Q0    =      0.337 Q0A   =0.3370E+00
 RHO0  = 1014.8100  DRHO0 =0.6990E+01  GP0   =0.6709E-01
 C0    =0.1000E+03  CUNITS=  deg.C
 IPOLL =  1         KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0    =0.1123E-01         SIGNJ0=      1.0
 m0 =U0^2*B0 =0.1151E-01   j0 =U0*GP0*B0 =0.5024E-03   (based on slot width B0)
 m0 =U0*q0   =0.1727E-01   j0 =q0*GP0    =0.7536E-03   (based on volume flux q0)
 Associated 2-d length scales (meters)
 lQ=B  =      0.007 lM    =      1.82  lm    =      6.91
 lmp   =      1.65  lbp   =      1.47  la    =      0.81

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0    =0.3370E+00  M0    =0.3454E+00  J0    =0.1507E-01
 Associated 3-d length scales (meters)
 LQ    =      0.27  LM    =      3.67  Lm    =     14.40  Lb    =    180.86
                                       Lmp   =      3.41  Lbp   =      3.12

NON-DIMENSIONAL PARAMETERS
 FR0   =     85.06  FRD0  =     10.75  R     =     30.75  PL    =  120.34
 (slot)             (port/nozzle)


FLOW CLASSIFICATION
 222222222222222222222222222222222222222222
 2  Flow class (CORMIX2)       =    MS4    2
 2  Applicable layer depth HS =    11.50  2
 222222222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
```

```
 C0    =0.1000E+03  CUNITS=  deg.C
 NTOX  =  0
 NSTD  =  0
 REGMZ =  0
 XINT  =   1000.00  XMAX  =   1000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
       750.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  20 display intervals per module
-----------------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------------
---
BEGIN MOD101: DISCHARGE MODULE (SINGLE PORT AT DIFFUSER CENTER)

      X        Y       Z        S       C       BV       BH       Uc        TT
     0.00     0.00    2.00     1.0 0.100E+03   0.15     0.15     1.538   .00000E+00

END OF MOD101: DISCHARGE MODULE (SINGLE PORT AT DIFFUSER CENTER)
-----------------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------------
---
BEGIN CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

 Jet-like motion in linear stratification with weak crossflow.

 Zone of flow establishment:            THETAE=     22.00  SIGMAE=     89.17
  LE    =      1.37  XE    =      0.01  YE    =      1.27  ZE    =      2.51

 Profile definitions:
   BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory
   BH = before merging: Gaussian 1/e (37%) half-width in horizontal plane
                        normal to trajectory
        after merging:  top-hat half-width in horizontal plane
                        parallel to diffuser line
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)
   Uc = Local centerline excess velocity (above ambient)
   TT = Cumulative travel time

      X        Y       Z        S       C       BV       BH       Uc        TT
  Individual jet/plumes before merging:
     0.01     1.27    2.51     1.0 0.100E+03   0.15     0.15     1.538   .00000E+00
     0.01     1.27    2.51     1.0 0.100E+03   0.15     0.15     1.538   .33789E-02
     0.19     2.01    2.83     1.4 0.720E+02   0.25     0.25     1.308   .50834E+00
     0.68     2.60    3.13     2.0 0.493E+02   0.35     0.35     0.903   .12654E+01
     1.36     3.01    3.39     2.7 0.368E+02   0.46     0.46     0.687   .22813E+01
     2.11     3.28    3.61     3.4 0.292E+02   0.56     0.56     0.558   .35427E+01
     2.90     3.46    3.83     4.1 0.241E+02   0.65     0.65     0.474   .50321E+01
     3.69     3.59    4.04     4.9 0.205E+02   0.75     0.75     0.413   .67353E+01
     4.49     3.67    4.24     5.6 0.177E+02   0.84     0.84     0.367   .86422E+01
     5.30     3.74    4.44     6.4 0.156E+02   0.93     0.93     0.330   .10746E+02
     6.11     3.78    4.62     7.2 0.139E+02   1.02     1.02     0.299   .13043E+02
     6.93     3.82    4.78     8.0 0.126E+02   1.11     1.11     0.274   .15529E+02
     7.75     3.84    4.92     8.7 0.115E+02   1.19     1.19     0.252   .18202E+02
     8.57     3.86    5.04     9.4 0.106E+02   1.27     1.27     0.233   .21059E+02
     9.40     3.88    5.14    10.1 0.987E+01   1.35     1.35     0.217   .24094E+02
    10.23     3.89    5.21    10.8 0.926E+01   1.42     1.42     0.204   .27300E+02
    11.06     3.90    5.25    11.4 0.875E+01   1.49     1.49     0.192   .30664E+02
  Maximum jet height has been reached.
    11.90     3.91    5.26    12.0 0.830E+01   1.55     1.55     0.183   .34175E+02
    12.73     3.92    5.24    12.7 0.790E+01   1.61     1.61     0.174   .37820E+02
    13.56     3.93    5.20    13.3 0.750E+01   1.67     1.67     0.167   .41599E+02
```

```
     14.39     3.94    5.14    14.0 0.713E+01   1.74     1.74     0.159   .45516E+02
     15.22     3.95    5.09    14.7 0.680E+01   1.80     1.80     0.152   .49571E+02
  Terminal level in stratified ambient has been reached.
 Cumulative travel time =          49.5707 sec  (    0.01 hrs)
  Merging of individual jet/plumes not found in this module, but interaction
    will occur in following module.  Overall jet/plume interaction dimensions:
     15.22     3.95    5.09    14.7 0.680E+01   1.80    15.15     0.152   .49571E+02

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION
-----------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------
---
BEGIN MOD237: TERMINAL LAYER INJECTION/UPSTREAM SPREADING

 UPSTREAM INTRUSION PROPERTIES:
        Maximum elevation of jet/plume rise     =      7.98 m
        Layer thickness in impingement region   =      1.94 m
        Upstream intrusion length               =     31.41 m
        X-position of upstream stagnation point =    -16.19 m
        Thickness in intrusion region           =      1.94 m
        Half-width at downstream end            =     62.18 m
        Thickness at downstream end             =      1.17 m

  Control volume inflow:
       X        Y       Z        S       C       BV       BH        TT
     15.22     3.95    5.09    14.7 0.680E+01   1.80    15.15   .49571E+02

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

       X        Y       Z        S       C       BV       BH      ZU      ZL       TT
    -16.19     3.95    5.09  9999.9 0.000E+00   0.00     0.00    5.09    5.09   .67778E+03
    -14.94     3.95    5.09    58.9 0.170E+01   0.48     8.79    5.33    4.84   .65278E+03
     -8.81     3.95    5.09    24.5 0.408E+01   1.16    21.36    5.67    4.50   .53028E+03
     -2.69     3.95    5.09    18.6 0.537E+01   1.53    28.90    5.85    4.32   .40778E+03
      3.44     3.95    5.09    16.1 0.620E+01   1.77    34.84    5.97    4.20   .28527E+03
      9.56     3.95    5.09    15.0 0.666E+01   1.90    39.91    6.03    4.14   .16277E+03
     15.69     3.95    5.09    14.7 0.680E+01   1.94    57.01    6.05    4.12   .58875E+02
     21.81     3.95    5.09    15.8 0.632E+01   1.81    58.20    5.99    4.18   .18138E+03
     27.94     3.95    5.09    18.0 0.554E+01   1.56    59.29    5.87    4.30   .30388E+03
     34.06     3.95    5.09    20.0 0.501E+01   1.34    60.31    5.76    4.41   .42638E+03
     40.19     3.95    5.09    21.0 0.476E+01   1.23    61.27    5.70    4.47   .54889E+03
     46.31     3.95    5.09    21.5 0.464E+01   1.17    62.18    5.67    4.50   .67139E+03
 Cumulative travel time =         671.3912 sec  (    0.19 hrs)

END OF MOD237: TERMINAL LAYER INJECTION/UPSTREAM SPREADING
-----------------------------------------------------------------------------------------
---
** End of NEAR-FIELD REGION (NFR) **
-----------------------------------------------------------------------------------------
---
BEGIN MOD242: BUOYANT TERMINAL LAYER SPREADING

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
```

C = average (bulk) concentration (includes reaction effects, if any)
TT = Cumulative travel time

Plume Stage 1 (not bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
46.31	3.95	5.09	21.5	0.464E+01	1.17	62.18	5.67	4.50	.67139E+03
94.00	3.95	5.09	24.7	0.405E+01	0.82	101.54	5.50	4.67	.16251E+04
141.68	3.95	5.09	27.0	0.370E+01	0.70	130.96	5.43	4.74	.25788E+04
189.37	3.95	5.09	29.3	0.341E+01	0.63	155.90	5.40	4.77	.35325E+04
237.05	3.95	5.09	31.7	0.316E+01	0.60	178.33	5.38	4.79	.44861E+04
284.73	3.95	5.09	34.3	0.292E+01	0.58	199.23	5.37	4.80	.54398E+04
332.42	3.95	5.09	37.0	0.270E+01	0.57	219.16	5.37	4.80	.63935E+04
380.10	3.95	5.09	40.0	0.250E+01	0.57	238.47	5.37	4.80	.73472E+04
427.79	3.95	5.09	43.2	0.232E+01	0.57	257.38	5.37	4.80	.83009E+04
475.47	3.95	5.09	46.5	0.215E+01	0.57	276.04	5.37	4.80	.92546E+04
523.16	3.95	5.09	49.9	0.200E+01	0.57	294.53	5.37	4.80	.10208E+05
570.84	3.95	5.09	53.5	0.187E+01	0.58	312.94	5.37	4.80	.11162E+05
618.53	3.95	5.09	57.2	0.175E+01	0.58	331.30	5.38	4.79	.12116E+05
666.21	3.95	5.09	61.0	0.164E+01	0.59	349.65	5.38	4.79	.13069E+05
713.89	3.95	5.09	64.9	0.154E+01	0.59	368.00	5.38	4.79	.14023E+05
761.58	3.95	5.09	68.9	0.145E+01	0.60	386.38	5.39	4.78	.14977E+05
809.26	3.95	5.09	73.0	0.137E+01	0.61	404.79	5.39	4.78	.15930E+05
856.95	3.95	5.09	77.2	0.130E+01	0.61	423.24	5.39	4.78	.16884E+05
904.63	3.95	5.09	81.5	0.123E+01	0.62	441.74	5.40	4.77	.17838E+05
952.32	3.95	5.09	85.8	0.117E+01	0.63	460.28	5.40	4.77	.18791E+05
1000.00	3.95	5.09	90.3	0.111E+01	0.64	478.87	5.40	4.77	.19745E+05

Cumulative travel time = 19745.1406 sec (5.48 hrs)

Simulation limit based on maximum specified distance = 1000.00 m.
This is the REGION OF INTEREST limitation.

END OF MOD242: BUOYANT TERMINAL LAYER SPREADING

CORMIX2: Multiport Diffuser Discharges End of Prediction File
22222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222

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CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 11.0G
                       HYDRO2:Version-11.0.0.0  April,2018
SITE NAME/LABEL:                BelfastBay
  DESIGN CASE:
  FILE NAME:                    C:\0 PROJECTS\171.05027-NordicAquaFarms\Modeling\CORMIX\Sim
ulations\diffuser\46-int-slow-fall-diff.prd
  Using subsystem CORMIX2:     Multiport Diffuser Discharges
  Start of session:             07/31/2018--08:14:38
****************************************************************************
SUMMARY OF INPUT DATA:
----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                              = unbounded
  Average depth                   HA         = 11.5 m
  Depth at discharge              HD         = 11.5 m
  Ambient velocity                UA         = 0.05 m/s
  Darcy-Weisbach friction factor  F          = 0.1
  Wind velocity                   UW         = 1 m/s
  Stratification Type             STRCND = A
  Surface density                 RHOAS  = 1020 kg/m^3
  Bottom density                  RHOAB  = 1023 kg/m^3
----------------------------------------------------------------------------
DISCHARGE PARAMETERS:             Submerged Multiport Diffuser Discharge
  Diffuser type                   DITYPE = staged perpendicular
  Diffuser length                 LD     = 30 m
  Nearest bank                           = right
  Diffuser endpoints              YB1    = 735 m;    YB2 = 765 m
  Number of openings              NOPEN  = 3
  Number of Risers                NRISER = 3
  Ports/Nozzles per Riser         NPPERR  = 1
  Spacing between risers/openings SPAC   = 15 m
  Port/Nozzle diameter            D0     = 0.305 m
    with contraction ratio               = 1
  Equivalent slot width           B0     = 0.004871 m
  Total area of openings          TA0    = 0.2192 m^2
  Discharge velocity              U0     = 1.54 m/s
  Total discharge flowrate        Q0     = 0.337 m^3/s
  Discharge port height           H0     = 2 m
  Nozzle arrangement              BETYPE = staged
  Diffuser alignment angle        GAMMA  = 90 deg
  Vertical discharge angle        THETA  = 22 deg
  Actual Vertical discharge angle THEAC  = 22 deg
  Horizontal discharge angle      SIGMA  = 90 deg
  Relative orientation angle      BETA   = 0 deg
  Discharge density               RHO0   = 1014.8100 kg/m^3
  Density difference              DRHO   = 6.6900 kg/m^3
  Buoyant acceleration            GP0    = 0.0642 m/s^2
  Discharge concentration         C0     = 100 deg.C
  Surface heat exchange coeff.    KS     = 0 m/s
  Coefficient of decay            KD     = 0 /s
----------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)         q0     = 0.011233 m^2/s
  Momentum flux
      (based on slot width B0)    m0 =U0^2*B0   = 0.011514 m^3/s^2
      (based on volume flux q0)   m0 =U0*q0     = 0.017271 m^3/s^2
  Buoyancy flux
      (based on slot width B0)    j0 =U0*GP0*B0 = 0.000481 m^3/s^3
      (based on volume flux q0)   j0 =q0*GP0    = 0.000721 m^3/s^3
----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.01 m         Lm  = 6.91 m         LM  = 2.15 m
  lm' = 99999 m         Lb' = 99999 m         La  = 99999 m
```

```
  (These refer to the actual discharge/environment length scales.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number              FR0    = 86.93
  Port/nozzle Froude number       FRD0   = 10.99
  Velocity ratio                  R      = 30.75
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                         = no
  Water quality standard specified        = no
  Regulatory mixing zone                  = no
  Region of interest                      = 1000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = MU6 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.  The ambient density stratification at the
  discharge site is relatively weak and unimportant so the discharge flow
  penetrates to the surface and/or breaks down the existing stratification
  through vigorous mixing.
  Applicable layer depth = water depth = 11.5 m
*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    750 m from the right bank/shore.
  Number of display steps NSTEP = 20 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 1.7331 deg.C
  Dilution at edge of NFR              s = 57.7
  NFR Location:                        x = 57.5 m
    (centerline coordinates)           y = 9.01 m
                                       z = 11.5 m
  NFR plume dimensions:  half-width (bh) = 16.91 m
                          thickness (bv) = 11.5 m
Cumulative travel time:       1150 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
-----------------------------------------------------------------------------
Stratification assessment:
  The specified ambient density stratification is weak relative to the
  discharge conditions and is dynamically unimportant. The discharge will
  behave as if the ambient were unstratified.
-----------------------------------------------------------------------------
Near-field instability behavior:
  The diffuser flow will experience instabilities with full vertical mixing
  in the near-field.
  There may be benthic impact of high pollutant concentrations.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed WITHIN NEAR-FIELD at 0 m
  downstream, but RE-STRATIFIES LATER and is not mixed in the far-field.
-----------------------------------------------------------------------------
```

```
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section does not contact bank in this simulation.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************* REGULATORY MIXING ZONE SUMMARY ***********************
No RMZ and no ambient water quality standard have been specified.
******************** FINAL DESIGN ADVICE AND COMMENTS **********************
CORMIX2 uses the TWO-DIMENSIONAL SLOT DIFFUSER CONCEPT to represent
  the actual three-dimensional diffuser geometry.  Thus, it approximates
  the details of the merging process of the individual jets from each
  port/nozzle.
In the present design, the spacing between adjacent ports/nozzles
  (or riser assemblies) is of the order of, or less than, the local
  water depth so that the slot diffuser approximation holds well.

Nevertheless, if this is a final design, the user is advised to use a
  final CORMIX1 (single port discharge) analysis, with discharge data
  for an individual diffuser jet/plume, in order to compare to
  the present near-field prediction.
-----------------------------------------------------------------------------
REMINDER:  The user must take note that HYDRODYNAMIC MODELING by any known
  technique is NOT AN EXACT SCIENCE.
Extensive comparison with field and laboratory data has shown that the
  CORMIX predictions on dilutions and concentrations (with associated
  plume geometries) are reliable for the majority of cases and are accurate
  to within about +-50% (standard deviation).
As a further safeguard, CORMIX will not give predictions whenever it judges
  the design configuration as highly complex and uncertain for prediction.
```

```
CORMIX2 PREDICTION FILE:
2222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
2222
                        CORMIX MIXING ZONE EXPERT SYSTEM
                Subsystem CORMIX2: Multiport Diffuser Discharges
                              CORMIX Version 11.0G
                      HYDRO2 Version 11.0.0.0 April 2018
---------------------------------------------------------------------------------------------
---
---------------------------------------------------------------------------------------------
---
CASE DESCRIPTION
 Site name/label:   BelfastBay
 Design case:
 FILE NAME:         C:\...IX\Simulations\diffuser\46-int-slow-fall-diff.prd
 Time stamp:        07/31/2018--08:14:38

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA    =     11.50  HD    =     11.50
 UA    =     0.050  F     =     0.100  USTAR =0.5590E-02
 UW    =     1.000  UWSTAR=0.1071E-02
 Density stratified environment
 STRCND=  A         RHOAM = 1021.5000
 RHOAS = 1020.0000  RHOAB = 1023.0000  RHOAH0= 1021.5000  E     =0.2501E-02

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:     DITYPE= staged_perpendicular
 BANK  =  RIGHT     DISTB =    750.00  YB1   =    735.00  YB2   =    765.00
 LD    =     30.00  NOPEN =    3       NRISER=    3       SPAC  =     15.00    NPPERR =
1
 D0    =     0.305  A0    =     0.073  H0    =      2.00  SUB0  =      9.50
 D0INP =     0.305  CR0   =     1.000  B0    =0.4871E-02
 Nozzle/port arrangement:   staged
 GAMMA =     90.00  THETA =     22.00  SIGMA =     90.00  BETA  =      0.00
 U0    =     1.538  Q0    =     0.337  Q0A   =0.3370E+00
 RHO0  = 1014.8100  DRHO0 =0.6690E+01  GP0   =0.6423E-01
 C0    =0.1000E+03  CUNITS=  deg.C
 IPOLL =  1         KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0    =0.1123E-01         SIGNJ0=      1.0
 m0 =U0^2*B0 =0.1151E-01   j0 =U0*GP0*B0 =0.4810E-03   (based on slot width B0)
 m0 =U0*q0   =0.1727E-01   j0 =q0*GP0    =0.7215E-03   (based on volume flux q0)
 Associated 2-d length scales (meters)
 lQ=B  =     0.007 lM    =      2.15  lm    =      6.91
 lmp   =  99999.00  lbp   =  99999.00  la    =  99999.00

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0    =0.3370E+00  M0    =0.3454E+00  J0    =0.1443E-01
 Associated 3-d length scales (meters)
 LQ    =      0.27  LM    =      4.15  Lm    =     14.40  Lb    =    173.15
                                       Lmp   =  99999.00  Lbp   =  99999.00

NON-DIMENSIONAL PARAMETERS
 FR0   =     86.93  FRD0  =     10.99  R     =     30.75  PL    =  118.60
 (slot)             (port/nozzle)


FLOW CLASSIFICATION
 222222222222222222222222222222222222222222
 2  Flow class (CORMIX2)      =    MU6    2
 2  Applicable layer depth HS =    11.50  2
 222222222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
```

```
 C0    =0.1000E+03  CUNITS=  deg.C
 NTOX  =  0
 NSTD  =  0
 REGMZ =  0
 XINT  =   1000.00  XMAX  =   1000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
       750.00 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  20 display intervals per module
-----------------------------------------------------------------------------------------------
---
-----------------------------------------------------------------------------------------------
---
BEGIN MOD202: DISCHARGE MODULE (STAGED DIFFUSER)

 Due to complex near-field motions:  EQUIVALENT SLOT DIFFUSER (2-D) GEOMETRY

 Profile definitions:
   BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory
   BH = Gaussian 1/e (37%) half-width in horizontal plane normal to trajectory
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)
   Uc = Local centerline excess velocity (above ambient)
   TT = Cumulative travel time

      X        Y       Z        S       C       BV       BH       Uc        TT
     0.00     0.00    2.00     1.0 0.100E+03   0.00    15.00     1.538   .00000E+00

END OF MOD202: DISCHARGE MODULE (STAGED DIFFUSER)
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-----------------------------------------------------------------------------------------------
---
BEGIN MOD275: STAGED PERPENDICULAR DIFFUSER IN STRONG CURRENT

 Because of the strong ambient current the diffuser plume of this crossflowing
   discharge gets RAPIDLY DEFLECTED.
 A near-field zone is formed that is VERTICALLY FULLY MIXED over the entire
   layer depth.  Full mixing is achieved at a downstream distance of about
   five (5) layer depths.

 Profile definitions:
   BV = layer depth (vertically mixed)
   BH = top-hat half-width, measured horizontally in Y-direction
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

      X        Y       Z        S       C       BV       BH        TT
     0.00     0.00    2.00     1.0 0.100E+03   0.00    15.00 .00000E+00
     2.88     0.45    2.19    13.7 0.731E+01   0.58    15.10 .57500E+02
     5.75     0.90    2.38    18.9 0.528E+01   1.15    15.19 .11500E+03
     8.62     1.35    2.56    23.0 0.436E+01   1.73    15.29 .17250E+03
    11.50     1.80    2.75    26.4 0.379E+01   2.30    15.38 .23000E+03
    14.38     2.25    2.94    29.4 0.341E+01   2.88    15.48 .28750E+03
    17.25     2.70    3.12    32.1 0.312E+01   3.45    15.57 .34500E+03
    20.12     3.15    3.31    34.5 0.289E+01   4.03    15.67 .40250E+03
    23.00     3.60    3.50    36.9 0.271E+01   4.60    15.76 .46000E+03
    25.88     4.06    3.69    39.0 0.256E+01   5.18    15.86 .51750E+03
    28.75     4.51    3.88    41.1 0.243E+01   5.75    15.95 .57500E+03
    31.62     4.96    4.06    43.1 0.232E+01   6.33    16.05 .63250E+03
    34.50     5.41    4.25    44.9 0.223E+01   6.90    16.15 .69000E+03
    37.38     5.86    4.44    46.7 0.214E+01   7.48    16.24 .74750E+03
    40.25     6.31    4.62    48.4 0.206E+01   8.05    16.34 .80500E+03
```

```
     43.12     6.76    4.81    50.1 0.200E+01   8.63    16.43 .86250E+03
     46.00     7.21    5.00    51.7 0.193E+01   9.20    16.53 .92000E+03
     48.88     7.66    5.19    53.3 0.188E+01   9.78    16.62 .97750E+03
     51.75     8.11    5.38    54.8 0.183E+01  10.35    16.72 .10350E+04
     54.62     8.56    5.56    56.3 0.178E+01  10.93    16.81 .10925E+04
     57.50     9.01    5.75    57.7 0.173E+01  11.50    16.91 .11500E+04
 Cumulative travel time =       1150.0000 sec  (    0.32 hrs)
   Plume centerline may exhibit slight discontinuities in transition
     to subsequent far-field module.

END OF MOD275: STAGED PERPENDICULAR DIFFUSER IN STRONG CURRENT
-------------------------------------------------------------------------------------------
---
** End of NEAR-FIELD REGION (NFR) **
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---
BEGIN MOD241: BUOYANT AMBIENT SPREADING

 Profile definitions:
   BV = top-hat thickness, measured vertically
   BH = top-hat half-width, measured horizontally in y-direction
   ZU = upper plume boundary (Z-coordinate)
   ZL = lower plume boundary (Z-coordinate)
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)
   TT = Cumulative travel time

 Plume Stage 1 (not bank attached):
       X        Y       Z        S       C        BV       BH       ZU       ZL        TT
     57.50     9.01   11.50    57.7 0.173E+01  11.50    16.91    11.50     0.00   .11500E+04
    104.62     9.01   11.50    81.2 0.123E+01   4.16    65.77    11.50     7.34   .20925E+04
    151.75     9.01   11.50    90.5 0.110E+01   3.06    99.65    11.50     8.44   .30350E+04
    198.88     9.01   11.50    97.2 0.103E+01   2.55   128.32    11.50     8.95   .39775E+04
    246.00     9.01   11.50   102.8 0.972E+00   2.25   153.92    11.50     9.25   .49200E+04
    293.12     9.01   11.50   108.1 0.925E+00   2.05   177.42    11.50     9.45   .58625E+04
    340.25     9.01   11.50   113.2 0.883E+00   1.91   199.33    11.50     9.59   .68050E+04
    387.38     9.01   11.50   118.5 0.844E+00   1.81   219.98    11.50     9.69   .77475E+04
    434.50     9.01   11.50   123.9 0.807E+00   1.74   239.61    11.50     9.76   .86900E+04
    481.62     9.01   11.50   129.6 0.772E+00   1.69   258.37    11.50     9.81   .96325E+04
    528.75     9.01   11.50   135.7 0.737E+00   1.65   276.40    11.50     9.85   .10575E+05
    575.88     9.01   11.50   142.1 0.704E+00   1.63   293.78    11.50     9.87   .11518E+05
    623.00     9.01   11.50   149.0 0.671E+00   1.62   310.60    11.50     9.88   .12460E+05
    670.12     9.01   11.50   156.4 0.640E+00   1.61   326.93    11.50     9.89   .13402E+05
    717.25     9.01   11.50   164.2 0.609E+00   1.61   342.81    11.50     9.89   .14345E+05
    764.38     9.01   11.50   172.6 0.579E+00   1.62   358.29    11.50     9.88   .15288E+05
    811.50     9.01   11.50   181.5 0.551E+00   1.64   373.41    11.50     9.86   .16230E+05
    858.62     9.01   11.50   191.0 0.524E+00   1.66   388.20    11.50     9.84   .17172E+05
    905.75     9.01   11.50   201.0 0.497E+00   1.68   402.69    11.50     9.82   .18115E+05
    952.88     9.01   11.50   211.7 0.472E+00   1.71   416.90    11.50     9.79   .19058E+05
   1000.00     9.01   11.50   223.0 0.448E+00   1.74   430.86    11.50     9.76   .20000E+05
 Cumulative travel time =      20000.0000 sec  (    5.56 hrs)

 Simulation limit based on maximum specified distance =   1000.00 m.
   This is the REGION OF INTEREST limitation.

END OF MOD241: BUOYANT AMBIENT SPREADING
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CORMIX2: Multiport Diffuser Discharges       End of Prediction File
222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222
2222
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ATTACHMENT C

Annotated ADCIRC Run Control File

Response to Review Comments
Nordic Aquafarms Inc., Land-based Aquaculture Facility
Belfast, Maine
L-28319-26-A-N

Ransom Consulting, Inc.
Project 171.05027.008

ADCIRC run control file (fort.15)


```
PenobscotBay                              ! 32 CHARACTER ALPHANUMERIC RUN DESCRIPTION Comment line
Tides 6/20/1999 - 7/31/1999               ! 24 CHARACTER ALPHANUMERIC RUN IDENTIFICATION Comment line
1                                         ! NFOVER - NONFATAL ERROR OVERRIDE OPTION Allow run to continue with non-fatal errors
0                                         ! NABOUT - ABREVIATED OUTPUT OPTION PARAMETER Don't output debugging information
-1000                                        ! NSCREEN - OUTPUT TO UNIT 6 PARAMETER Write timestepping output to adcirc.log every 1000 timesteps
0                                         ! IHOT - HOT START OPTION PARAMETER This is a coldstart run (i.e. run starts from still water)
2                                         ! ICS - COORDINATE SYSTEM OPTION PARAMETER Model grid is in geographic coordinates
511111                                    ! IM Indicates a 2D depth integrated barotropic run, Implicit GWCE solution, with symmetric lateral stress formula for Smagorinsky turbulence model
1                                         ! NOLIBF - NONLINEAR BOTTOM FRICTION OPTION use non-linear bottom friction (Manning's formula is used)
2                                         ! NOLIFA - OPTION TO INCLUDE FINITE AMPLITUDE TERMS Include wetting and drying
1                                         ! NOLICA - OPTION TO INCLUDE CONVECTIVE ACCELERATION TERMS Include "advective" terms
1                                         ! NOLICAT - OPTION TO CONSIDER TIME DERIVATIVE OF CONV ACC TERMS Include time derivative of advective terms
4                                         ! NWP - Number of nodal attributes.
mannings_n_at_sea_floor -use spatially variable Manning's n bottom friction (described in the fort.13 file)
advection_state - used to turn off NOLICA and NOLICAT near boundary to enhance model stability
primitive_weighting_in_continuity_equation Use spatially variable Tau0 parameter
elemental_slope_limiter Used to report but not attempt to correct potential model instabilities.
1                                         ! NCOR - VARIABLE CORIOLIS IN SPACE OPTION PARAMETER applies coriolis forcing
1                                         ! NTIP - TIDAL POTENTIAL OPTION PARAMETER apply tidal potential forcing
0                                         ! NWS - WIND STRESS AND BAROMETRIC PRESSURE OPTION PARAMETER no wind stress
1                                         ! NRAMP - RAMP FUNCTION OPTION use ramping function at beginning of simulation to ramp up boundary conditions
9.80665                                   ! G - ACCELERATION DUE TO GRAVITY - DETERMINES UNITS this is g
-3                                        ! TAU0 - WEIGHTING FACTOR IN GWCE Use time and spatially dependent values based on supplied nodal attributes in fort.13
1.00000                                   ! DT - TIME STEP (IN SECONDS) 1 second model timestep
0.00000                                   ! STATIM - STARTING SIMULATION TIME IN DAYS start simulation time at zero
0.00000                                   ! REFTIME - REFERENCE TIME FOR NODAL FACTORS AND EQUILIBRIUM ARGS tidal reference time starts at zero
42.00000                                  ! RNDAY - TOTAL LENGTH OF SIMULATION (IN DAYS) simulates 42 days of tides
14.00000                                  ! DRAMP - DURATION OF RAMP FUNCTION (IN DAYS) ramp up boundary forcing over the first 14 days of the simulation
0.350000 0.300000 0.350000                ! TIME WEIGHTING FACTORS FOR THE GWCE EQUATION for implicit solver
0.050000 12 12 0.050000                   ! H0, NODEDRYMIN, NODEWETMIN, VELMIN dry when less than 5 cm of water, wet when velocity toward node is 5 cm/s
-68.674774 43.956598                      ! SLAM0, SFEA0 - LONGITUDE AND LATITUDE FOR CPP PROJECTION origin of projection for grid
0.002500                                  ! FFACTOR - 2DDI BOTTOM FRICTION COEFFICIENT minimum quadratic bottom friction coefficient after determined from depth and Manning's n
-0.25                                     ! ESLM - Smagorinsky coefficient for horizontal turbulence closure
0.000100                                  ! CORI - CONSTANT CORIOLIS COEFFICIENT
8     ! NTIF - TOTAL NUMBER OF TIDAL POTENTIAL CONSTITUENTS
M2
0.242334  0.000140518902509   0.693   1.02634    209.32
S2
0.112841  0.000145444104333   0.693   1.00000      0.00
N2
0.046398  0.000137879699487   0.693   1.02634    108.56
K2
0.030704  0.000145842317201   0.693   0.82235    162.19
K1
0.141565  0.000072921158358   0.736   0.92649    170.69
O1
0.100514  0.000067597744151   0.695   0.88023     42.28
P1
0.046843  0.000072522945975   0.706   1.00000    182.23
Q1
0.019256  0.000064958541129   0.695   0.88023    301.52
```

Tidal potential forcing parameters

ADCIRC run control file (fort.15)


```
8          !NFBR number of forcing frequencies on open boundaries
M2      !BOUNTAG
0.0001405189027   1.02634     209.32
S2      !BOUNTAG
0.0001454441043   1.00000       0.00
N2      !BOUNTAG
0.0001378797074   1.02634     108.56
K2      !BOUNTAG
0.0001458423017   0.82235     162.19
K1      !BOUNTAG
7.29211508e-005   0.92649     170.69
O1      !BOUNTAG
6.75977518e-005   0.88023      42.28
P1      !BOUNTAG
7.25229535e-005   1.00000     182.23
Q1      !BOUNTAG
6.49585572e-005   0.88023     301.52
M2      !BOUNTAG
0.039459791360291 100.730269079789
0.039459791360291 100.730269079789
0.039459791360291 100.730269079789
0.098310568946937 100.488014297742
0.157397900805293 100.248833387736
0.216719153176965 100.01283395402
0.276271830330723 99.780122735384
0.336053564131591 99.5508054845139
0.396062103358654 99.3249868913616
0.456295303834117 99.1027704794273
0.516751117801834 98.8842585325913
0.577427587113876 98.6695519997414
0.638322832637326 98.4587504060066
0.69943504472154 98.2519517758479
0.760762477658633 98.0492525633917
0.822303440212044 97.8507475504521
0.884056288709408 97.656529796246
0.946019420315806 97.4666905499837
1.0081912668298 97.2813191756336
1.07485126157609 97.2113010760541
1.14185341037351 97.18610483317
1.2073428671345 97.1621678529297
1.27137594111709 97.1392965647097
1.33401090340396 97.1173482124421
1.39530793375816 97.0962174011221
1.44458491043903 97.0551816495127
1.44325810382949 96.9185088214394
1.44198853126279 96.7825132057632
1.44077573230568 96.6471998213415
1.43961923040219 96.512572584009
1.43851853361721 96.3786343211824
1.43747313531413 96.245386793811
1.43648251490279 96.1128307047342
```

Open Boundary Tidal harmonic forcing parameters
(determines timing of tides, depends on date of model run)

Tidal amplitude and phase at boundary nodes for M2 tide constituent

```
1.43554613830124 95.9809657259485
1.43466345892835 95.8497905176886
1.43383391799486 95.7193027470981
1.43305694545863 95.5894991175706
1.43233196047482 95.4603753895186
1.43165837215843 95.3319264101575
1.43103558019604 95.2041461410119
1.43046297538188 95.0770276855116
1.42993994031792 94.9505633207242
1.42946585006691 94.8247445274948
1.42904007263416 94.6995620257712
1.42866196960137 94.5750058038178
1.42833089685456 94.4510651558408
1.42804299866312 94.3273795308777
1.4276536685968 94.1882179260897
1.42731059002519 94.0496510637631
1.42701335751088 93.9116448750075
1.42676156897842 93.7741647699608
1.426554826067 93.6371757059818
1.42639273423918 93.5006422508008
1.4262749032989 93.364528656122
1.42620094737023 93.2287989165551
1.42617048528918 93.0934168420814
1.42618314078369 92.9583461245193
1.42623854263787 92.8235504017397
1.4263363249081 92.6889933246742
1.4264761271276 92.5546386273783
1.42665759436486 92.420450188746
1.42688037752248 92.2863921007049
1.42714413337128 92.152428733504
1.42744852459988 92.0185247975527
1.42779322019249 91.8846454116176
1.4281778951419 91.750756163222
1.42860223088466 91.616823168931
1.42898314944175 91.4912640101138
1.42914344635902 91.3919632798988
1.42933598195523 91.2929562156955
1.4295601352153 91.1942499357747
1.42981528724164 91.0958515108564
1.43010082137624 90.9977679700867
1.43041612391907 90.9000063116838
1.43076058441712 90.8025735184276
1.43113359613808 90.7054765630183
1.43153455652182 90.6087224253217
1.43196286749212 90.5123180979078
1.43241793591573 90.4162706025479
1.43289917406268 90.3205869955296
1.43340599982265 90.2252743848012
1.43421975762801 90.1303393622637
1.4350553779001 90.0358840185619
1.43393739913638 89.9432102503977
```

M2 continued

```
1.41302259886652 89.8603975448752
1.38903346113561 89.772935829432
1.36191700244595 89.6799259370572
1.33162352641344 89.5803113346625
1.29810669263806 89.4728349059984
1.26563734400394 89.3738479862302
1.24536392652364 89.3225028103617
1.22713378758259 89.2733415286878
1.21098814200685 89.2267719005113
1.19696515605271 89.1832001416828
1.18509991947968 89.1430220668376
1.1754244198905 89.1066137009585
1.16796752007277 89.0743217249401
1.16275493719571 89.0464541819033
1.15980922444224 89.0232718938097
1.15914975449469 89.004981030263
1.16079270561547 88.9917272310307
1.16475104712097 88.9835916048211
1.17103452980423 88.9805888192015
1.17964967452871 88.9826673774294
1.19059976470313 88.9897120376087
1.20388483817029 89.0015482084061
1.21950168310134 89.0179480405344
1.23744383256854 89.038637856205
1.2577015651616 89.0633064959261
1.2802619014186 89.0916141679451
1.30510861063293 89.1232013675168
1.33222221226052 89.1576975149104
1.36157998534712 89.1947289893577
1.39315597849888 89.2339263316114
1.42692102230498 89.2749304528571
1.46284274477663 89.3173977707068
1.49399330055194 89.3551898558721
1.49668794194173 89.3697047132969
1.49940033263897 89.3859970189539
1.50212981399331 89.4040417875475
1.50487571080734 89.4238129416887
1.50763733134028 89.4452833417106
1.51041396743737 89.4684248232098
1.47871483110615 89.4592451828508
1.44398534041431 89.4489602527267
1.41150168185055 89.4430835603807
1.38121052600288 89.441855591214
1.35305557623465 89.445487985132
1.32697761817433 89.4541588784618
1.30291456895667 89.4680087821449
1.2808015315083 89.487137169006
1.26057084827017 89.5115999325256
1.2421521559815 89.5414078458949
1.22547244221433 89.5765261109465
1.21045610475491 89.616875041731
```

```
1.19702501053165 89.6623318836878
1.18509855634659 89.7127337121889
1.17459373370185 89.7678813110314
1.16542519254629 89.8275438998494
1.15750530825829 89.8914645293586
1.15074425008065 89.9593659630656
1.14505005409431 90.0309568508807
1.14032869295723 90.1059379875519
1.13648415503657 90.1840084872597
1.13341852110059 90.2648717116542
1.13103204154673 90.3482408244898
1.12922322257594 90.4338438730311
1.12788890866618 90.5214283365917
1.12692436762178 90.6107651229907
1.12622338161297 90.7016520044969
1.12567833412255 90.7939165425892
1.12518030547496 90.8874185497658
1.09902216834422 90.8938033802224
1.06899099300548 90.8938033802224
1.03699871950209 90.8938033802224
1.00316546730883 90.8938033802224
0.967612576555963 90.8938033802224
0.930462510318372 90.8938033802224
0.891838752104961 90.8938033802224
0.858725015309219 90.8938033802224
0.832275777863576 90.8938033802224
S2      !BOUNTAG
0.00596375350149546 133.654939033855
0.00596375350149546 133.654939033855
0.00596375350149546 133.654939033855
0.0148891602558564 133.374671696679
0.0238870888692339 133.099104684069
0.0329567642788451 132.828313591156
0.0420973774489516 132.562371815463
0.0513080843810247 132.301350530033
0.0605880051437033 132.045318708879
0.0699362231006868 131.794343122926
0.0793517840715812 131.548488371691
0.0888336961459881 131.307816890505
0.0983809289744974 131.072388965759
0.107992413265167 130.842262763555
0.117667040936523 130.617494366075
0.127403664743416 130.398137771613
0.137201098293563 130.184244951266
0.147058116168874 129.975865863393
0.156973454158046 129.773048480457
0.167429627759335 129.701910887736
0.177869689493755 129.680717346837
0.188071938582149 129.659883314723
0.198045225911764 129.639376027611
0.207798710064494 129.619177397033
```

M2 Contiuned

S2 tidal amplitude and phase at boundary nodes

```
0.217341849014347 129.599280386207
0.224991333950633 129.55640451423
0.224667306142131 129.40535031865
0.224352986451708 129.254841129213
0.2240482694541 129.104876878346
0.223753046447163 128.95545607598
0.223467205623332 128.806575826786
0.223190632237901 128.658231856636
0.222923208771253 128.510418523333
0.222664815070161 128.363128851214
0.222415328550583 128.216354553633
0.222174624304106 128.070086059343
0.221942575302742 127.924312547741
0.221719052525795 127.779021977463
0.221503925135988 127.634201123891
0.221297060631537 127.489835615208
0.221098324986897 127.345909969363
0.220907582817853 127.202407635053
0.220724697537288 127.059311031388
0.220549531491941 126.916601594969
0.220381946112063 126.774259819107
0.220221802080034 126.632265302313
0.220069683411564 126.490556385469
0.219957912660608 126.347321801782
0.219852930521152 126.204425419517
0.219754713253316 126.061836695427
0.219663237611658 125.919524715256
0.219578480881216 125.777458256145
0.219500420876819 125.63560584502
0.21942903600397 125.493935825728
0.219364305237436 125.352416413677
0.219306208163348 125.211015762465
0.219254724988714 125.069702025376
0.219209836547488 124.928443414631
0.219171524314996 124.787208263346
0.219139770421756 124.645965090793
0.219114557642814 124.504682659747
0.219095869424252 124.363330039451
0.219083689870204 124.221876666962
0.219078003730547 124.080292404865
0.219078796439075 123.938547604121
0.219086054051365 123.796613162079
0.219099763288612 123.654460576948
0.219100371888936 123.51971019639
0.219046113059979 123.408493798584
0.218996733776155 123.297275992693
0.218952129045334 123.18605911769
0.218912194725963 123.074845598865
0.218876827559297 122.963637961982
0.218845925291357 122.852438849355
0.218819386735381 122.74125104354
```

```
0.218797111852377 122.630077478578
0.218779001836948 122.518921264553
0.218764959172917 122.407785699707
0.218754887718071 122.296674293902
0.218748692779375 122.185590779318
0.218746281161643 122.07453913586
0.218787892312339 121.961696426222
0.218832679299292 121.848957938618
0.218581158128101 121.739216328406
0.215327259557688 121.652404827514
0.211605338338794 121.558275354305
0.2074073785468 121.455674839023
0.202725876290227 121.343232759613
0.197553853152443 121.219302647036
0.192526392137394 121.106205554532
0.18930893313044 121.056426061397
0.186396070612424 121.007404345493
0.183794004930953 120.959460443893
0.181508480373171 120.91292657142
0.179544780633959 120.868141163531
0.177907724638203 120.825442109299
0.176601662829127 120.785159381097
0.175630473773385 120.747607339136
0.174997561189404 120.713077035429
0.174705851317777 120.681828869612
0.174757790774395 120.654085957071
0.175155344382955 120.630028540269
0.17589999385154 120.609789726107
0.176992736258136 120.593452758366
0.178434083173155 120.581049935128
0.180224059779977 120.572563191677
0.182362204614043 120.567926257994
0.184847569136991 120.567028224492
0.187678718223056 120.569718266844
0.190853729990963 120.575811250408
0.19437019717427 120.58509389145
0.198225227635863 120.597331180133
0.202415446035033 120.612272770774
0.206936995522291 120.62965909941
0.211785539753256 120.649227029473
0.216956265291516 120.670714885215
0.221419254805462 120.691001408323
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0.167902849590031 121.527412358335
0.166930064641733 121.611027495025
0.166099254687903 121.697588631891
0.165396480743075 121.786796667825
0.164807525697803 121.878362248409
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0.163054466145719 122.362737109553
0.162835806840786 122.463523953694
0.162624684823857 122.565297976007
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N2 tidal amplitude and phase at boundary nodes

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K2 tidal amplitude and phase at boundary nodes

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0.0563422808093515 126.875439581843
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K1 tidal amplutude and phase at boundary nodes

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O1 tidal amplitude and phase at boundary nodes

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P1 tidal amplitude and phase at boundary nodes

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Q1 tidal amplitude and phase at boundary nodes

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ADCIRC run control file (fort.15)


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90                                        ! ANGINN - MINIMUM ANGLE FOR TANGENTIAL FLOW
1 !NFFR
STEADY
0.0 1.0 0.0 !freq,nodal factor, equ arg for flux bnd
STEADY
1.67264702454175 0.0     ! unitFlux for bndId 3, node 3, 10000 cfs
1.67264702454175 0.0     ! unitFlux for bndId 3, node 1, 10000 cfs
-1 14 100.000000 360                     ! NOUTE, TOUTSE, TOUTFE, NSPOOLE - FORT 61 OPTIONS
-1                                         ! NSTAE - NUMBER OF ELEVATION RECORDING STATIONS,
0 0.000000 00.000000 0                     ! NOUTV, TOUTSV, TOUTFV, NSPOOLV - FORT 62 OPTIONS
0                                         ! NSTAV - NUMBER OF VELOCITY RECORDING STATIONS,
-1 14 100.000000 900                 ! NOUTGE, TOUTSGE, TOUTFGE, NSPOOLGE - GLOBAL ELEVATION OUTPUT
-1 14 100.000000 900                 ! NOUTGE, TOUTSGE, TOUTFGE, NSPOOLGE - GLOBAL ELEVATION OUTPUT
```

Input 10,000 cfs inflow at Penobscot River boundary

Don't write any station putput

Global water level and velocity output every 900 seconds

```
0                                         ! NHARF - NUMBER OF FREQENCIES IN HARMONIC ANALYSIS
0.000000 0.000000 0 0.000000              ! THAS,THAF,NHAINC,FMV - HARMONIC ANALYSIS PARAMETERS
0 0 0 0                                   ! NHASE,NHASV,NHAGE,NHAGV - CONTROL HARMONIC ANALYSIS
0 0                                       ! NHSTAR,NHSINC - HOT START FILE GENERATION PARAMETERS
1 0 1e-010 50                             ! ITITER, ISLDIA, CONVCR, ITMAX - ALGEBRAIC SOLUTION PARAMETERS
&timeBathyControl  !NDDT, BTIMINC, BCHGTIMINC -- BATHYMETRY TIME RECORDS (IN SECONDS) AND TRANSITION TIME
   NDDT = 0
   BTIMINC = 0
   BCHGTIMINC = 43200
/
```

no harmonic analysis

Don't write hotstart files

do not use time varying bathymetry.

Maureparticle run control input file (particles.inp)

DESC line	Comment
80641 ! NP - Number of particles	Track this many particles
10 ! TS - Tracking time Step	Use a 10 second timestep for particle tracking
2419200 ! RUNTIM - Run time in seconds	Track particles for 28 days
3600 ! OUTPER- Output time period seconds	Write particle position output every hour
1 ! RK2 - 1 for RK2 0 for Euler	use 2nd order Runge-Kutta method for velocity integration
1 ! DYN - 1 for dynamic	perform dynamic tracking (i.e. read in time variable velocity field from ADCIRC output)
1296000 ! STEADY_TIME	Start tracking 15 days into ADCIRC run (1 day after ramp period)
2 ! EDDY_DIF	Use random walk diffusion with eddy diffusivity of 2 m^2/s
0 ! NWS	Don't use wind input
0 ! WFACTOR	
2 ! ICS	Model grid is in geographic coordinates
-68.972526 44.395004 !SLAM0 SFEA0	Center of grid projection

```
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-68.9721128856857 44.3951189015697 1296030 0
-68.9719417577511 44.3951664982461 1296060 0
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```

List of 80641 initial particle positions and their release time every 30 seconds distributed randomly along the diffuser location

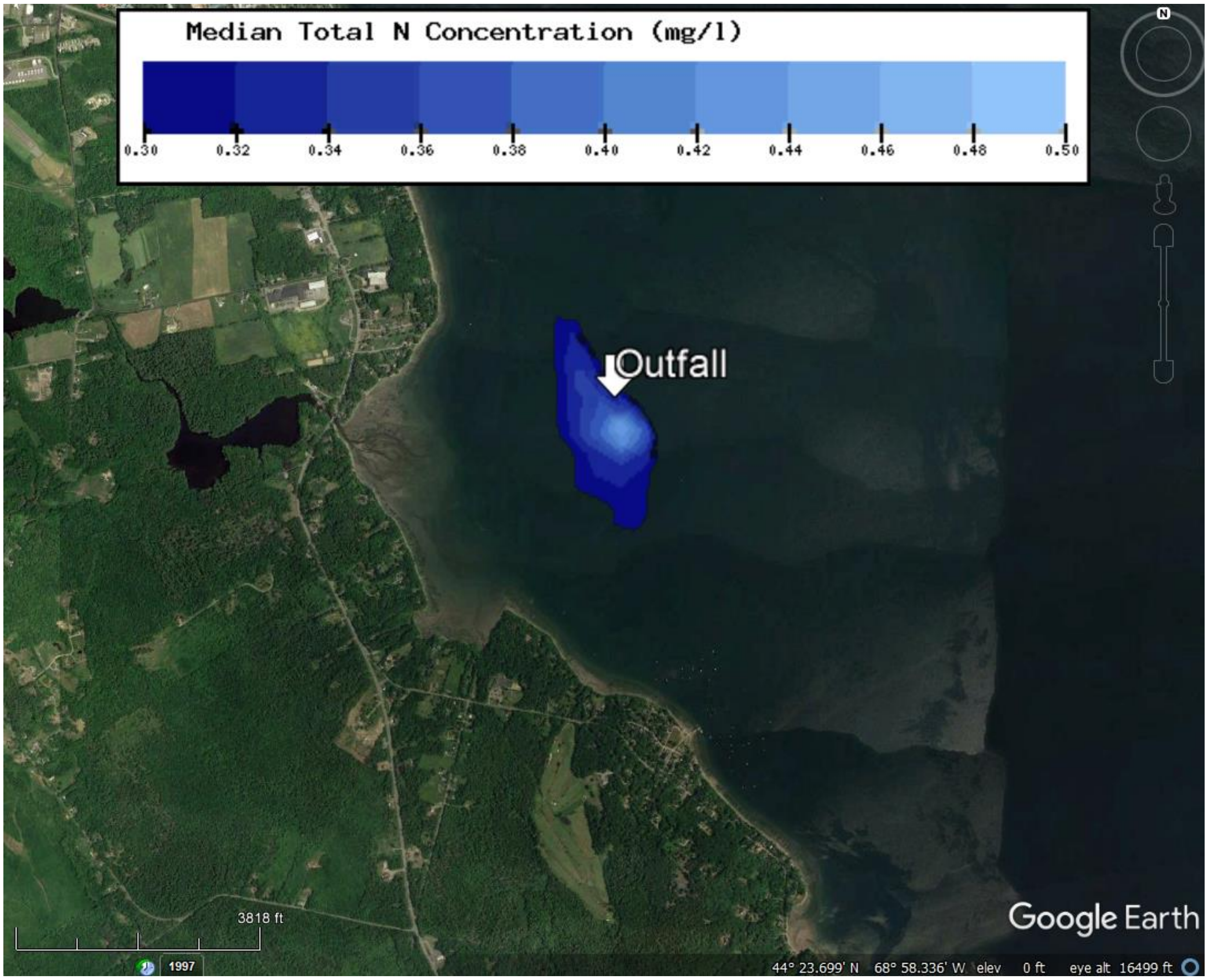
Continues for a total of 80641 particles....

ATTACHMENT D

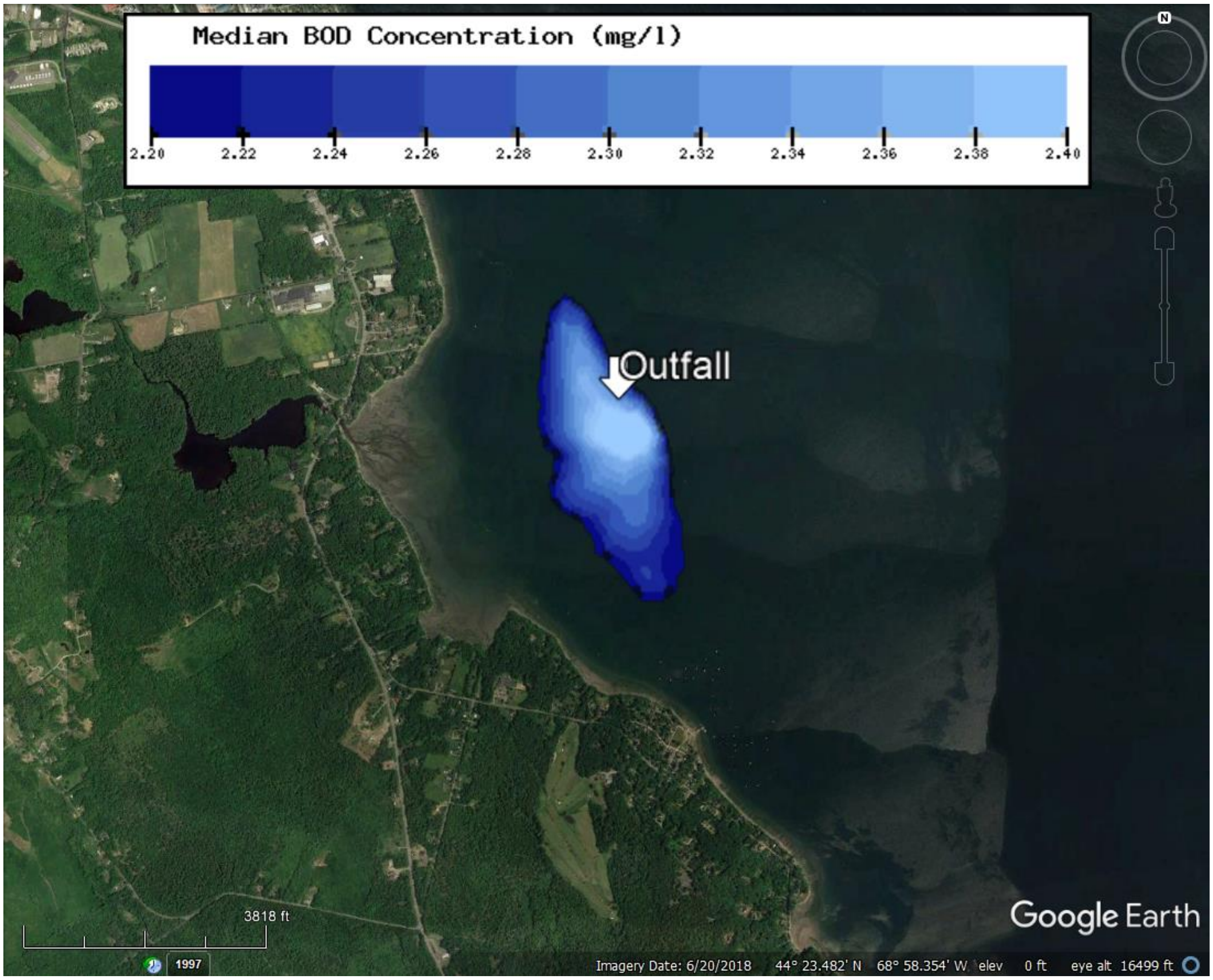
Time Median Total Nitrogen & BOD Concentrations

Response to Review Comments
Nordic Aquafarms Inc., Land-based Aquaculture Facility
Belfast, Maine
L-28319-26-A-N

Ransom Consulting, Inc.
Project 171.05027.008



Time Median Total Nitrogen concentration above 0.3 mg/l derived from far-field dilution analysis with effluent concentration of 23 mg/l and background concentration of 0.17 mg/l.



Time Median BOD concentration above 2.2 mg/l derived from far-field dilution analysis with effluent concentration of 50.0 mg/l and background concentration of 2.0 mg/l.

ATTACHMENT E

Chemicals for the Fish Farm

Response to Review Comments
Nordic Aquafarms Inc., Land-based Aquaculture Facility
Belfast, Maine
L-28319-26-A-N

Ransom Consulting, Inc.
Project 171.05027.008

Chemicals for the Fish Farm

Note: Annual usage estimates represent approximate quantity required given a product is the only one used for this application. The quantities needed will be dependent on the site-specific conditions experienced which are difficult to establish prior to operations and are indicated as estimates only. Likely a fraction of the estimated annual use of each of these products will be used. All products listed will be used according to label.

Cleaners

Detergents

Aqualife® Multipurpose Cleaner. A biodegradable, nonhazardous cleaner that is designed specifically for use in fish hatcheries, aquaculture facilities, fish & food processing plants, & agricultural farms. Active ingredients: sodium hydroxide (1-5%), the product is phosphate free, contains no volatile organic compounds and is NSF certified for use in food processing facilities. Used according to the label at dilutions of 1:20. Approximate annual use: 2232 gallons/year (8449 l/year).

Gil Save®. High-foaming chlorinated, alkaline, liquid detergent, Gil Save is designed for foam and high pressure spray cleaning of meat and poultry plants, breweries, dairies and canneries. It is a complete product containing alkalis, water conditioners, chlorine and high-foaming wetting agents. Gil Save is an effective cleaner of food processing equipment by removing fatty and protein soils, pectin, mold, yeast and organic greases. Active ingredients: sodium hydroxide (7-9%), sodium hypochlorite (3-4%). Use according to label at concentrations of 0.2-3% (¼-4 oz/gal). Approximate annual use: 678 gallons/year (2567 l/year).

Clean in Place (CIP)

Gil Super CIP®. A heavy-duty, chelated-liquid caustic cleaner for use in CIP, boil-out, soak, spray clean and atomization cleaning systems, Gil Super CIP is formulated to remove protein, fatty and carbonized soils typically found in dairy and food processing. Active ingredients: sodium hydroxide (49%). Used according to label at 0.1-3% (1/8-4 oz/gal). Approx. annual use: 5840 gallons/year (22107 l/year).

Gil Hydrox®. A concentrated organic, liquid acid cleaner, Gil Hydrox rapidly removes milk/beer stone, alkaline/hard water film and stains/protein build-up from dairy and food processing equipment. It is specially formulated for use in CIP, spray and acid rinse operations. Active ingredients: glycolic acid (29-31%). Used according to label at 0.3-1.5% (½-2 oz/gal). Approx. annual use: 5840 gallons/year (22107 l/year).

Disinfectants/Sanitizers

Bleach. Active ingredient: sodium hypochlorite (8%) in concentrated form. Typically used at 100-1000 ppm for general cleaning/disinfection. Approximate annual use: 1500 gallons/year (5700 l/year).

Ozone. Ozone can be dissolved into water to provide an aqueous ozone solution that is stable, safe, easy to control, leaves no residue and has been granted GRAS approval by both the USDA and FDA for direct contact with food. This water containing ozone can replace chlorine as an antimicrobial agent or be used to supplement existing water rinses and achieve improved antimicrobial intervention. This is now a common application to sanitize fillet machines, cutting tables, knives, and all equipment that may be used in the seafood processing areas. Approximate annual use: TBD. Concentration in discharge = 0 ppm

Virkon® Aquatic. A powerful cleaning and disinfecting solution with efficacy against fish viruses, bacteria, fungi, and molds. Virkon® Aquatic is EPA registered (except in California where registration is pending) for the disinfection of environmental surfaces associated with aquaculture**.** Active ingredient: Potassium monopersulfate (21.4%). Used in accordance with label as a general cleaner and in footbaths. Working solution strengths normally range from 0.5% - 2.0%. Approx. annual use: 1100 lbs/year (500 kg/year).

Zep FS Formula 12167® Chlorinated Disinfectant and Germicide. A liquid chlorine sanitizer and deodorant for use in all types of food-handling establishments. Authorized as no rinse sanitizer for equipment. Provides deodorizing activity by destroying bacteria which generate many disagreeable odors. Can also be used to sanitize commercial laundry. Active ingredients: Sodium hypochlorite (5-10%) and sodium hydroxide (1-3%). Used according to label, effective at concentrations as low as 0.3% (1 oz/ 2 gallons). USDA applicable and EPA and Maine registered. Approx. annual use: 1980 gallons/year (7495 l/year).

Therapeutants

Compounds Potentially Used:

Note: the quantities needed will be dependent on the site-specific conditions experienced which are difficult to establish prior to operations and so are indicated as estimates only. All products listed will be used according to label use or a licensed veterinarian's prescription.

Parasite-S, Formalin-F, and Formacide-B. (Formalin). Active ingredient 37% formaldehyde. Used periodically according to the label if needed to alleviate fish health issues due to *saprolegniasis*, external protozoa and monogenetic trematodes. Typical dose rates from 25 ppm to 1,000 ppm. Approximate annual use: 925 gallons/year (3500 l/year).

Finquel® or Tricane-S. (Tricaine methanesulfonate). Used periodically in accordance with the label to reduce stress on the fish when handling small numbers for examination. Typical dose rates of 15-330 mg/L. Approximate annual use: 1.1 lbs/year (500 g/year).

Halamid® Aqua. (Chloramine-T). Active ingredients N-chloro, p-toluenesulfonamide and sodium salt trihydrate. Used periodically according to the label if needed to alleviate fish health issues due to bacterial gill disease. Typical dose range 12-20 ppm. Approximate annual use: 1100 lbs/year (500 kg/year).

Ovadine® (PVP Iodine). A buffered 1% Iodine solution (Iodophor) specifically formulated for use in disinfecting fish eggs. It contains a 10% Povidone-Iodine (PVP Iodine) complex, which provides 1% available iodine. Used according to the label at dose rates of 50 -100 ppm as available iodine solution. Estimated usage: 160 gallons/year (600 l/year).

Compounds Rarely Used Only in Emergency Situations:

Praziquantel. Considered as 100% active. Can be used if fish are suffering from trematode/cestode infections. Typical dose ranges from 5-200 ppm depending on length of standing bath treatment. Used as needed/intermittent or emergency use only, according to label use or as prescribed by a licensed veterinarian. Approx. annual use: 0 lbs/year (0 kg/year).

Potassium permanganate. Considered as 97% active. Can be used if fish are suffering from certain parasites and fungal infections in younger fish life-stages. Typical dose range 1.5-2.5 ppm. Used as needed/intermittent or emergency use only, according to label use or as prescribed by a licensed veterinarian. Approx. annual use: 0 lbs/year (0 kg/year).

Terramycin® 200. (oxytetracycline dehydrate, 44% active): Can be used as an in-feed treatment (maximum of 0.08 g active oxytetracycline/kg fish/day) if fish are suffering from certain bacterial infections. Used as needed/intermittent or emergency use only, according to label use or as prescribed by a licensed veterinarian. Approx. annual use: 0 lbs/year (0 kg/year).

Aquaflor®. (florfenicol; 50% active). Can be used as an in-feed treatment (maximum of 15 mg/kg fish/day) if fish are suffering from certain bacterial infections. Used as needed/intermittent or emergency use only, according to label use or as prescribed by a licensed veterinarian. Approx. annual use: 0 lbs/year (0 kg/year).

Romet® 30/Romet® TC. (sulfadimethoxine/ormetoprim, 30% active or 20% active, respectively). Can be used as an in-feed treatment (maximum of 50 mg/kg fish/day) if fish are suffering from certain bacterial infections. Used as needed/intermittent or emergency use only, according to label use or as prescribed by a licensed veterinarian. Approx. annual use: 0 lbs/year (0 kg/year).

Waste Water Treatment

Formic Acid (85%). Used for pH correction of fish processing water prior to disinfection with sodium hypochlorite. Approx. annual use: 18200 gallons/year (69000 l/year).

Bleach. Active ingredient: sodium hypochlorite (15%). Used to disinfect water used in fish processing. Applied at concentration of 50 mg/l. Estimated discharge concentration: 0.4 mg/l. Approx. annual use: 14800 gallons/year (56000 l/year).

MicroC® 2000. (1.1 million mg/l COD). A non-hazardous, green chemical developed specifically for use as an electron donor / carbon source for wastewater denitrification applications. It is used as supplemental carbon source in wastewater treatment plants to stimulate denitrification processes. Approx. annual use: 1.0 million gallons/year (3.8 million l/year).

ENVIRONMENTAL OPERATING SOLUTIONS, INC.

MicroC® SERIES

MicroC® 2000

PRODUCT INFORMATION

MicroC® 2000 is a proprietary, non-hazardous, green chemical designed specifically for use as a carbon source for biological contaminant removal applications in water/wastewater treatment.

COST EFFECTIVENESS

- Best value among non-hazardous alternative carbon sources

NON-HAZARDOUS

- Eliminates flammability and toxicity concerns of traditional chemicals such as methanol
- Provides capital cost savings vs. installation of flammable liquid storage and feed system
- Non-hazardous product enables rapid and flexible deployment of carbon augmentation solutions

PERFORMANCE ADVANTAGES

- Rapid start-up/acclimation
- Superior cold weather performance

ENVIRONMENTALLY SUSTAINABLE

- Derived from abundant, renewable resources produced in the United States vs. largely imported fossil-fuel derived carbon sources (methanol)
- USDA BioPreferred designation

CONSISTENT AND SUPERIOR QUALITY

- Rigorous end to end quality control program
- Consistent Chemical Oxygen Demand (COD) values
- No product degradation during long-term storage

VALIDATED PERFORMANCE

- MicroC® products in use at over 550 plants in North America
- Performance validated by leading equipment/process suppliers, consulting engineers and academic institutions
- Full scale, documented performance validation for:
  - Nitrate removal
  - Enhanced Biological Phosphorus Removal (EBPR)
  - Metals removal
  - BOD augmentation
  - Perchlorate removal
  - Fixed film biological processes (i.e. denitrification filters)
  - Startup/acclimation dynamics
  - Cold weather performance
- Denitrification rates and kinetic parameters determined by Northeastern University

TECHNICAL SERVICES

- Application guidance from team of BNR/contaminant removal experts
- Dedicated support to ensure achievement of contaminant removal goals

SUPPLY CHAIN CAPABILITY & EXPERIENCE

- 20 nationwide MicroC® manufacturing facilities provides redundancy and flexibility, reducing the risk of supply and quality interruptions even during drastic demand changes
- Extensive multi-industry raw material sourcing capability and vast storage infrastructure facilitates ability to offer long term, fixed pricing
- An expansive supply chain infrastructure designed for proximity to customers, reduces transportation costs and improves responsiveness

PACKAGING

- Bulk (1000-4500 gallon)*
- 265-gallon IBC/tote
- 55-gallon drum
- 30-gallon drum
- 5-gallon pail

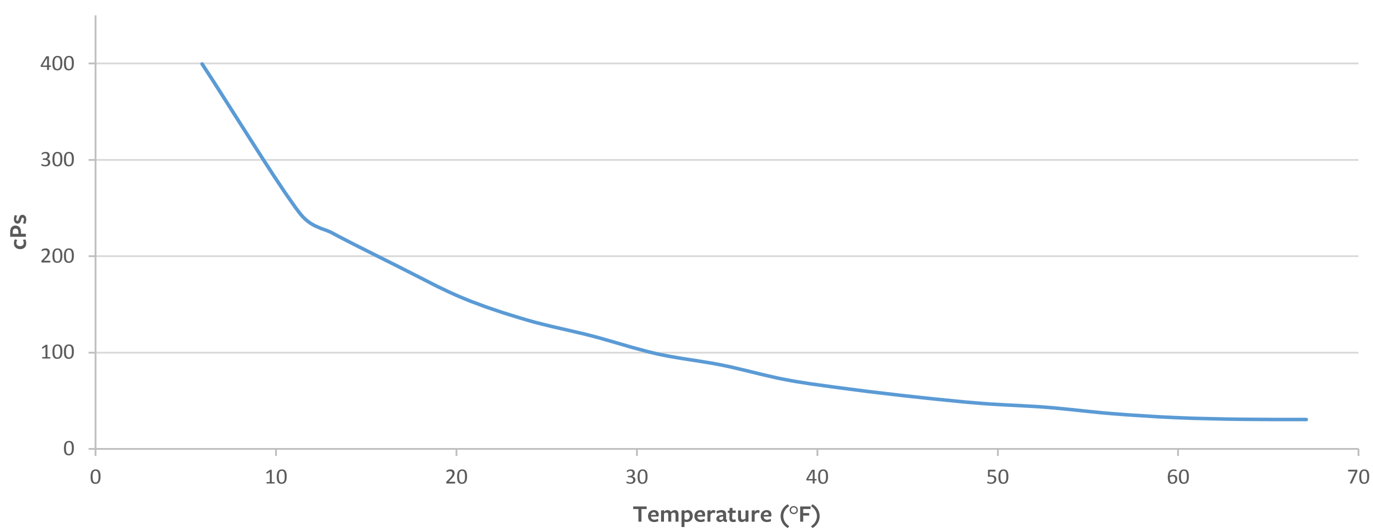
*Maximum volume 4800 gallons in some markets

EOSi
Empowering Clean Water®

TECHNICAL SPECIFICATIONS

PROPERTY	SPECIFICATIONS	TYPICAL VALUE	TEST METHOD
Glycerin Content	70% - 74%	71%	ASTM D7637-10
Methanol Content	0.3%, max	< 0.1%	EN 14110
Fatty Acid Content	0.75%, max	0.3%	ASTM D5555-95
COD (mg/L)	1,050,000 - 1,150,000	1,100,000	ASTM D1252
pH	4.0 - 11.0	6	ASTM E-70
Specific Gravity at 20°C	1.21 - 1.25	1.235	ASTM D891-00
Bulk Density (lbs/gal)	10.09 - 10.43	10.30	ASTM D891-00
Viscosity (cPs) at 20°C	75, max	45	ASTM D2196
Flash Point	None to 93°C	None to Boil	ASTM D93
Freezing Point (°C)	-18, max	-35	ASTM D1177

TEMPERATURE / VISCOSITY RELATIONSHIP



Note: Although product freezes below 0°F, viscosity analyses stopped at 0°F due to practical considerations

MicroC® 2000

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name: MicroC® 2000 **Publication Date:** March 6, 2018

Product Code: NA **Replaces:** December 28, 2016

Product Use: A reducing agent for biological processes

Supplier Information:

Environmental Operating Solutions, Inc
160 MacArthur Blvd., Unit 6
Bourne, MA 02532

Phone: 508-743-8440
Fax: 508-743-8443
Website: www.microc.com

EMERGENCY TELEPHONE NUMBER: CHEMTREC 800-424-9300

2. HAZARDS IDENTIFICATION

OSHA Regulatory Status:
This product when used as intended is not hazardous according to 29 CFR 1910.1200
This product when used as intended is not hazardous according to GHS categories

GHS Pictograms: None Applicable
Signal Word: None Applicable
GHS Hazard Classification: None Applicable
Hazard Statements: None Applicable

Note: When vaporized, glycerin mist may cause irritation of the respiratory tract.

Potential Health Effects

Routes of Exposure	Ingestion, inhalation, skin contact, eye contact
Eyes	May cause slight irritation
Skin	May cause slight irritation
Inhalation	High mist concentrations may cause irritation of respiratory tract.
Ingestion	May be harmful if swallowed in large quantities

3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name	CAS #	% by Weight
Glycerin; glycerol	56-81-5	70-74%
Water	7732-18-5	22-26%
Sodium Chloride	7647-14-5	4-6%
Methanol	67-56-1	< 1%

4. FIRST AID MEASURES

Eye Contact	Immediately flush eyes thoroughly with plenty of water for 15 minutes and consult a physician immediately.
Skin Contact	Remove contaminated clothing and wash affected area with water and soap. Consult physician if irritation develops
Inhalation	Remove individual to fresh air. Seek medical attention if breathing problems persist
Ingestion	Do not induce vomiting. Rinse mouth thoroughly. Seek medical attention.
General Advice	If individual feels unwell following the exposure to the product consult a physician immediately. Present this Safety Data Sheet to the doctor in attendance
Note to physician	Treat patient symptomatically

5. FIRE FIGHTING MEASURES

Flammability Summary (OSHA and NFPA)	Non-flammable Material
Protection of Firefighters:	Wear suitable protective equipment. Wear self contained breathing apparatus if necessary
Extinguishing Media	Use equipment appropriate to the main source of the fire. Water spray, alcohol foam, dry chemical or CO2. Water or alcohol foam may cause frothing
Specific hazards arising from the chemical	Carbon oxides

6. ACCIDENTAL RELEASE MEASURES

Personal Protection for Spills	Keep unnecessary personnel away from spill. Use personal protective equipment. Ventilate area of leak or spill. Avoid breathing vapors and mist.
Methods for Containment	Eliminate all sources of ignition. Stop flow of material if safe to do so. Dike spilled material. Absorb spill with inert absorbent material. Sand, earth and vermiculite are suitable absorbent materials.
Environmental Precautions	Prevent further leakage. Contain spill if safe to do so. Do not let product enter storm drains if possible.

7. HANDLING AND STORAGE

Precautions for Safe Handling	See other relevant sections of this SDS. Avoid contact with skin and eyes. Avoid breathing mist. Use with adequate ventilation. Do not handle and store near open flames, high heat or sources of ignition.
Storage	Keep containers closed when not in use. Minimize evaporative losses. Keep away from ignition sources.
Incompatible Materials for Storage	None known

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

INSUFFICIENT DATA ON MIXTURE. DATA ON INDIVIDUAL COMPONENTS PROVIDED BELOW

Component	Concentration in Product	ACGIH TLV	OSHA TABLE Z-1 Limits for Air Contaminants	NIOSH
Glycerin CAS No: 56-81-5	70-74% w/w	Form: Glycerin Mist TWA: 10 mg/m3	Form: Total Dust PEL: 15 mg/m3 Form: Respirable Fraction PEL: 5 mg/m3	Insufficient Data on Glycerin Mist
Methanol CAS No: 67-56-1	< 1 % w/w	TWA: 260 mg/m3	PEL: 260 mg/m3	TWA: 260 mg/m3

Engineering Controls — Use proper equipment and storage conditions to control airborne levels below recommended exposure limits.

Personal Protective Equipment

Eye Protection: — Use normal eye protection practices such as safety glasses with side shields. Use chemical goggles if risk of splashing is high.

Skin Protection — Handle with chemical resistant gloves. Dispose of contaminated gloves after use. Nitrile gloves recommended.

Respiratory Protection — If workers could be exposed to concentrations above the exposure limits in Section 8, use a full face respirator with multipurpose combination cartridges.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Liquid	**Flash Point**	None to Boil (ASTM D93)
Color	Light brown	**Boiling Point**	Not determined
Odor	Musty – Sweet Odor	**Evaporation Rate**	Not determined
Odor Threshold	Not determined	**UEL/LEL**	Not determined
		Flammability (solid, gas)	Not determined
pH	4.00-11.00	**Vapor Pressure**	Not determined
Solubility in Water	Highly soluble in water	**Vapor Density**	Not determined
		Relative Density	Not Determined
Bulk Density	10.22 lbs/gal	**Partition Coefficient**	Not determined
Specific gravity	1.225@ 20°C	**Autoignition Temperatures**	
Viscosity	45 cPs @ 20C	**Decomposition Temperature**	Not determined

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10. STABILITY AND REACTIVITY

Reactivity	Avoid contact with oxidizing agents (e.g. nitric acid, peroxides, chromates)
Chemical Stability	Stable under normal storage conditions
Possibility of hazardous reactions	None known
Conditions to Avoid	Heat, flames, sparks. Contact with oxidizing agents
Incompatible Materials	None known
Hazardous Decomposition Products	Oxides of carbon under high heat

11. TOXICOLOGY

INSUFFICIENT DATA ON MIXTURE. DATA ON INDIVIDUAL COMPONENTS PROVIDED BELOW

Eye Contact	The components in this product may result in mild eye irritation from contact with liquid or vapors. Symptoms include redness, swelling, watering.
Skin Contact	The components in this product may result in mild skin irritation. Symptoms include redness, itching, burning, dermatitis.
Inhalation	Breathing high mist concentrations may be harmful. Inhalation can cause irritation of the throat and lungs.
Ingestion	Ingestion of this product may result in nausea, vomiting and diarrhea. Aspiration into the lungs can cause damage and inflammation to the lungs.
Target Organs	Lungs, Kidneys
Prolonged Exposure	Symptoms include nausea, headache, vomiting

Glycerin; Glycerol CAS No. 56-81-5

Acute Toxicity	Dermal LD50 = > 10,000 mg/kg (Rabbit) Inhalation LC50 = > 570 mg/m^3 1 hr (Rat) Oral LD50 = 12,600 mg/kg (Rat)
Carcinogenicity	Not listed by ACGIH, IARC, NIOSH, NTP or OSHA
Mutagenicity	No data available
Reproductive Toxicity	No data available

Methanol 67-56-1

Acute Toxicity	Dermal LD50 = 15,800 mg/kg (Rabbit) Inhalation LC50 = 64,000 mg/m^3 4 hr (Rat) Oral LD50 = 5,600 mg/kg (Rat)
Carcinogenicity	Not listed by ACGIH, IARC, NIOSH, NTP or OSHA
Mutagenicity	No data available
Reproductive Toxicity	No data available

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12. ECOLOGICAL INFORMATION

Ecotoxicity	Glycerin: 96 hr LC50: 51,000-57,000 mg/L (Rainbow Trout), > 5000 mg/L Goldfish Methanol: 96 hr LC50: > 15,400-29,400 mg/L (Fish)
Persistence and degradability	No data available
Bioaccumulative potential	No data available
Mobility in soil	No data available
Other adverse effects	No data available

13. DISPOSAL CONSIDERATIONS

This product as supplied is not classified as a RCRA hazardous waste according to 40 CFR 261. However it should be fully characterized prior to disposal as contamination with other materials may subject it to hazardous waste regulations. RCRA requires the user of the product to determine whether the product meets RCRA criteria for hazardous waste. Always consult with local, state and federal regulations prior to disposal.

14. TRANSPORTATION INFORMATION

US Domestic DOT	Not Regulated
Shipping Name	Glycerin; Glycerol
IMDG	Not dangerous goods
IATA	Not dangerous goods
Marine pollutant	No

15. REGULATORY INFORMATION

United States

Toxic Substances Control Act

The components of this product are listed on the TSCA Inventory of Existing Chemical Substances

Section 302 (EHS) TPQ	Not applicable
Section 304 (EHS) TPQ	Not applicable

SARA Section 311/312 Hazard Categories

Acute - NO
Chronic – NO
Physical - None
Pressure Hazard - NO
Fire Hazard - NO

SARA Section 313

This product may contain trace amounts of a chemical that is subject to reporting requirements of SARA

Methanol CAS # 67-56-1 Typical % Weight in Product 0.0-0.10%

CERCLA

This product may contain trace amounts of a chemical that is subject to reporting requirements of CERCLA
Methanol RQ # 5,000. Typical % Weight in Product 0.0-0.10%

Clean Water Act Section 311 Hazardous Substances (40 CFR 117.3): None

State Right to Know Regulations

Chemical Name: Glycerin

California – Proposition 65	Not applicable
Massachusetts Right to Know	Glycerin
Minnesota Hazardous Substances List	Glycerin mist
New Jersey Right to Know	None
Pennsylvania Right to Know	Glycerin
Rhode Island Right to Know	Glycerin

16. ADDITIONAL INFORMATION

MSDS REVISION STATUS: March 6, 2018 | Replaces December 28, 2016

THIS SAFETY DATA SHEET (SDS) HAS BEEN PREPARED IN COMPLIANCE WITH THE FEDERAL OSHA HAZARD COMMUNICATION STANDARD, 29 CFR 1910.1200. THE INFORMATION IN THIS SDS SHOULD BE PROVIDED TO ALL WHO WILL USE, HANDLE, STORE, TRANSPORT, OR OTHERWISE BE EXPOSED TO THIS PRODUCT. WE BELIEVE THIS INFORMATION TO BE RELIABLE AND UP TO DATE AS OF ITS PUBLICATION DATE, BUT MAKE NO WARRANTY THAT IT IS. IF THIS SDS IS MORE THAN THREE YEARS OLD YOU SHOULD CONTACT THE SUPPLIER TO MAKE CERTAIN THAT THE INFORMATION IS CURRENT.

MicroC®
Premium Carbon Sources

CASE STUDY

MUNICIPAL WWTP IMPLEMENTS NITRACK® PROGRAM TO MEET NITROGEN PERMIT LIMITS

MicroC® and Nitrack® Program Enable BNR System to Outperform its Design Basis Without Capital Improvements

Client: Large Water Pollution Abatement District

Location: Northeast

Flow (Average Design/Actual): 45 MGD/30 MGD

Treatment Technology: Anaerobic/Anoxic/Oxic (A2/O) process

Total Nitrogen Limit: 6 mg/L (Monthly Average) May to October

Total Phosphorus Limit: 0.45 mg/L (Monthly Average) April to October

Study Period: 2015

Scope: MicroC® Evaluation & Application Support (ME&AS) and Nitrack® Program

Product: MicroC® 2000A

Environmental Operating Solutions, Inc. (EOSi) helped this Water Pollution Abatement District find an operational solution to meet stricter seasonal discharge requirements for nitrogen and phosphorus. A pilot study in 2015 was conducted in one of the treatment trains to demonstrate that by using MicroC® 2000A supplemental carbon source in conjunction with EOSi's Nitrack® Program, the District could meet new permit requirements with its existing treatment facilities.

Background

The District had recently completed a plant improvement project that included an upgraded biological nutrient removal (BNR) system. The District anticipated enhanced nitrogen and phosphors removal requirements to meet new NPDES limits on nutrient discharges to protect receiving waters, including a sensitive coastal bay. However, the new NPDES permit included discharge standards for nitrogen and phosphorus that were much more stringent than the design basis for the BNR system. To avoid another capital improvement project, the District began exploring operational solutions.

The BNR system uses the A2/O process with four treatment trains. The system has sequential anaerobic, anoxic and aerobic zones that facilitate denitrification and phosphorus removal. By optimizing this process, the District was able to achieve lower effluent nitrogen concentrations than expected based on the process design, but

EOSi
Green Solutions For Achieving Your Limits

could not consistently meet the average monthly total nitrogen limit of 6.0 mg/L (May to October). The District retained EOSi to conduct a pilot study of denitrification with MicroC® 2000A supplemental carbon in one of the four treatment trains.

Challenge

The District and EOSi agreed on the following success criteria for the evaluation study:

- **Meet permit requirements:** Achieve an average effluent of nitrate-nitrogen (NO3-N) concentration of less than 4.5 mg/L, and of total nitrogen of less than 6.0 mg/L.
- **Minimize supplemental carbon costs:** Achieve a carbon-to-nitrogen (COD:N) ratio less than or equal to the theoretical minimum (i.e., 5.5 pounds of COD added per pound of nitrogen removed). This ensures that carbon in the primary effluent is used for denitrification, minimizing supplemental carbon needs.

Solution Summary

EOSi conducted a MicroC® Evaluation & Application Support (ME&AS) study to design the MicroC® program, including determination of optimal feed rates, injection points and control strategies. EOSi provided in-line analyzers, a chemical storage tank, and pumping equipment for the evaluation study. EOSi also set up the Nitrack® Program, including the installation of a Nitrack® Controller and all related monitoring, control, and automation equipment. A process flow diagram is shown in Figure 1.

MicroC® 2000A was fed to the anoxic zone of the A2/O process beginning in April 2015. EOSi began optimizing the supplemental carbon program to consistently meet the permit requirement for total nitrogen of 6 mg/L while minimizing MicroC® 2000A usage. EOSi's technical staff continuously monitored key process parameters, optimized set-points, and modified the process control strategy.

One challenge with the District's treatment system configuration was finding the right combination of feedforward (FF) control and feedback (FB) control. Feedforward control actively adjusts process conditions as influent conditions change, but does not make adjustments based on system performance. Feedback control actively adjusts process conditions as system performance changes, but does not make adjustments based on changes in influent conditions. Combining feedforward and feedback control strategies enables the most consistent effluent quality with the lowest supplemental carbon usage.

FIGURE 1 Process Diagram and Schematic of MicroC® 2000A Dosing in a Single BNR Treatment Train

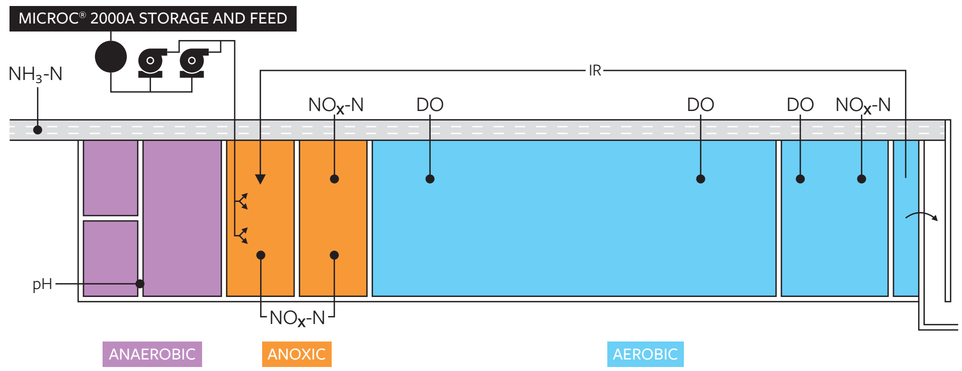
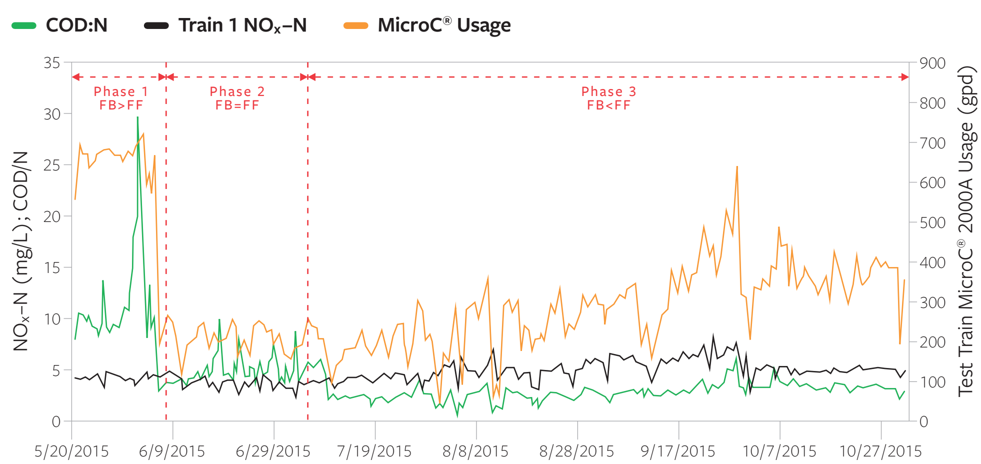


FIGURE 2 Process Performance Data with Control Phases



EOSi technical staff completed regular data analysis and systematically evaluated possible control strategies, considering factors such as ambient temperature, kinetics, loading, flows, and internal recirculation rates. EOSi concluded that this process responded best to a control mode that favored feedforward control over feedback control, with an internal recirculation rate of 3.25 times the influent flow. These conditions promoted the use of internal COD while returning enough nitrate to the anoxic zone for denitrification. Results of the evaluation study are summarized in Figure 2.

Benefits

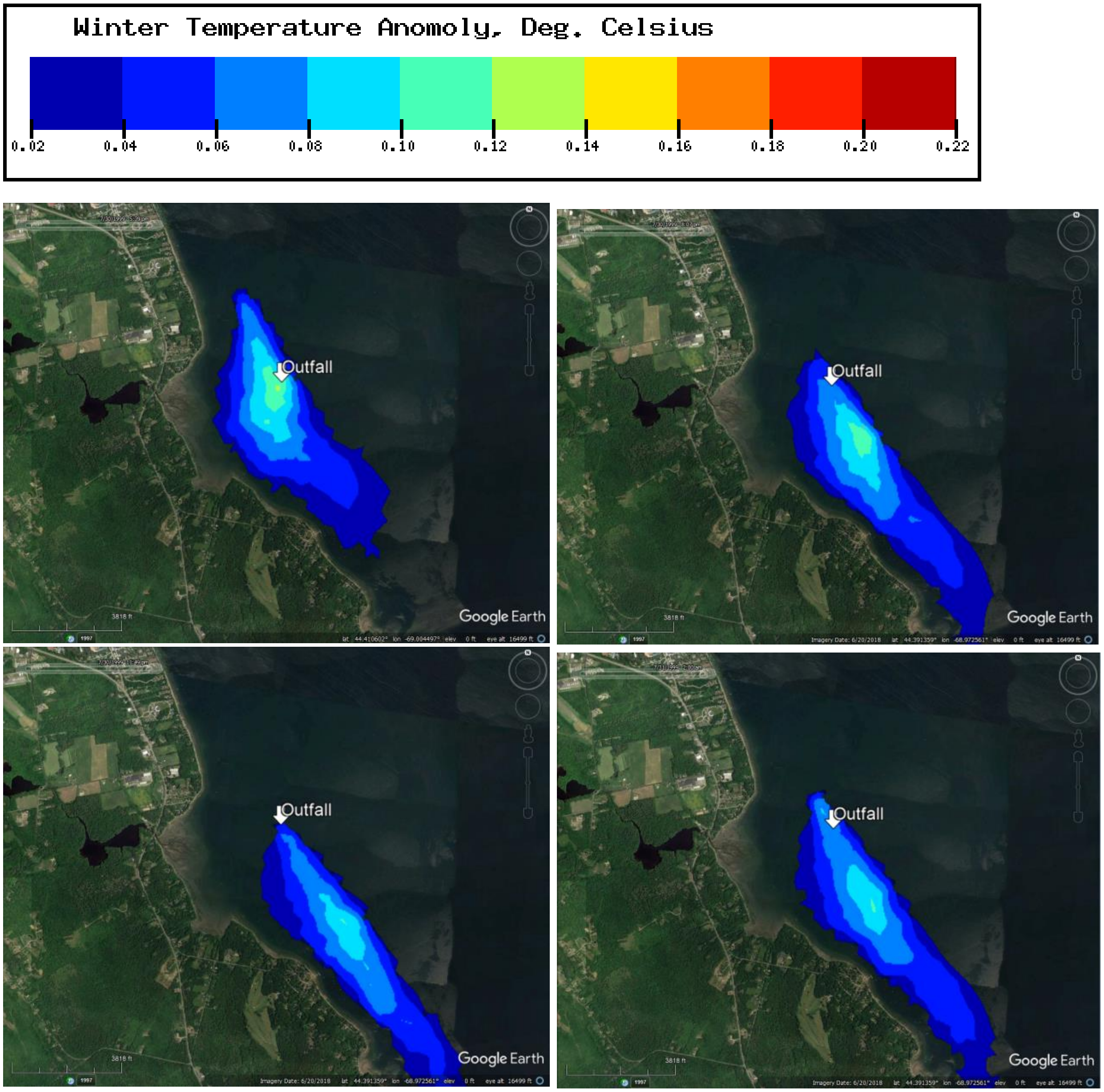
Results of the pilot study met the success criteria, described in the Challenge section. By using MicroC® 2000A as a supplemental carbon source and real-time dosage optimization using EOSi's Nitrack® Program, the selected treatment train was able to achieve effluent total nitrogen concentrations largely consistent with the target limit of 6.0 mg/L. The Nitrack® Controller allowed internal COD to be used for denitrification when available, and achieved an average COD:N ratio of less than 5.5. Based on the success of the evaluation, the District has decided to expand the supplemental carbon program to all four biological treatment trains in 2016.

ATTACHMENT F

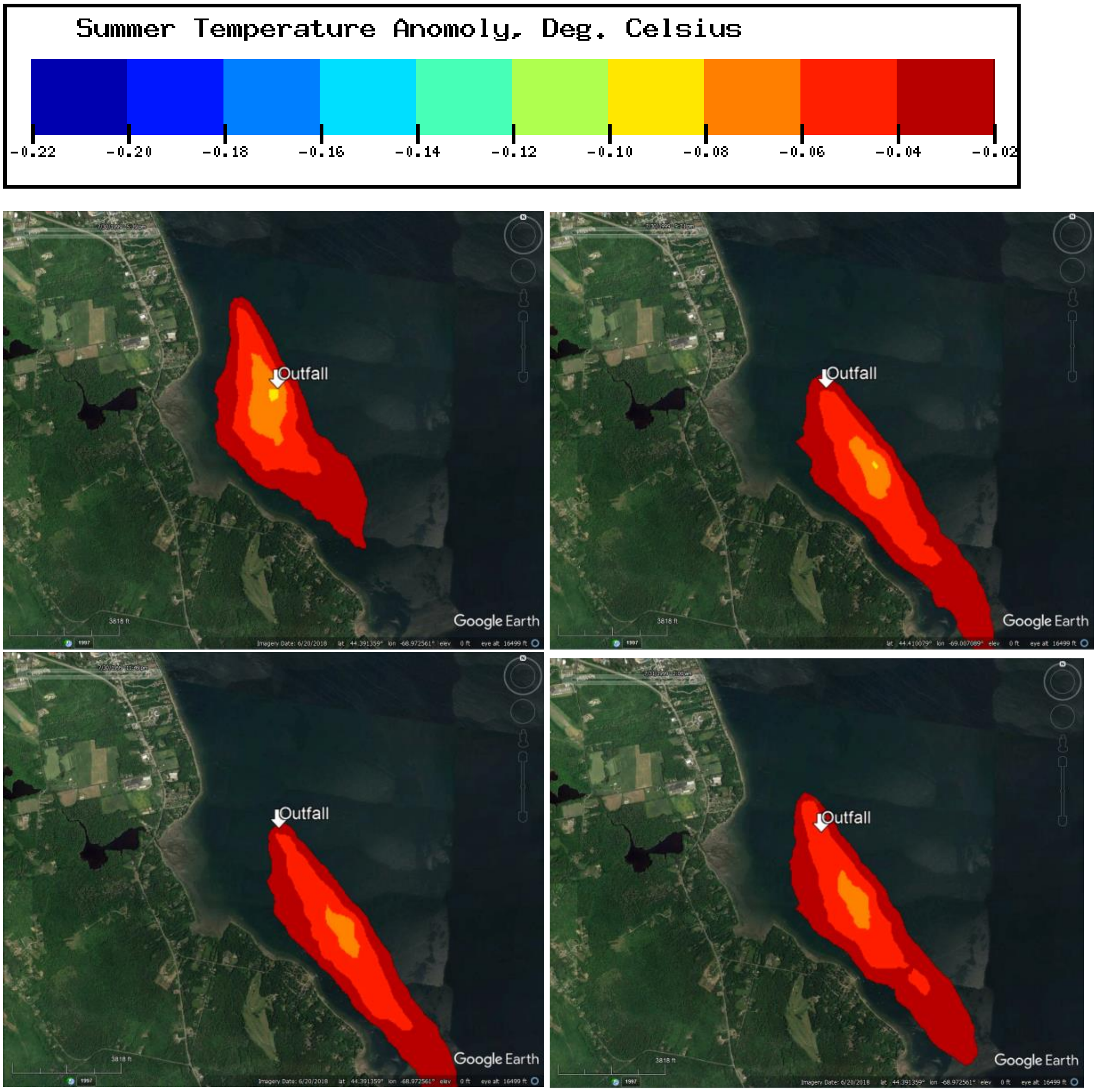
Summer/Winter Effluent Temperatures

Response to Review Comments
Nordic Aquafarms Inc., Land-based Aquaculture Facility
Belfast, Maine
L-28319-26-A-N

Ransom Consulting, Inc.
Project 171.05027.008



Temperature anomoly in winter assuming 0 degree C ambient temperature. high slack (upper left), mid-ebb (upper right), low slack (lower left), mid-flood (lower right)



Temperature anomoly in Summer assuming 22 degree C ambient temperature. high slack (upper left), mid-ebb (upper right), low slack (lower left), mid-flood (lower right)