Appendices

Appendix Contents

Appendix A

Draft Permit, Tides and CORMIX Manual
Excerpts & MZ Sizes

Appendix A1

Draft Permit Discharge Numbers and Types

1.5   Authorized Discharges

1.5.1   This Permit authorizes and places conditions on discharges from mobile oil and gas exploration, fixed platforms, and onshore production facilities that are located within Cook Inlet (See Figure 1) under the Offshore and Coastal Subcategories of the Oil and Gas Extraction Point Source Category (40 CFR 435, Subparts A and D) as adopted by reference at 18 AAC 83.010(g)(3). In addition, this Permit authorizes discharges from non-oil and gas facilities discharging wastewater with similar characteristics to those from oil and gas facilities including drilling fluids and drill cuttings from geotechnical surveys and HDD projects that discharge to Cook Inlet.

1.5.2   Permittees may request authorization for the following discharges under this Permit:

Discharge Number	Discharge Description
001	Drilling Fluids and Drill Cuttings
002	Deck Drainage
003	Domestic Wastewater
004	Graywater
005	Desalination Unit Wastes
006	Blowout Preventer Fluid
007	Boiler Blowdown
008	Fire Control System Test Water
009	Noncontact Cooling Water
010	Uncontaminated Ballast Water
011	Bilge Water
012	Excess Cement Slurry
013	Mud, Cuttings, and Cement at the Seafloor
014	Waterflooding (Filter Backwash)
015	Produced Water
016	Completion Fluids
017	Workover Fluids
018	Well Treatment Fluids
019	Test Fluids
020	Hydrostatic Test Water

1.6   Area and Depth Prohibitions

1.6.1   The area of coverage for the permit is generally depicted in Figure 1 in Appendix D. An applicant should contact DEC if there is uncertainty whether discharges will be located in a prohibited area. However, the applicant is ultimately responsible for clearly identifying sites in the NOI process with respect to prohibited areas to demonstrate applicability of coverage under the permit.

1.6.2   MODUs conducting oil and gas exploration are prohibited from discharging Drilling Fluids and Drill Cuttings shoreward of 10 meter mean lower low water (MLLW) isobaths.

1.6.3   All fixed platforms or MODUs conducting oil and gas exploration, development, or production are prohibited from discharging shoreward of the 5 meter isobaths.

Appendix A2

CORMIX Manual - Tidal Cycle
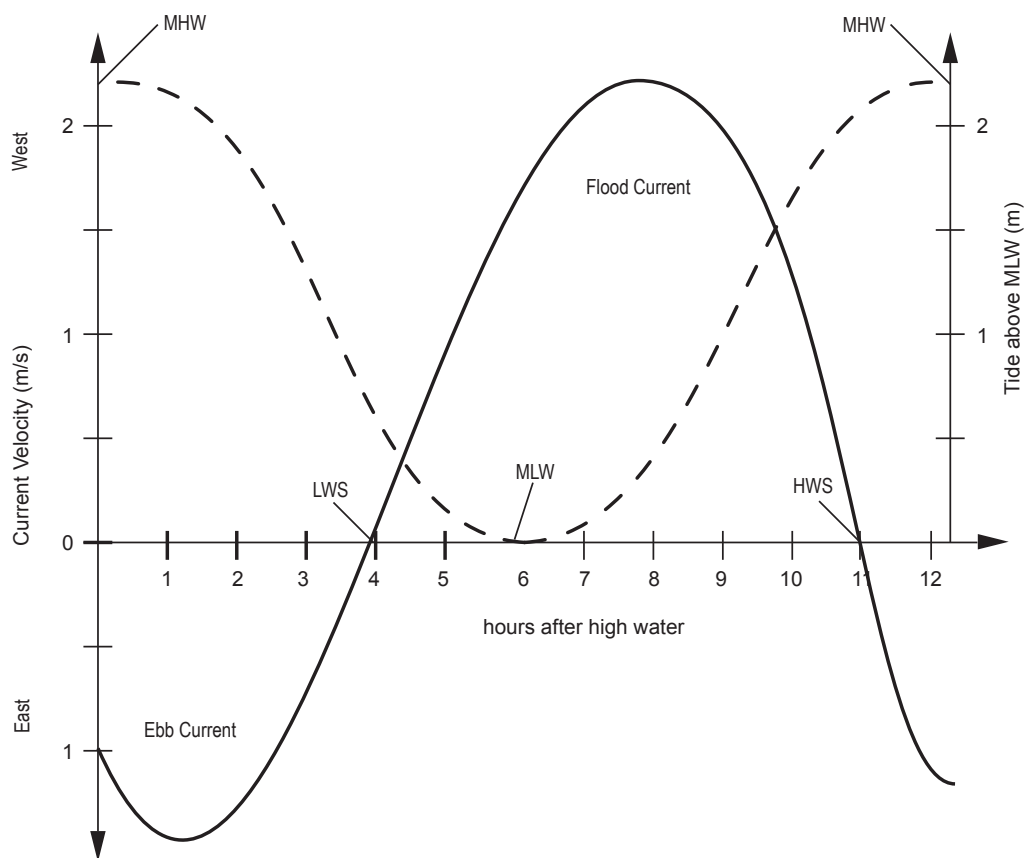
Figure 4.6   *Example of tidal cycle, showing stage and velocity as a function of time after Mean High Water (MHW).*

6. For brine and sediment effluent types, the discharge is assumed to occur in an unbounded coastal environment for simulation purposes. For these effluent types, an offshore bottom slope is assumed with the slope breaking perpendicular to the shoreline, as shown in Figure 4.5. Two slope values are specified - a near-shore slope s_1 and a far-shore slope s_2 - each with a corresponding velocity and roughness value. The change in bottom slope is specified by entering a value of YBREAK from the shoreline. Ambient roughness characteristics are specified as described previously for the bounded case (see Section 4.4). The depth at discharge value (HD) must be consistent with the values for slope and YBREAK or a warning message is issued.

4.4.3 Tidal Reversing Ambient Conditions

When predictions are desired in an unsteady ambient flow field, information on the tidal cycle must be supplied. In general, estuaries or coastal waters can exhibit considerable complexity with variations in velocity magnitude, direction, and water depth. For example, Figure 4.6 shows the time history of tidal velocities and tidal height for a mean tidal cycle at a site in Long Island Sound. The tidal height varies between *Mean Low Water* (MLW) and *Mean High Water* (MHW).

The tidal velocity changes its direction twice during the tidal cycle at each slack tide. One of these times occurs near, but not necessarily coincident with the

MLW and is referred to as *Low Water Slack* (LWS). The slack period near MHW is referred to as *High Water Slack* (HWS). The rate of reversal (time gradient of the tidal velocity) near these slack tides is of considerable importance for the concentration build-up in the transient discharge plume, as tidal reversals will reduce the effective dilution of a discharge by re-entraining the discharge plume remaining from the previous tidal cycle (42). Hence, CORMIX needs some information on the ambient design conditions relative to any of the two slack tides.

The tidal period (PERIOD) must be supplied; in most cases it is 12.4 hours, but in some locations it varies. The maximum tidal velocity (UAmax) for the location must be specified; this can usually be taken as the average of the absolute values of the two actual maxima, independent of their direction. A CORMIX design case consists then of an instantaneous ambient condition, before, at or after one of the two slack tides. Hence, the analyst must specify the time (in hours) before, at, or after slack that defines the design condition, followed by the actual tidal ambient velocity (UA) at that time. The ambient depth conditions are then those corresponding to that time.

In general, tidal simulations should be repeated for several time intervals (usually hourly or bi-hourly intervals will suffice) before and after slack time to determine plume characteristics in unsteady ambient conditions.

Strongly unsteady conditions also occur in other environments, such as wind-induced current reversals in shallow lakes or coastal areas. In this case, any typical reversal period can be analyzed following an approach similar to the above.

4.4.4 Ambient Density Specification

Information about the density distribution in the ambient water body is very important for the correct prediction of effluent discharge plume behavior. CORMIX first inquires whether the ambient water is fresh water or non-fresh (i.e. brackish or saline). If ambient water is fresh and above $4^O C$, the system provides the option of entering ambient temperature data so that the ambient density values can be internally computed from an equation of state. This is the recommended option for specifying the density of fresh water, even though ambient temperature per se is not needed for the analysis of mixing conditions. In the case of salt water conditions, Figure 4.7 is included as a practical guide for specifying the density if "salinity values" in parts-per-thousand (ppt) are available for the water body. Typical open ocean salinities range from 33 to 35 ppt.

The user then specifies whether the ambient density (or temperature) can be considered as uniform or as non-uniform within the water body and in particular, within the expected plume regions. As a practical guide, vertical variation in density of less than 0.1 kg/m^3 or in temperature of less than $1^O C$ can be neglected. For uniform conditions, the average ambient density or average temperature must be specified.

When conditions are non-uniform, CORMIX requires that the actual measured vertical density distribution be approximated by one of three schematic stratification profile types illustrated in Figure 4.8 for most effluent discharges. These are:

* Type A - linear density profile
* Type B - two layer system with constant densities and density jump
* Type C - constant density surface layer with linear density profile in bottom layer separated by a density jump
* Type D - 3-layer ambient density profile, available for coastal brine and/or sediment effluent types only

Corresponding profile types exist for approximating a temperature distribution when it is used for specifying ambient density distribution.

Note: When in doubt about the specification of the ambient density values it is reasonable to first simplify as much as possible. The sensitivity of a given assumption can be explored in subsequent CORMIX simulations. Furthermore,

Density [kg/m^3] = 1000.0 + σ_t
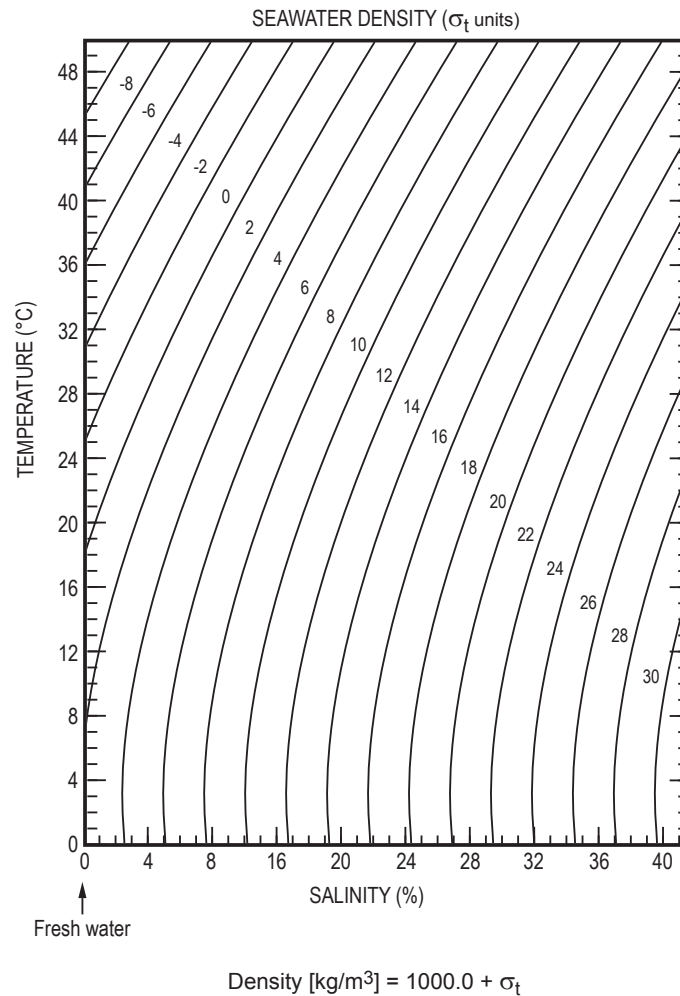
Figure 4.7 *Diagram for density of seawater as a function of temperature and salinity*

if CORMIX indicates a flow configuration (flow class) with near-field stability, additional studies with the post-processor option CorJet (see Section 6.1) can be performed to investigate any arbitrary stable density distribution.

After selecting the stratification approximation to be used, the user then enters all appropriate density (or temperature) values and pycnocline heights (HINT or h_{int}) to fully specify the profiles. The pycnocline is defined as the zone or level of strong density change that separates upper and lower layers of the water column. The program checks the density specification to ensure that stable ambient stratification exists (i.e. density at higher elevations must not exceed that at lower elevations).

Note: A dynamically correct approximation of the actual density distribution should keep a balance between over- and under-estimation of the actual data similar to a best fit in regression analysis. If simulation results indicate internal plume trapping, then it is desirable to test - through repeated use of CORMIX- different approximations (i.e. with different stratification types and/or parameter values) in order to evaluate the sensitivity of the resulting model predictions.

4.4.5 Wind Speed

When specifying the **wind speed (UW)** at design conditions, it should be kept in mind that wind is unimportant for near-field mixing, but may critically

Appendix A3

Hilcorp - Tidal Data and Charts
From Supplemental MZ Study (SMZS) Pdf
Pages 80-82 of 2732

Appendix A-5 August 20, 2008, CTD Cast Figure

August 20, 2008 Tidal Current Speed Estimates and CTD Cast Times
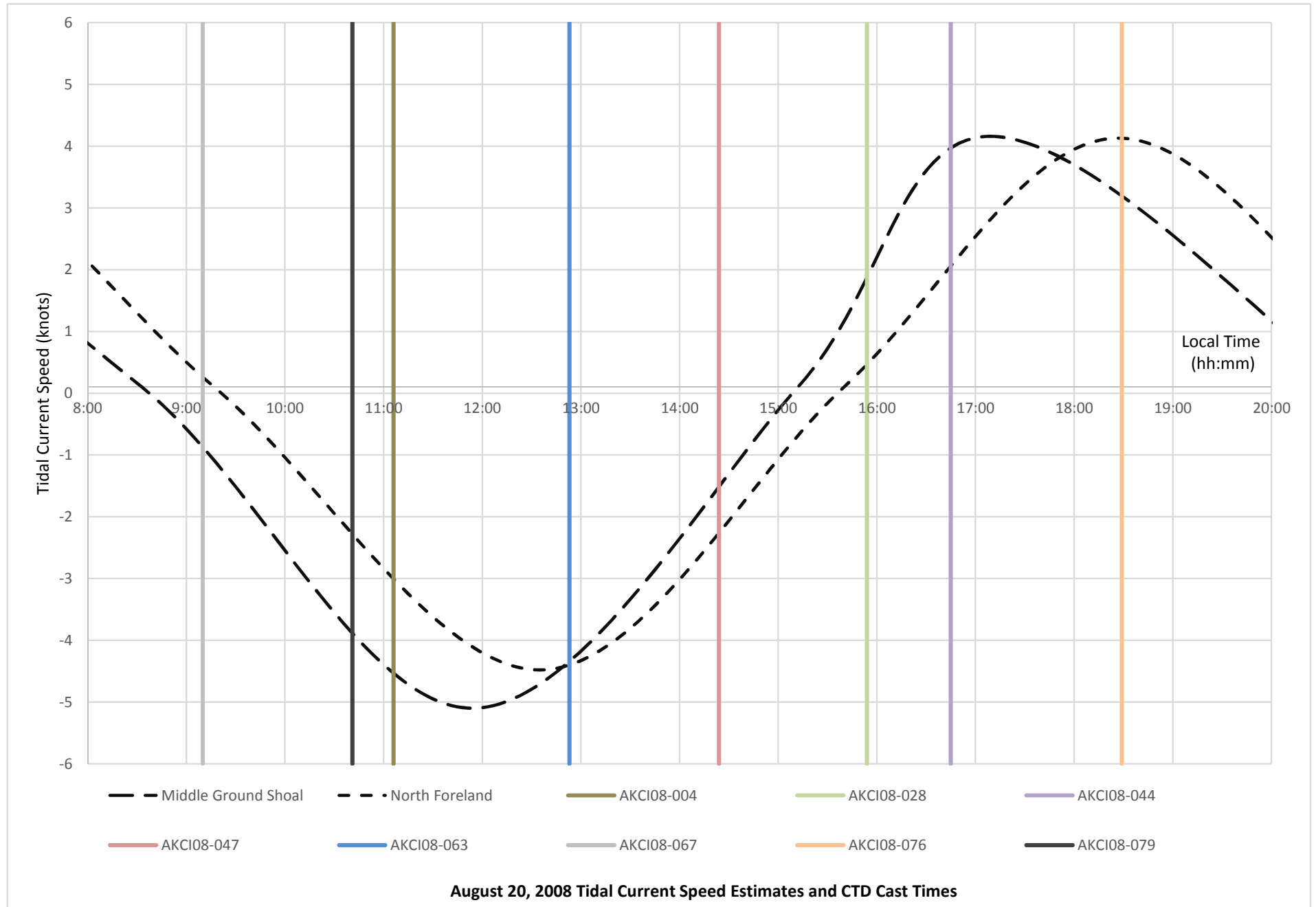
Appendix A-6 August 23, 2008, CTD Cast Figure

August 23, 2008 Tidal Current Speed Estimates and CTD Cast Times
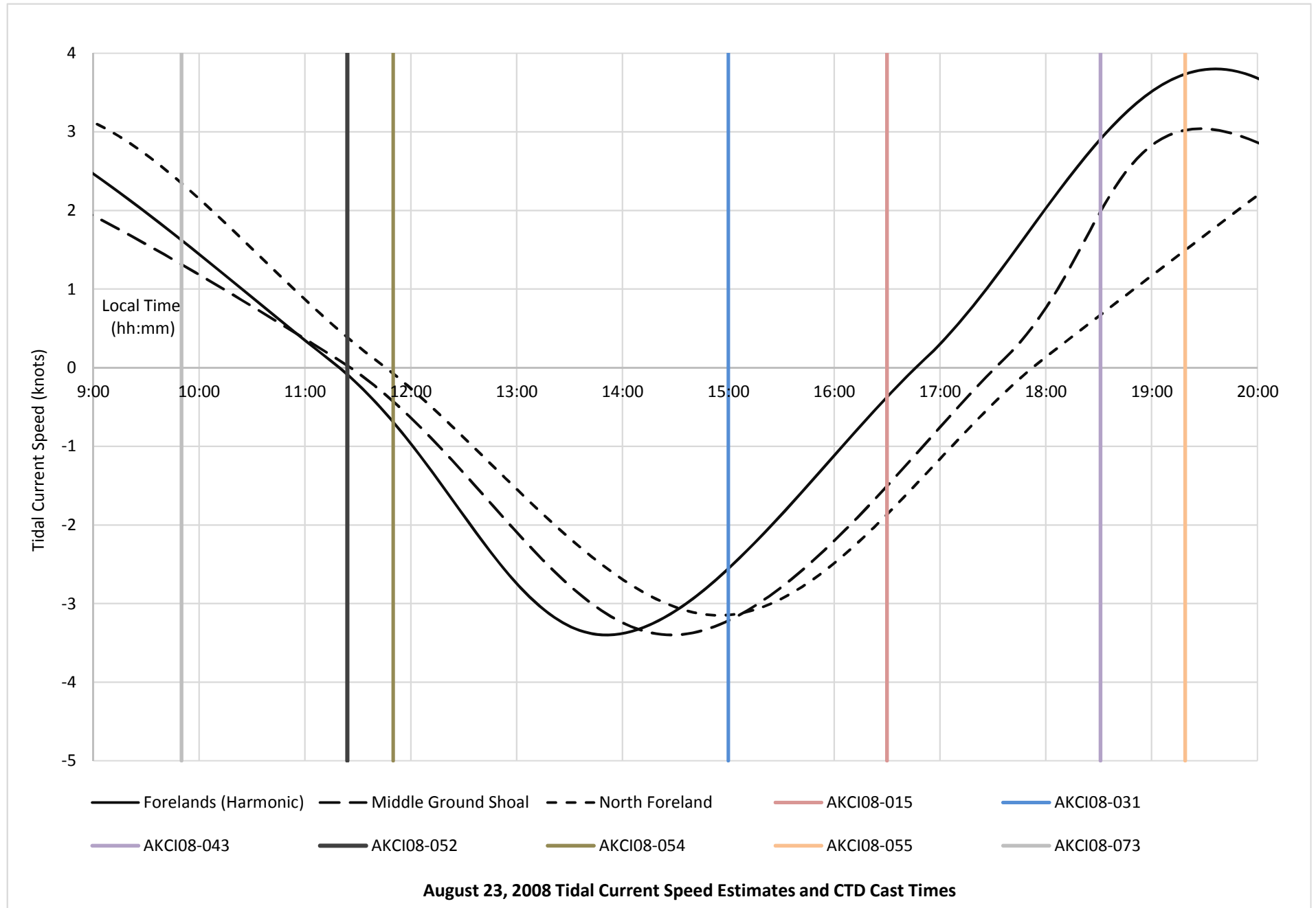
Appendix A-7 August 24, 2008, CTD Cast Figure

August 24, 2008 Tidal Current Speed Estimates and CTD Cast Times
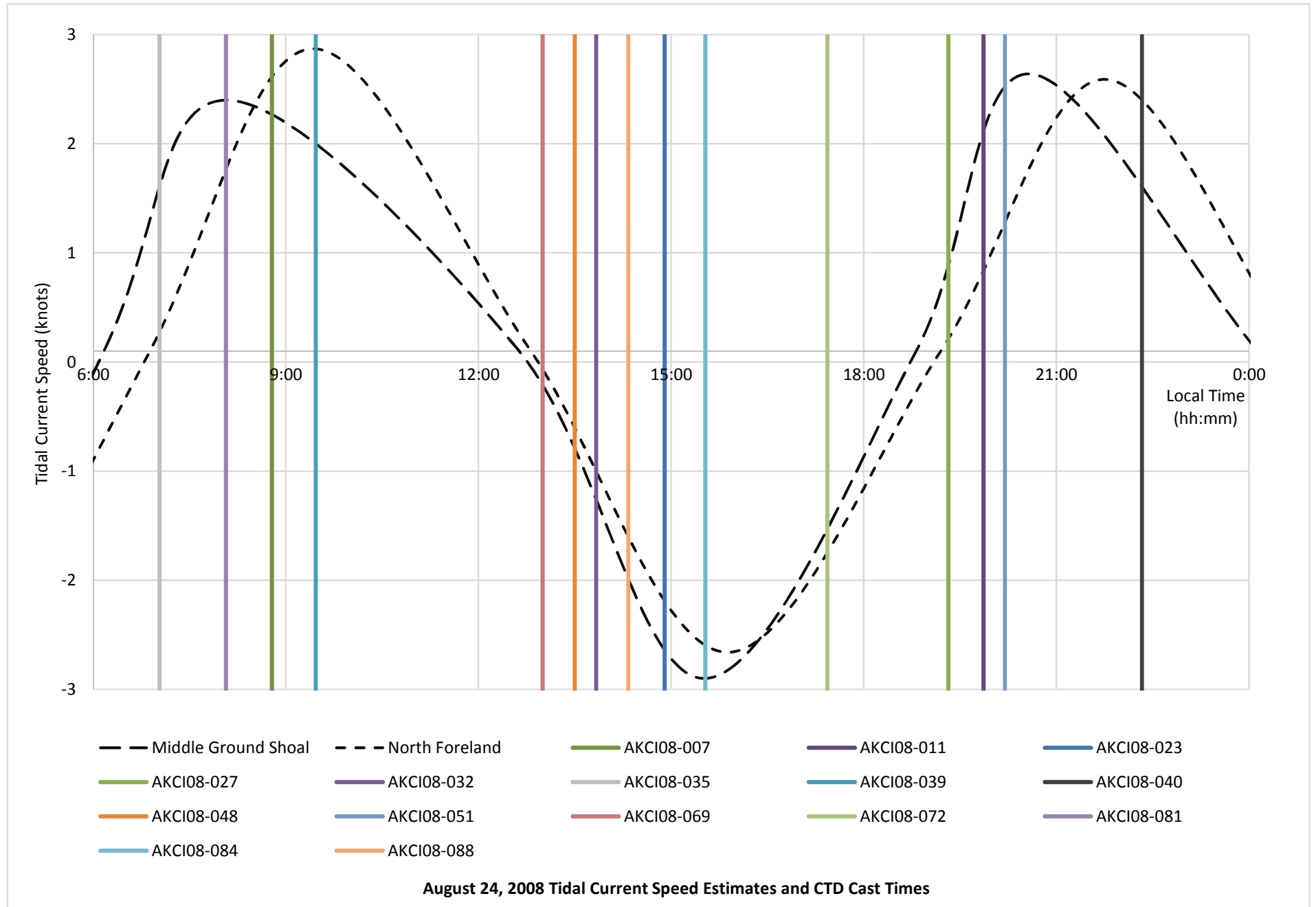
Appendix A4

CORMIX Manual – Session Report
For Estuary with Unsteady Tidal Conditions

Table D.2 *CORMIX Session Report for C-Plant discharge into Estuary with unsteady tidal conditions*

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                     CORMIX MIXING ZONE EXPERT SYSTEM
                        CORMIX-GI Version 5.0GTR
                     HYDRO3:Version-5.0.0.0  October,2006
SITE NAME/LABEL:               C-Plant Estuary
  DESIGN CASE:                 Tidal-1 hour after slack
  FILE NAME:                   C:\cormix\source 5.0\Sample Files\Sample3t.
prd
  Using subsystem CORMIX3:     Buoyant Surface Discharges
  Start of session:            08/29/2006--11:45:33
******************************************************************************
SUMMARY OF INPUT DATA:
------------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                       = unbounded
  Average depth               HA      = 5.65 m
  Depth at discharge          HD      = 5.65 m
  Darcy-Weisbach friction factor  F   = 0.025
  Wind velocity               UW      = 2 m/s
TIDAL SIMULATION at time      Tsim    = 1 hours
  Instantaneous ambient velocity  UA  = 0.22 m/s
  Maximum tidal velocity      UaMAX   = 0.75 m/s
Rate of tidal reversal        dUA/dt  = 0.22 (m/s)/hour
  Period of reversal          T       = 12.4 hours
  Stratification Type         STRCND  = U
  Surface density             RHOAS   = 1018 kg/m^3
  Bottom density              RHOAB   = 1018 kg/m^3
------------------------------------------------------------------------------
DISCHARGE PARAMETERS:         Buoyant Surface Discharge
  Discharge located on                = right bank/shoreline
  Discharge configuration             = flush discharge
  Distance from bank to outlet  DISTB = 0 m
  Discharge angle             SIGMA   = 90 deg
  Depth near discharge outlet  HD0    = 2.15 m
  Bottom slope at discharge   SLOPE   = 11 deg
  Rectangular discharge:
    Discharge cross-section area  A0  = 1.3 m^2
    Discharge channel width     B0    = 2 m
    Discharge channel depth     H0    = 0.65 m
    Discharge aspect ratio      AR    = 0.325
  Discharge flowrate          Q0      = 2.2 m^3/s
  Discharge velocity          U0      = 1.69 m/s
  Discharge temperature (freshwater)  = 22 degC
  Corresponding density       RHO0    = 997.7714 kg/m^3
  Density difference          DRHO    = 20.2286 kg/m^3
  Buoyant acceleration        GP0     = 0.1949 m/s^2
  Discharge concentration     C0      = 80 mg/l
  Surface heat exchange coeff.  KS    = 0 m/s
  Coefficient of decay        KD      = 0 /s
------------------------------------------------------------------------------
```

Table D.2 *Continued*

```
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 1.14 m          Lm  = 8.77 m          Lbb = 40.26 m
  LM  = 4.09 m
UNSTEADY TIDAL SCALES:
  Tu  = 0.2229 hours    Lu  = 39.35 m           Lmin= 2.57 m
  ----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Densimetric Froude number       FR0    = 3.59 (based on LQ)
  Channel densimetric Froude no.  FRCH   = 4.76 (based on H0)
  Velocity ratio                  R      = 7.69
  ----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                      = yes
  CMC concentration               CMC  = 25 mg/l
  CCC concentration               CCC  = 15 mg/l
  Water quality standard specified     = given by CCC value
  Regulatory mixing zone               = yes
  Regulatory mixing zone specification = distance
  Regulatory mixing zone value         = 250 m (m^2 if area)
  Region of interest                   = 2000 m
  ****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
    *-----------------------*
    | FLOW CLASS   = FJ1 |
    *-----------------------*
  ****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

  ----------------------------------------------------------------------------
X-Y-Z Coordinate system:
Origin is located at water surface and at centerline of discharge channel:
    0 m from the right bank/shore.
  Number of display steps NSTEP = 10 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 mg/l
  Dilution at edge of NFR              s = 0
  NFR Location:                        x = 0 m
    (centerline coordinates)           y = 0 m
                                       z = 0 m
  NFR plume dimensions:  half-width (bh) = 0 m
                         thickness (bv) = 0 m
Cumulative travel time:        0 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.
  ----------------------------------------------------------------------------
```

Table D.2 *Continued*

```
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section does not contact bank in this simulation.
--------------------------------------------------------------------------
UNSTEADY TIDAL ASSESSMENT:
 Because of the unsteadiness of the ambient current during the tidal
  reversal, CORMIX predictions have been TERMINATED at:
                                      x = 289.39 m
                                      y = 180.23 m
                                      z = 0 m.
  For this condition AFTER TIDAL REVERSAL, mixed water from the previous
  half-cycle becomes re-entrained into the near field of the discharge,
  increasing pollutant concentrations compared to steady-state predictions.
  A pool of mixed water formed at slack tide will be advected downstream
  in this phase.
*********************** TOXIC DILUTION ZONE SUMMARY ***********************
Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA
  Technical Support Document (TSD) for Water Quality-based Toxics Control,
  1991 (EPA/505/2-90-001).
  Criterion maximum concentration (CMC)  = 25  mg/l
Corresponding dilution                   = 3.2
The CMC was encountered at the following plume position:
  Plume location:                     x = 9.55 m
    (centerline coordinates)          y = 34.26 m
                                      z = 0 m
  Plume dimension:       half-width (bh) = 12.59 m
                          thickness (bv) = 0.82 m
 CRITERION 1: This location is within 50 times the discharge length scale of
              Lq = 1.14 m.
 +++++ The discharge length scale TEST for the TDZ has been SATISFIED. ++++++

 CRITERION 2: This location is within 5 times the ambient water depth of
              HD = 5.65 m.
 ++++++++++ The ambient depth TEST for the TDZ has been SATISFIED.++++++++++

 CRITERION 3: This location is within one tenth the distance of the extent
              of the Regulatory Mixing Zone of 250.10 m downstream.
 +++++ The Regulatory Mixing Zone TEST for the TDZ has been SATISFIED. +++++
 The diffuser discharge velocity is equal to 1.69 m/s.
   This is below the value of 3.0 m/s recommended in the TSD.

 *** All three CMC criteria for the TDZ are SATISFIED for this discharge. ***
********************** REGULATORY MIXING ZONE SUMMARY **********************
The plume conditions at the boundary of the specified RMZ are as follows:
  Pollutant concentration              c = 10.059008  mg/l
  Corresponding dilution               s = 8.0
  Plume location:                      x = 250.10 m
    (centerline coordinates)           y = 167.58 m
                                       z = 0 m
  Plume dimensions:      half-width (bh) = 80.23 m
                          thickness (bv) = 0.39 m
Cumulative travel time < 0 sec. (RMZ is within NFR)
At this position, the plume is NOT IN CONTACT with any bank.
However, the CCC for the toxic pollutant was not encountered within the
  predicted plume region.
******************** FINAL DESIGN ADVICE AND COMMENTS ********************
REMINDER:  The user must take note that HYDRODYNAMIC MODELING by any known
  technique is NOT AN EXACT SCIENCE.
```

Table D.3 *CORMIX3 Prediction File for C-Plant discharge into Estuary with unsteady tidal conditions*

```
CORMIX3 PREDICTION FILE:
33333333333333333333333333333333333333333333333333333333333333333333333
                    CORMIX MIXING ZONE EXPERT SYSTEM
            Subsystem CORMIX3:   Buoyant Surface Discharges
                     CORMIX-GI Version 5.0GTR
                  HYDRO3 Version 5.0.0.0 October 2006
-----------------------------------------------------------------------------
CASE DESCRIPTION
 Site name/label:   C-Plant Estuary
 Design case:       Tidal-1 hour after slack
 FILE NAME:         C:\cormix\source_5.0\Sample Files\Sample3t.prd
 Time stamp:        Tue Aug 29 11:45:33 2006

ENVIRONMENT PARAMETERS (metric units)
 Unbounded section
 HA    =       5.65  HD    =      5.65
 Tidal Simulation at TIME =       1.000 h
 PERIOD=    12.40 h UAmax =       0.750 dUa/dt=       0.220 (m/s)/h
 UA    =      0.220 F     =       0.025 USTAR =0.1230E-01
 UW    =      2.000 UWSTAR=0.2198E-02
 Uniform density environment
 STRCND=   U         RHOAM = 1018.0000

DISCHARGE PARAMETERS (metric units)
 BANK  =  RIGHT      DISTB =      0.00  Configuration: flush_discharge
 SIGMA =     90.00  HD0   =      2.15  SLOPE =   11.00 deg.
 Rectangular channel geometry:
 B0    =      2.000 H0    =      0.650 A0    =0.1300E+01  AR    =       0.325
 U0    =      1.692 Q0    =      2.200       =0.2200E+01
 RHO0  =  997.7714  DRHO0 =0.2023E+02  GP0   =0.1949E+00
 C0    =0.8000E+02  CUNITS=  mg/l
 IPOLL = 1          KS    =0.0000E+00  KD    =0.0000E+00

FLUX VARIABLES (metric units)
 Q0    =0.2200E+01  M0    =0.3723E+01  J0    =0.4287E+00
 Associated length scales (meters)
 LQ    =      1.14  LM    =      4.09  Lm    =      8.77  Lb    =      40.26
 Tidal:            Tu    =   0.2229 h Lu    =      39.347 Lmin  =      2.573

NON-DIMENSIONAL PARAMETERS
 FR0   =      3.59  FRCH  =      4.76  R     =      7.69

FLOW CLASSIFICATION
 33333333333333333333333333333333333333333333333
 3  Flow class (CORMIX3)       =     FJ1    3
 3  Applicable layer depth HS =     5.65   3
 33333333333333333333333333333333333333333333333

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.8000E+02  CUNITS=  mg/l
 NTOX  = 1          CMC   =0.2500E+02  CCC   =  CSTD
 NSTD  = 1          CSTD  =0.1500E+02
```

Table D.3 *Continued*

```
 REGMZ =  1
 REGSPC=  1          XREG  =    250.00  WREG  =      0.00  AREG  =      0.00
 XINT  =   2000.00  XMAX  =   2000.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the WATER SURFACE and at center of discharge
      channel/outlet:      0.00 m  from the RIGHT bank/shore.
    X-axis points downstream
    Y-axis points to left as seen by an observer looking downstream
    Z-axis points vertically upward (in CORMIX3, all values Z = 0.00)
NSTEP =  10 display intervals per module
-----------------------------------------------------------------------
BEGIN MOD301: DISCHARGE MODULE
Efflux conditions:
       X         Y         Z         S         C         BV        BH
      0.00      0.00      0.00      1.0 0.800E+02   0.65      1.00


END OF MOD301: DISCHARGE MODULE
-----------------------------------------------------------------------
BEGIN MOD302: ZONE OF FLOW ESTABLISHMENT
 Control volume inflow:
       X         Y         Z         S         C         BV        BH
      0.00      0.00      0.00      1.0 0.800E+02   0.65      1.00


 Profile definitions:
   BV = Gaussian 1/e (37%) vertical thickness
   BH = Gaussian 1/e (37%) horizontal half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)

  Control volume outflow:                              SIGMAE=     89.20
       X         Y         Z         S         C         BV        BH
      0.09      6.54      0.00      1.0 0.800E+02   0.54      1.85
 Cumulative travel time =            3.8660 sec

END OF MOD302: ZONE OF FLOW ESTABLISHMENT
-----------------------------------------------------------------------
BEGIN CORSURF (MOD310): BUOYANT SURFACE JET - NEAR-FIELD REGION

 Surface jet in deep crossflow with strong buoyancy effects.

 Profile definitions:
   BV = Gaussian 1/e (37%) vertical thickness
   BH = Gaussian 1/e (37%) horizontal half-width, normal to trajectory
   S = hydrodynamic centerline dilution
   C = centerline concentration (includes reaction effects, if any)


       X         Y         Z         S         C         BV        BH
      0.09      6.54      0.00      1.0 0.800E+02   0.54      1.85
** CMC HAS BEEN FOUND **
```

Table D.3 *Continued*

```
   The pollutant concentration in the plume falls below CMC value of 0.250E+02
     in the current prediction interval.
   This is the extent of the TOXIC DILUTION ZONE.
       22.78    51.16    0.00    3.7 0.219E+02   0.71    20.12
       61.61    83.04    0.00    4.1 0.196E+02   0.57    35.37
      105.07   108.40    0.00    4.2 0.190E+02   0.50    48.25
      150.98   130.04    0.00    4.3 0.187E+02   0.45    59.67
      197.66   148.90    0.00    4.3 0.185E+02   0.42    69.89
      245.06   165.87    0.00    4.4 0.183E+02   0.39    79.28
   ** REGULATORY MIXING ZONE BOUNDARY is within the Near-Field Region (NFR) **
   In this prediction interval the plume DOWNSTREAM distance meets or exceeds
   the regulatory value =   250.00 m.
   This is the extent of the REGULATORY MIXING ZONE.
      289.39   180.23    0.00    4.4 0.181E+02   0.37    87.35
   Cumulative travel time =        1120.7694 sec

    CORMIX prediction has been TERMINATED at last prediction interval.
      Limiting distance due to TIDAL REVERSAL has been reached.

   END OF CORSURF (MOD310): BUOYANT SURFACE JET - NEAR-FIELD REGION
   -------------------------------------------------------------------------
   CORMIX3: Buoyant Surface Discharges                 End of Prediction File
   3333333333333333333333333333333333333333333333333333333333333333333333333333
```

Appendix A5

Acute and Chronic MZ Size Comparison
Between the Present 2007 and Draft 2019 Permits

Table A5. Acute and Chronic MZ Size Comparison between the Present 2007 Permit and the Draft Permit 2019

| | | **2007 GP** Chronic Boundary | | | | acute boundary | | | | | |
		meters	feet		meters	feet		meters	feet		meters	feet
TBPF	Length (L)=	2418	7,933.1	Width (W)=	360	1181.1	L=	1	3.3	W=	80	262.5
MGS Onshore	Length (L)=	1749	5,738.2	Width (W)=	8	26.2	L=	142	465.9	W=	1	3.3
GPTF	Length (L)=	2685	8,809.1	Width (W)=	20	65.6	L=	19	62.3	W=	1	3.3
Baker	Length (L)=	3016	9,895.0	Width (W)=	6.6	21.7	L=	202	662.7	W=	26	85.3
Bruce	Length (L)=	1840	6,036.7	Width (W)=	11	36.1	L=	201	659.4	W=	26	85.3
Dillon	Length (L)=	2121	6,958.7	Width (W)=	6.6	21.7	L=	11	36.1	W=	1	3.3
Tyonek A	Length (L)=	60	196.9	Width (W)=	1	3.3	L=	36	118.1	W=	1	3.3
Osprey	Length (L)=	-----		Width (W)=	-----		L=	-----		W=	-----	

| | | **Current (2019 Draft) Permit** Chronic Boundary | | | | acute boundary | | | | | |
		meters	feet		meters	feet		meters	feet		meters	feet
TBPF	Length (L)=	4521	14832.7	Width (W)=	1872	6141.7	L=	2	6.6	W=	81	265.7
MGS Onshore	Length (L)=	3299	10823.5	Width (W)=	483	1584.6	L=	115	377.3	W=	27	88.6
GPTF	Length (L)=	698	2290.0	Width (W)=	546	1791.3	L=	4	13.1	W=	4	13.1
Baker	Length (L)=	1188	3897.6	Width (W)=	444	1456.7	L=	86	282.2	W=	28	91.9
Bruce	Length (L)=	860	2821.5	Width (W)=	370	1213.9	L=	160	524.9	W=	62	203.4
Dillon	Length (L)=	169	554.5	Width (W)=	856	2808.4	L=	20	65.6	W=	14	45.9
Tyonek A	Length (L)=	286	938.3	Width (W)=	114	374.0	L=	158	518.4	W=	63	206.7
Osprey	Length (L)=	1060	3477.7	Width (W)=	438	1437.0	L=	13	42.7	W=	13	42.7

Conversions
0.3048 m/ft

Appendix A6

Table 3a. Increase in Toxic Contaminants for Trading Bay Production Facility (Existing TBPF)
Based on FINAL Permit Table 7-B7 for **Existing** Flow for Produced Water

a.) Average Monthly

Effluent Concentration Limitations

Parameter		Avg. Monthly Final[B]	Avg. Monthly Previous[C]	Percent[D] of	Change Comment[E]
Effluent Flow[A]	MGD	5.60	2.74	204.1%	-----
TAH	mg/l	18.0	12.2	147.5%	-----
TAqH	mg/l	------	18.3	Not Limited	Limit Removed
Ammonia	mg/l	------	NC[C]	Not Limited	Draft Removed
Total Copper	ug/l	47.0	93.4	50.3%	-----
Total Lead	*ug/l*	------	*605*	Not Limited	Limit Removed
Total Mercury	ug/l	0.6	**0.12**	500%	ADDED
Total Manganese	mg/l	25.0	**1.89**	1,323%	ADDED
Total Nickel	mg/l	------	**0.115**	Not Limited	Draft Removed
Total Silver	*ug/l*	*23.0*	**1.44**	1,597%	ADDED
Total Zinc	mg/l	*0.90*	**0.0069**	13,043%	ADDED
Acute WET[F]	TU$_a$	------	------	Not Limited	-----
Chronic WET[F]	TU$_c$	283	96	294.8%	-----

Pollutant Mass Loads (lbs/day)

Avg. Monthly Final[B]	Avg. Monthly Previous[C]	Percent[D] of
5.60	2.74	204.1%
840.5	279.1	301.2%
------	418.6	------
------	-----	-----
2.2	2.1	102.7%
------	*13.8*	-----
0.028	0.003	1,021%
1167.3	43.2	2700.1%
------	2.6	------
1.1	*0.0*	3260.4%
42.0	0.2	26,626%
------	------	
------	------	

b.) Maximum Daily

Effluent Concentration Limitations

Parameter		Daily Max. Final[B]	Daily Max. Previous[C]	Percent[D] of	Change Comment[E]
Effluent Flow[A]	MGD	5.60	2.74	204.1%	-----
TAH	mg/l	27	24.5	110.2%	-----
TAqH	mg/l	------	36.8	Not Limited	Limit Removed
Ammonia	mg/l	------	NC[C]	Not Limited	Draft Removed
Total Copper	ug/l	117	136	86.0%	-----
Total Lead	*ug/l*	------	*883*	Not Limited	Limit Removed
Total Mercury	ug/l	1.0	**0.95**	105%	ADDED
Total Manganese	mg/l	50	**24.95**	200.4%	ADDED
Total Nickel	mg/l	------	**1.518**	Not Limited	Draft Removed
Total Silver	*ug/l*	*47*	**19.01**	247.2%	ADDED
Total Zinc	mg/l	1.9	**0.0911**	2,086%	ADDED
Acute WET[F]	TU$_a$	------	------	Not Limited	-----
Chronic WET[F]	TU$_c$	586	140	418.6%	-----

Pollutant Mass Loads (lbs/day)

Daily Max. Final[B]	Daily Max. Previous[C]	Percent[D] of
5.60	2.74	204.1%
1260.7	560.4	225.0%
------	841.8	------
------	**-----**	**-----**
5.5	3.1	175.6%
------	*20.2*	-----
0.05	0.022	215%
2334.6	570.7	409.1%
------	34.7	------
2.2	*0.4*	504.7%
88.7	2.1	4,257%
------	------	
------	**------**	

[A] Facility concentration effluent limits are based on these flows (see Table 2, Page 34 of 73, Final Fact Sheet, 2007)

Corresponds to MZ Lengths and Dilutions from Final 401 Certification (Tables 2b & 2c), see DEC/Parametrix file "Trading Bay summer 90th.ses"

[B] Final is the 2007 Final NPDES Permit, Fact Sheet and 401 Certification.

[C] Previous is the 1999 NPDES Permit, Fact Sheet and 401 Certification.

[D] Percent of final over previous permit limits where 100% represents no change.

[E] Change comment regarding effluent limitations added or dropped for final permit, compared to the previous permit.

[F] Whole Effluent Toxicity (WET) has two components acute and chronic WET

conversions:	
8.34	[lbs/Mgal]/[mg/l]
1000	ug/mg

Bold indicates this value is from the MZ Application-Effluent Analysis Historical Data.
Bolded data are not reported in the draft permit. [Parametrix, 2005a, page C-6, Table C-1f]

Appendix B

Draft Permit Loadings (lb/d) for Produced Water
By Discharge Pollutant Type (Appendix B1)
And Facility (Appendix B2)

Appendix B1

Draft Permit Loadings (lb/d) for Produced Water
By Discharge Pollutant Type

Table B1-1. Produced Water Loadings (lb/d) - All Facilities
For Oil and Grease from concentrations in mg/l

	AML Flow Rate (mgd)	Loading pounds-per-day (lb/d)		Per Year 365 days Loading pounds-per-year (lb/yr)	
		AML basis	MDL basis	AML basis	MDL basis
TBPF	8.4	2031.6	2942.4	741,543	1,073,958
MGS Onshore	0.365	88.3	127.9	32,222	46,666
GPTF	0.195	47.2	68.3	17,214	24,931
Baker Platform	0.045	10.9	15.8	3,973	5,753
Bruce Platform	0.025	6.0	8.8	2,207	3,196
Dillon Platform	0.195	47.2	68.3	17,214	24,931
Tyonek A	0.038	9.2	13.3	3,355	4,858
Osprey	1.05	254.0	367.8	92,693	134,245
Totals:				910,420	1,318,540

Table B1-2. Produced Water Loadings (lb/d) - All Facilities

For TAH from concentrations in mg/l

	AML Flow Rate (mgd)	Loading pounds-per-day (lb/d)		Per Year 365 days Loading pounds-per-year (lb/yr)	
		AML basis	MDL basis	AML basis	MDL basis
TBPF	8.4	840.7	1191.0	306,845	434,697
MGS Onshore	0.365	60.9	85.2	22,222	31,111
GPTF	0.195	22.8	32.5	8,310	11,872
Baker Platform	0.045	12.8	17.6	4,657	6,438
Bruce Platform	0.025	6.5	9.6	2,359	3,501
Dillon Platform	0.195	50.4	68.3	18,402	24,931
Tyonek A Platform	0.038	0.0	13.3	10	4,858
Osprey Platform	1.05	67.4	78.8	24,612	28,767
			Totals:	387,418	546,175

Table B1-3. Produced Water Loadings (lb/d) - All Facilities

For Copper from concentrations in ug/l

	AML	Loading (lb/d)		Per Year 365 days Loading pounds-per-year (lb/yr)	
	Flow Rate (mgd)	AML	MDL	AML basis	MDL basis
TBPF	8.4	0.84	1.54	307	563
MGS Onshore	0.365	0.16	0.24	59	88
GPTF	0.195	0.03	0.09	12	32
Baker Platform	0.045	0.16	0.33	60	120
Bruce Platform	0.025	0.30	0.60	109	218
Dillon Platform	0.195	0.02	0.02	6	8
Tyonek A Platform	0.038	0.10	0.33	38	119
Osprey Platform	1.05	0.85	1.71	310	623
			Totals:	900	1,771

Table B1-4. Produced Water Loadings (lb/d) - All Facilities

For Silver from concentrations in ug/l

	AML Flow Rate (mgd)	Loading (lb/d) AML	Loading (lb/d) MDL	Per Year 365 days Loading pounds-per-year (lb/yr) AML basis	MDL basis
TBPF	8.4	1.611	3.293	588	1,202
MGS Onshore	0.365	0.058	0.146	21.1	53.3
GPTF	0.195	0.060	0.120	22.0	43.9
Baker Platform	0.045	0.065	0.130	23.7	47.5
Bruce Platform	0.025	0.002	0.002	0.6	0.8
Dillon Platform	0.195	0.031	0.078	11.3	28.5
Tyonek A Platform	0.038	0.065	0.130	23.7	47.5
Osprey Platform	1.05	-----	-----	-----	-----
			Totals:	690	1,423

Table B1-5. Produced Water Loadings (lb/d) - All Facilities

For Zinc from concentrations in mg/l

	AML Flow Rate (mgd)	Loading (lb/d)		Per Year 365 days Loading pounds-per-year (lb/yr)	
		AML	MDL	AML basis	MDL basis
TBPF	8.4	63.1	133.1	23,013	48,584
MGS Onshore	0.365	67.0	173.5	24,444	63,333
GPTF	0.195	2.4	5.0	890	1,840
Baker Platform	0.045	2.3	4.9	822	1,781
Bruce Platform	0.025	2.1	5.2	761	1,903
Dillon Platform	0.195	2.0	3.7	712	1,365
Tyonek A Platform	0.038	2.7	5.4	972	1,966
Osprey Platform	1.05	-----	-----	-----	-----
			Totals:	51,615	120,772

Table B1-6. Produced Water Loadings (lb/d) - All Facilities

For Mercury from concentrations in ug/l

	AML Flow Rate (mgd)	Loading (lb/d)		Per Year 365 days Loading pounds-per-year (lb/yr)	
		AML	MDL	AML basis	MDL basis
TBPF	8.4	0.0420	0.0701	15.3	25.6
MGS Onshore	0.365	0.0116	0.0289	4.2	10.6
GPTF	0.195	0.0050	0.0128	1.8	4.7
Baker Platform	0.045	0.0001	0.0002	0.041	0.055
Bruce Platform	0.025	0.0008	0.0019	0.282	0.700
Dillon Platform	0.195	0.0020	0.0041	0.712	1.484
Tyonek A Platform	0.038	0.00002	0.00003	0.006	0.012
Osprey Platform	1.05	-----	-----	-----	-----
Totals:				22.4	43.1

Table B1-7. Produced Water Loadings (lb/d) - All Facilities

For Manganese from concentrations in mg/l

| | Flow Rate (mgd) | Loading (lb/d) | | Per Year 365 days Loading pounds-per-year (lb/yr) | |
		AML	MDL	AML basis	MDL basis
TBPF	8.4	1751.4	3502.8	639,261	1,278,522
MGS Onshore	0.365	22.5	45.1	8,222	16,444
GPTF	0.195	9.9	20.0	3,621	7,301
Baker Platform	0.045	2.7	5.3	973	1,945
Bruce Platform	0.025	1.5	3.0	548	1,096
Dillon Platform	0.195	3.7	7.5	1,365	2,731
Tyonek A Platform	0.038	0.0	0.1	11.6	23.1
Osprey Platform	1.05	-----	-----	-----	-----
			Totals:	654,001	1,308,062

Appendix B2

Draft Permit Loadings (lb/d) for Produced Water
By Facility

Table B2-1. Trading Bay Production Facility Effluent Loadings (lb/day)

For Produced Water 015 Discharges - 2019 (draft) Permit Derived from Table 13

	MGD	Based on Permitted Average Facility Flow AML	Based on Permitted Average Facility Flow MDL	Loading lb/day
Flow Rate (mgd)	8.4			
Oil and Grease (mg/L)	8.4	29		2,031.6
	8.4		42	2,942.4
TAH (mg/L)	8.4	12		840.7
	8.4		17	1,191.0
Copper (ug/L)	8.4	12		0.8
	8.4		22	1.5
TAqH (mg/L)	8.4	Not Limited		
	8.4		Not Limited	
Silver (ug/L)	8.4	23		1.61
	8.4		47	3.3
Zinc (mg/L)	8.4	0.9		63.1
	8.4		1.9	133.1
Mercury (ug/L)	8.4	0.6		0.042
	8.4		1	0.070
Manganese (mg/L)	8.4	25		1,751.4
	8.4		50	3,502.8
WET (TUc)	8.4			0.0
	8.4			0.0

Conversion Factor: 8.34 to lb/d for mg/l

0.00834 to lb/d for ug/l

Table B2-2. MGS Onshore Effluent Loadings (lb/day)

For Produced Water 015 Discharges - 2019 (draft) Permit Derived from Table 14

	MGD	Based on Permitted Average Facility Flow		Loading
		AML	MDL	lb/day
Flow Rate (mgd)	0.365			
Oil and Grease (mg/L)	0.365	29		88.3
	0.365		42	127.9
TAH (mg/L)	0.365	20		60.9
	0.365		28	85.2
Copper (ug/L)	0.365	53		0.161
	0.365		79	0.240
TAqH (mg/L)	0.365	Not Limited		
	0.365		Not Limited	
Silver (ug/L)	0.365	19		0.058
	0.365		48	0.146
Zinc (mg/L)	0.365	22		67.0
	0.365		57	173.5
Mercury (ug/L)	0.365	3.8		0.012
	0.365		9.5	0.029
Manganese (mg/L)	0.365	7.4		22.5
	0.365		14.8	45.1
WET (TUc)	0.365			0.0
	0.365			0.0

Conversion Factor: 8.34   to lb/d for mg/l

0.00834   to lb/d for ug/l

Table B2-3: Granite Point Tank Farm Effluent Loadings (lb/day)

For Produced Water 015 Discharges - 2019 (draft) Permit Derived from Table 15

	MGD	Based on Permitted Average Facility Flow		Loading
		AML	MDL	lb/day
Flow Rate (mgd)	0.195			
Oil and Grease (mg/L)	0.195	29		47.2
	0.195		42	68.3
TAH (mg/L)	0.195	14		22.8
	0.195		20	32.5
Copper (ug/L)	0.195	21		0.034
	0.195		54	0.088
TAqH (mg/L)	0.195	Not Limited		
	0.195		Not Limited	
Silver (ug/L)	0.195	37		0.060
	0.195		74	0.120
Zinc (mg/L)	0.195	1.5		2.4
	0.195		3.1	5.0
Mercury (ug/L)	0.195	3.1		0.005
	0.195		7.9	0.013
Manganese (mg/L)	0.195	6.1		9.9
	0.195		12.3	20.0
WET (TUc)	0.195			0.0
	0.195			0.0

Conversion Factor: 8.34 to lb/d for mg/l

0.00834 to lb/d for ug/l

Table B2-4. Baker Platform Effluent Loadings (lb/day)

For Produced Water 015 Discharges - 2019 (draft) Permit Derived from Table 16

	MGD	Based on Permitted Average Facility Flow		Loading
		AML	MDL	lb/day
Flow Rate (mgd)	0.045			
Oil and Grease (mg/L)	0.045	29		10.9
	0.045		42	15.8
TAH (mg/L)	0.045	34		12.8
	0.045		47	17.6
Copper (ug/L)	0.045	435		0.163
	0.045		873	0.328
TAqH (mg/L)	0.045	Not Limited		
	0.045		Not Limited	
Silver (ug/L)	0.045	173		0.065
	0.045		347	0.130
Zinc (mg/L)	0.045	6		2.3
	0.045		13	4.9
Mercury (ug/L)	0.045	0.3		0.0001
	0.045		0.4	0.0002
Manganese (mg/L)	0.045	7.1		2.7
	0.045		14.2	5.3
WET (TUc)	0.045			0.0
	0.045			0.0

Conversion Factor: 8.34   to lb/d for mg/l

                            0.00834   to lb/d for ug/l

Table B2-5.   Bruce Platform Effluent Loadings (lb/day)

For Produced Water 015 Discharges - 2019 (draft) Permit Derived from Table 17

	MGD	Based on Permitted Average Facility Flow		Loading
		AML	MDL	lb/day
Flow Rate (mgd)	0.025			
Oil and Grease (mg/L)	0.025	29		6.0
	0.025		42	8.8
TAH (mg/L)	0.025	31		6.5
	0.025		46	9.6
Copper (ug/L)	0.025	1429		0.298
	0.025		2867	0.598
TAqH (mg/L)	0.025	Not Limited		
	0.025		Not Limited	
Silver (ug/L)	0.025	7.3		0.002
	0.025		11	0.002
Zinc (mg/L)	0.025	10		2.1
	0.025		25	5.2
Mercury (ug/L)	0.025	3.7		0.0008
	0.025		9.2	0.0019
Manganese (mg/L)	0.025	7.2		1.5
	0.025		14.4	3.0
WET (TUc)	0.025			0.0
	0.025			0.0

Conversion Factor: 8.34   to lb/d for mg/l

0.00834   to lb/d for ug/l

Table B2-6. Dillon Platform Effluent Loadings (lb/day)

For Produced Water 015 Discharges - 2019 (draft) Permit Derived from Table 18

	MGD	Based on Permitted Average Facility Flow		Loading
	MGD	AML	MDL	lb/day
Flow Rate (mgd)	0.195			
Oil and Grease (mg/L)	0.195	29		47.2
	0.195		42	68.3
TAH (mg/L)	0.195	31		50.4
	0.195		42	68.3
Copper (ug/L)	0.195	9.3		0.015
	0.195		14	0.023
TAqH (mg/L)	0.195	Not Limited		
	0.195		Not Limited	
Silver (ug/L)	0.195	19		0.031
	0.195		48	0.078
Zinc (mg/L)	0.195	1.2		2.0
	0.195		2.3	3.7
Mercury (ug/L)	0.195	1.2		0.0020
	0.195		2.5	0.0041
Manganese (mg/L)	0.195	2.3		3.7
	0.195		4.6	7.5
WET (TUc)	0.195			0.0
	0.195			0.0

Conversion Factor: 8.34   to lb/d for mg/l

               0.00834   to lb/d for ug/l

Table B2-7. Tyonek A Platform Effluent Loadings (lb/day)

For Produced Water 015 Discharges - 2019 (draft) Permit Derived from Table 19

	MGD	Based on Permitted Average Facility Flow AML	Based on Permitted Average Facility Flow MDL	Loading lb/day
Flow Rate (mgd)	0.038			
Oil and Grease (mg/L)	0.038	29		9.2
	0.038		42	13.3
TAH (mg/L)	0.038	0.09		0.0
	0.038		42	13.3
Copper (ug/L)	0.038	328		0.104
	0.038		1033	0.327
TAqH (mg/L)	0.038	Not Limited		
	0.038		Not Limited	
Silver (ug/L)	0.038	205		0.065
	0.038		411	0.130
Zinc (mg/L)	0.038	8.4		2.7
	0.038		17	5.4
Mercury (ug/L)	0.038	0.05		0.0000
	0.038		0.1	0.0000
Manganese (mg/L)	0.038	0.1		0.03
	0.038		0.2	0.1
WET (TUc)	0.038			0.0
	0.038			0.0

Conversion Factor: 8.34   to lb/d for mg/l

                      0.00834   to lb/d for ug/l

Table B2-8. Osprey Platform Effluent Loadings (lb/day)

For Produced Water 015 Discharges - 2019 (draft) Permit Derived from Table 20

	MGD	Based on Permitted Average Facility Flow		Loading
		AML	MDL	lb/day
Flow Rate (mgd)	1.05			
Oil and Grease (mg/L)	1.05	29		254.0
	1.05		42	367.8
TAH (mg/L)	1.05	7.7		67.4
	1.05		9	78.8
Copper (ug/L)	1.05	97		0.849
	1.05		195	1.708
TAqH (mg/L)	1.05	Not Limited		
	1.05		Not Limited	
Silver (ug/L)	1.05			
	1.05		Report	
Zinc (mg/L)	1.05			
	1.05		Report	
Mercury (ug/L)	1.05			
	1.05		Report	
Manganese (mg/L)	1.05			
	1.05		Report	
WET (TUc)	1.05			
	1.05			

Conversion Factor: 8.34   to lb/d for mg/l

0.00834   to lb/d for ug/l

Appendix C

Produced Water Facilities
Effluent Limitations and Monitoring Requirements

Appendix C1

Produced Water Facilities
Effluent Limitations and Monitoring Requirements
For AML and MDL
Comparisons between 2019 (draft) and 2007 Permits

Table C1-1a. Trading Bay Production Facility Effluent Limitations and Monitoring Requirements

For Produced Water 015 Discharges

AML Comparison between 2019 (draft) and 2007 Permits

Parameter (Units)	AML Effluent Limitations			Monitoring Requirements	
	AML (2019 Draft)	AML (2007)	Comment	Frequency (2019 Draft)*	Frequency (2007)*
Flow Rate (mgd)	8.4	None	-----------------	l/Week	None
pH (Standard Units (SU))	6.0 < pH < 9.0		-----------------	1/Week	None
Oil and Grease (mg/L)	29	None	-----------------	1/Week	None
TAH (mg/L)	12	18	Reduced to 67%	l/Month	l/Month
Copper (ug/L)	12	47	Reduced to 26%	l/Quarter	l/Month
TAqH (mg/L)	Report			l/Quarter	l/Month
Silver (ug/L)	23	23	No Change	l/Quarter	l/Month
Zinc (mg/L)	0.9	0.9	No Change	l/Quarter	l/Month
Mercury (ug/L)	0.6	0.6	No Change	l/Quarter	l/Month
Manganese (mg/L)	25	25	No Change	l/Quarter	l/Month
WET (TUc)	None, Report	568 TU$_c$	Criterion Removed	None	1/Quarter

*All sample types are grab samples except 2019 WET, which may be grab or composite sample. The permit allows the facility flow rate to be either measured or estimated.

Table C1-1b. Trading Bay Production Facility Effluent Limitations and Monitoring Requirements

For Produced Water 015 Discharges

MDL Comparison between 2019 (draft) and 2007 Permits

Parameter (Units)	MDL Effluent Limitations			Monitoring Requirements	
	MDL (2019 Draft)	MDL (2007)	Comment	Frequency (2019 Draft)*	Frequency (2007)*
Flow Rate (mgd)	Report	None	-----------------	l/Week	None
pH (Standard Units (SU))	6.0 < pH < 9.0		-----------------	1/Week	None
Oil and Grease (mg/L)	42	None	-----------------	1/Week	None
TAH (mg/L)	17	27	Reduced to 63%	l/Month	l/Month
Copper (ug/L)	22	117	Reduced to 19%	l/Quarter	l/Month
TAqH (mg/L)	Report			l/Quarter	l/Month
Silver (ug/L)	47	47	No Change	l/Quarter	l/Month
Zinc (mg/L)	1.9	1.9	No Change	l/Quarter	l/Month
Mercury (ug/L)	1	1	No Change	l/Quarter	l/Month
Manganese (mg/L)	50	50	No Change	l/Quarter	l/Month
WET (TUc)	None, Report	283 TU$_c$	Criterion Removed	l/Quarter	1/Quarter

*All sample types are grab samples except 2019 WET, which may be grab or composite sample. The permit allows the facility flow rate to be either measured or estimated.

Table C1-2a. MGS Onshore Effluent Limitations and Monitoring Requirements

For Produced Water 015 Discharges

AML Comparison between 2019 (draft) and 2007 Permits

Parameter (Units)	AML Effluent Limitations			Monitoring Requirements	
	AML (2019 Draft)	**AML (2007)**	**Comment**	**Frequency (2019 Draft)***	**Frequency (2007)***
Flow Rate (mgd)	0.365	None	-----------------	l/Week	None
pH (Standard Units (SU))	6.0 < pH < 9.0		-----------------	1/Week	None
Oil and Grease (mg/L)	29	None	-----------------	1/Week	None
TAH (mg/L)	12	24	Reduced to 50%	l/Month	l/Month
Copper (ug/L)	12	60	Reduced to 20%	l/Quarter	l/Month
TAqH (mg/L)	Report			l/Quarter	l/Month
Silver (ug/L)	23	46	Reduced to 50%	l/Quarter	l/Month
Zinc (mg/L)	0.9	3.1	Reduced to 29%	l/Quarter	l/Month
Mercury (ug/L)	0.6	0.5	**Increased to 120.0%**	l/Quarter	l/Month
Manganese (mg/L)	25	7.9	**Increased to 316.5%**	l/Quarter	l/Month
WET (TUc)	None, Report	1209 TU$_c$	Criterion Removed	None	1/Quarter

*All sample types are grab samples except 2019 WET, which may be grab or composite sample. The permit allows the facility flow rate to be either measured or estimated.

Table C1-2b. MGS Onshore Effluent Limitations and Monitoring Requirements

For Produced Water 015 Discharges

MDL Comparison between 2019 (draft) and 2007 Permits

Parameter (Units)	MDL Effluent Limitations			Monitoring Requirements	
	MDL (2019 Draft)	MDL (2007)	Comment	Frequency (2019 Draft)	Frequency (2007)
Flow Rate (mgd)	Report	None	-----------------	l/Week	None
pH (Standard Units (SU))	6.0 < pH < 9.0		-----------------	1/Week	None
Oil and Grease (mg/L)	42	None	-----------------	1/Week	None
TAH (mg/L)	17	32	Reduced to 53.1%	l/Month	l/Month
Copper (ug/L)	22	90	Reduced to 24.4%	l/Quarter	l/Month
TAqH (mg/L)	Report			l/Quarter	l/Month
Silver (ug/L)	47	149	Reduced to 31.5%	l/Quarter	l/Month
Zinc (mg/L)	1.9	6.1	Reduced to 31.1%	l/Quarter	l/Month
Mercury (ug/L)	1	0.8	**Increased to 125.0%**	l/Quarter	l/Month
Manganese (mg/L)	50	15.8	**Increased to 316.5%**	l/Quarter	l/Month
WET (TUc)	None, Report	2425 TU$_c$	Criterion Removed	l/Quarter	l/Month

*All sample types are grab samples except 2019 WET, which may be grab or composite sample. The permit allows the facility flow rate to be either measured or estimated.

Table C1-3a. GPTF Effluent Limitations and Monitoring Requirements

For Produced Water 015 Discharges

AML Comparison between 2019 (draft) and 2007 Permits

Parameter (Units)	AML Effluent Limitations			Monitoring Requirements	
	AML (2019 Draft)	**AML (2007)**	**Comment**	**Frequency (2019 Draft)***	**Frequency (2007)***
Flow Rate (mgd)	0.195	None	-----------------	l/Week	None
pH (Standard Units (SU))	6.0 < pH < 9.0		-----------------	1/Week	None
Oil and Grease (mg/L)	29	None	-----------------	1/Week	None
TAH (mg/L)	14	14	Unchanged	l/Month	l/Month
Copper (ug/L)	21	67	Reduced to 31.3%	l/Quarter	l/Month
TAqH (mg/L)	Report			l/Quarter	l/Month
Silver (ug/L)	37	37	Unchanged	2/year	l/Month
Zinc (mg/L)	1.5	1.5	Unchanged	2/year	l/Month
Mercury (ug/L)	3.1	3.1	Unchanged	2/year	l/Month
Manganese (mg/L)	6.1	6.1	Unchanged	2/year	l/Month
WET (TUc)	None, Report	1341 TU_c	Criterion Removed	2/year	1/Quarter

*All sample types are grab samples except 2019 WET, which may be grab or composite sample. The permit allows the facility flow rate to be either measured or estimated.

Table C1-3b. GBTF Effluent Limitations and Monitoring Requirements

For Produced Water 015 Discharges

MDL Comparison between 2019 (draft) and 2007 Permits

Parameter (Units)	MDL Effluent Limitations			Monitoring Requirements	
	MDL (2019 Draft)	MDL (2007)	Comment	Frequency (2019 Draft)	Frequency (2007)
Flow Rate (mgd)	Report	None	-----------------	l/Week	None
pH (Standard Units (SU))	6.0 < pH < 9.0		-----------------	1/Week	None
Oil and Grease (mg/L)	42	None	-----------------	1/Week	None
TAH (mg/L)	20	20	Unchanged	l/Month	l/Month
Copper (ug/L)	54	130	Reduced to 41.5%	l/Quarter	l/Month
TAqH (mg/L)	Report			l/Quarter	l/Month
Silver (ug/L)	74	74	Unchanged	2/year	l/Month
Zinc (mg/L)	3.1	3.1	Unchanged	2/year	l/Month
Mercury (ug/L)	7.9	7.9	Unchanged	2/year	l/Month
Manganese (mg/L)	12.3	12.3	Unchanged	2/year	l/Month
WET (TUc)	None, Report	2691 TU$_c$	Criterion Removed	2/year	1/Quarter

*All sample types are grab samples except 2019 WET, which may be grab or composite sample. The permit allows the facility flow rate to be either measured or estimated.

Table C1-4a. Baker Effluent Limitations and Monitoring Requirements

For Produced Water 015 Discharges

AML Comparison between 2019 (draft) and 2007 Permits

Parameter (Units)	AML Effluent Limitations			Monitoring Requirements	
	AML (2019 Draft)	AML (2007)	Comment	Frequency (2019 Draft)*	Frequency (2007)*
Flow Rate (mgd)	0.045	None	-----------------	l/Week	None
pH (Standard Units (SU))	6.0 < pH < 9.0		-----------------	1/Month	None
Oil and Grease (sheen & mg/L)	29	None	-----------------	1/Week (Visual)	None
TAH (mg/L)	34	128	Reduced to 26.6%	l/Month	l/Month
Copper (ug/L)	435	435	Unchanged	2/year	l/Month
TAqH (mg/L)	Report			l/Quarter	l/Month
Silver (ug/L)	173	173	Unchanged	2/year	l/Month
Zinc (mg/L)	6.0	6.7	Reduced to 89.6%	l/Quarter	l/Month
Mercury (ug/L)	0.3	0.3	Unchanged	2/year	l/Month
Manganese (mg/L)	7.1	7.1	Unchanged	2/year	l/Month
WET (TUc)	None, Report	172 TU_c	Criterion Removed	2/year	1/Quarter

*All sample types are grab samples except 2019 WET, which may be grab or composite sample. The permit allows the facility flow rate to be either measured or estimated.

Table C1-4b. Baker Effluent Limitations and Monitoring Requirements

For Produced Water 015 Discharges

MDL Comparison between 2019 (draft) and 2007 Permits

Parameter (Units)	MDL Effluent Limitations			Monitoring Requirements	
	MDL (2019 Draft)	**MDL (2007)**	**Comment**	**Frequency (2019 Draft)**	**Frequency (2007)**
Flow Rate (mgd)	Report	None	-----------------	1/Week	None
pH (Standard Units (SU))	6.0 < pH < 9.0		-----------------	1/Month	None
Oil and Grease (sheen & mg/L)	42	None	-----------------	1/Week (Visual)	None
TAH (mg/L)	47	257	Reduced to 18.3%	1/Month	1/Month
Copper (ug/L)	873	873	Unchanged	2/year	1/Month
TAqH (mg/L)	Report			1/Quarter	1/Month
Silver (ug/L)	347	347	Unchanged	2/year	1/Month
Zinc (mg/L)	13	14.3	Reduced to 90.9%	1/Quarter	1/Month
Mercury (ug/L)	0.4	0.4	Unchanged	2/year	1/Month
Manganese (mg/L)	14.2	14.2	Unchanged	2/year	1/Month
WET (TUc)	None, Report	345 TU$_c$	Criterion Removed	2/year	1/Quarter

*All sample types are grab samples except 2019 WET, which may be grab or composite sample. The permit allows the facility flow rate to be either measured or estimated.

Table C1-5a. Bruce Effluent Limitations and Monitoring Requirements5

For Produced Water 015 Discharges

AML Comparison between 2019 (draft) and 2007 Permits

Parameter (Units)	AML Effluent Limitations			Monitoring Requirements	
	AML (2019 Draft)	AML (2007)	Comment	Frequency (2019 Draft)*	Frequency (2007)*
Flow Rate (mgd)	0.025	None	-----------------	l/Week	None
pH (Standard Units (SU))	6.0 < pH < 9.0		-----------------	1/Month	None
Oil and Grease (sheen & mg/L)	29	None	-----------------	1/Week (visual)	None
TAH (mg/L)	31	78	Reduced to 39.7%	l/Month	l/Month
Copper (ug/L)	1429	1429	Unchanged	2/year	l/Month
TAqH (mg/L)	Report			l/Quarter	l/Month
Silver (ug/L)	7.3	7.3	Unchanged	l/Quarter	l/Month
Zinc (mg/L)	10.0	28.0	Reduced to 35.7%	2/year	l/Month
Mercury (ug/L)	3.7	3.7	Unchanged	2/year	l/Month
Manganese (mg/L)	7.2	7.2	Unchanged	2/year	l/Month
WET (TUc)	None, Report	2149 TU$_c$	Criterion Removed	2/year	1/Quarter

*All sample types are grab samples except 2019 WET, which may be grab or composite sample. The permit allows the facility flow rate to be either measured or estimated.

Table C1-5b. Bruce Effluent Limitations and Monitoring Requirements

For Produced Water 015 Discharges

MDL Comparison between 2019 (draft) and 2007 Permits

Parameter (Units)	MDL Effluent Limitations			Monitoring Requirements	
	MDL (2019 Draft)	**MDL (2007)**	**Comment**	**Frequency (2019 Draft)**	**Frequency (2007)**
Flow Rate (mgd)	Report	None	-----------------	1/Week	None
pH (Standard Units (SU))	6.0 < pH < 9.0		----------------	1/Month	None
Oil and Grease (sheen & mg/L)	42	None	-----------------	1/Week (visual)	None
TAH (mg/L)	46	143	Reduced to 32.2%	1/Month	1/Month
Copper (ug/L)	2867	2867	Unchanged	2/year	1/Month
TAqH (mg/L)	Report			1/Quarter	1/Month
Silver (ug/L)	11	11.0	Unchanged	1/Quarter	1/Month
Zinc (mg/L)	25	47.0	Reduced to 53.2%	2/year	1/Month
Mercury (ug/L)	9.2	9.2	Unchanged	2/year	1/Month
Manganese (mg/L)	14.4	14.4	Unchanged	2/year	1/Month
WET (TUc)	None, Report	4312 TU_c	Criterion Removed	2/year	1/Quarter

*All sample types are grab samples except 2019 WET, which may be grab or composite sample. The permit allows the facility flow rate to be either measured or estimated.

Table C1- 6a. Dillon Effluent Limitations and Monitoring Requirements

For Produced Water 015 Discharges

AML Comparison between 2019 (draft) and 2007 Permits

Parameter (Units)	AML Effluent Limitations			Monitoring Requirements	
	AML (2019 Draft)	AML (2007)	Comment	Frequency (2019 Draft)*	Frequency (2007)*
Flow Rate (mgd)	0.195	None	-----------------	1/Week	None
pH (Standard Units (SU))	6.0 < pH < 9.0		-----------------	1/Month	None
Oil and Grease (sheen & mg/L)	29	None	-----------------	1/Week (visual)	None
TAH (mg/L)	31	31	Unchanged	1/Month	1/Month
Copper (ug/L)	9.3	9.3	Unchanged	2/year	1/Month
TAqH (mg/L)	Report			1/Quarter	1/Month
Silver (ug/L)	19	28	Reduced to 67.9%	1/Quarter	1/Month
Zinc (mg/L)	1.2	1.2	Unchanged	2/year	1/Month
Mercury (ug/L)	1.2	1.2	Unchanged	2/year	1/Month
Manganese (mg/L)	2.3	2.3	Unchanged	2/year	1/Month
WET (TUc)	None, Report	293 TU$_c$	Criterion Removed	2/year	1/Quarter

*All sample types are grab samples except 2019 WET, which may be grab or composite sample. The permit allows the facility flow rate to be either measured or estimated.

Table C2-6b. Dillon Effluent Limitations and Monitoring Requirements

For Produced Water 015 Discharges

MDL Comparison between 2019 (draft) and 2007 Permits

Parameter (Units)	MDL Effluent Limitations			Monitoring Requirements	
	MDL (2019 Draft)	**MDL (2007)**	**Comment**	**Frequency (2019 Draft)**	**Frequency (2007)**
Flow Rate (mgd)	Report	None	-----------------	l/Week	None
pH (Standard Units (SU))	6.0 < pH < 9.0		-----------------	1/Month	None
Oil and Grease (sheen & mg/L)	42	None	-----------------	1/Week (visual)	None
TAH (mg/L)	42	42	Unchanged	l/Month	l/Month
Copper (ug/L)	14	14	Unchanged	2/year	l/Month
TAqH (mg/L)	Report			l/Quarter	l/Month
Silver (ug/L)	48	55.0	Reduced to 87.3%	l/Quarter	l/Month
Zinc (mg/L)	2.3	2.3	Unchanged	2/year	l/Month
Mercury (ug/L)	2.5	2.5	Unchanged	2/year	l/Month
Manganese (mg/L)	4.6	4.6	Unchanged	2/year	l/Month
WET (TUc)	None, Report	588 Tuc	Criterion Removed	2/year	1/Quarter

*All sample types are grab samples except 2019 WET, which may be grab or composite sample. The permit allows the facility flow rate to be either measured or estimated.

Table C1-7a. Tyonek A Effluent Limitations and Monitoring Requirements

For Produced Water 015 Discharges

AML Comparison between 2019 (draft) and 2007 Permits

Parameter (Units)	AML Effluent Limitations			Monitoring Requirements	
	AML (2019 Draft)	AML (2007)	Comment	Frequency (2019 Draft)*	Frequency (2007)*
Flow Rate (mgd)	0.038	None	-----------------	1/Week	None
pH (Standard Units (SU))	6.0 < pH < 9.0		-----------------	1/Month	None
Oil and Grease (sheen & mg/L)	29	None	-----------------	1/Week (visual)	None
TAH (mg/L)	0.09	0.09	Unchanged	1/Month	1/Month
Copper (ug/L)	328	328	Unchanged	1/Quarter	1/Month
TAqH (mg/L)	Report			1/Quarter	1/Month
Silver (ug/L)	205	205	Unchanged	2/year	1/Month
Zinc (mg/L)	8.4	8.4	Unchanged	2/year	1/Month
Mercury (ug/L)	0.05	0.05	Unchanged	2/year	1/Month
Manganese (mg/L)	0.1	0.1	Unchanged	2/year	1/Month
WET (TUc)	None, Report	268 TU$_c$	Criterion Removed	2/year	1/Quarter

*All sample types are grab samples except 2019 WET, which may be grab or composite sample. The permit allows the facility flow rate to be either measured or estimated.

Table C1-7b. Tyonek A Effluent Limitations and Monitoring Requirements

For Produced Water 015 Discharges

MDL Comparison between 2019 (draft) and 2007 Permits

Parameter (Units)	MDL Effluent Limitations			Monitoring Requirements	
	MDL (2019 Draft)	**MDL (2007)**	**Comment**	**Frequency (2019 Draft)**	**Frequency (2007)**
Flow Rate (mgd)	Report	None	-----------------	l/Week	None
pH (Standard Units (SU))	6.0 < pH < 9.0		-----------------	1/Month	None
Oil and Grease (sheen & mg/L)	42	None	-----------------	1/Week (visual)	None
TAH (mg/L)	0.14	0.14	Unchanged	l/Month	l/Month
Copper (ug/L)	1033	1033	Unchanged	l/Quarter	l/Month
TAqH (mg/L)	Report			l/Quarter	l/Month
Silver (ug/L)	411	411	Unchanged	2/year	l/Month
Zinc (mg/L)	17	17.0	Unchanged	2/year	l/Month
Mercury (ug/L)	0.1	0.1	Unchanged	2/year	l/Month
Manganese (mg/L)	0.2	4.6	Unchanged	2/year	l/Month
WET (TUc)	None, Report	537 TU_c	Criterion Removed	2/year	1/Quarter

*All sample types are grab samples except 2019 WET, which may be grab or composite sample. The permit allows the facility flow rate to be either measured or estimated.

Appendix D

CORMIX Simulations Session Reports
By Discharger for New and Expanded Facilities

Appendix D1

Osprey Platform
CORMIX Session Report for TAH
By the Discharger

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                        CORMIX Version 10.0G
                      HYDRO2:Version-10.0.2.0  April,2017
SITE NAME/LABEL:               Osprey
 DESIGN CASE:                  Organics MZ (TAH)
 FILE NAME:                    U:\PSO\Projects\Clients\7784-Glacier Oil and Gas\553-7784-001
Osprey Platform Mixing\02WBS\4-Modeling\MZ Summary\Organics(TAH).prd
 Using subsystem CORMIX2:    Multiport Diffuser Discharges
 Start of session:            04/27/2018--14:20:39
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
 Cross-section                        = unbounded
 Average depth             HA    = 13.70 m
 Depth at discharge        HD    = 13.70 m
 Ambient velocity          UA    = 0.2 m/s
 Darcy-Weisbach friction factor  F = 0.0205
   Calculated from Manning's n    = 0.025
 Wind velocity             UW    = 0 m/s
 Stratification Type       STRCND = U
 Surface density           RHOAS = 1016.7000 kg/m^3
 Bottom density            RHOAB = 1016.7000 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:           Submerged Multiport Diffuser Discharge
 Diffuser type             DITYPE = alternating parallel
 Diffuser length           LD    = 13.70 m
 Nearest bank                    = left
 Diffuser endpoints        YB1   = 2723 m;   YB2 = 2723.70 m
 Number of openings        NOPEN = 4
 Number of Risers          NRISER = 4
 Ports/Nozzles per Riser   NPPERR = 1
 Spacing between risers/openings SPAC = 4.57 m
 Port/Nozzle diameter      D0    = 0.0737 m
   with contraction ratio        = 1
 Equivalent slot width     B0    = 0.0009 m
 Total area of openings     TA0   = 0.0171 m^2
 Discharge velocity        U0    = 2.70 m/s
 Total discharge flowrate  Q0    = 0.046 m^3/s
 Discharge port height     H0    = 0.5 m
 Nozzle arrangement        BETYPE = alternating without fanning
 Diffuser alignment angle  GAMMA = 3 deg
 Vertical discharge angle  THETA = 90 deg
 Actual Vertical discharge angle THEAC = 90 deg
 Horizontal discharge angle SIGMA = 0 deg
 Relative orientation angle BETA  = 90 deg
 Discharge density         RHO0  = 1010 kg/m^3
 Density difference        DRHO  = 6.7000 kg/m^3
 Buoyant acceleration      GP0   = 0.0646 m/s^2
 Discharge concentration   C0    = 8279 ppb
 Surface heat exchange coeff.  KS = 0 m/s
 Coefficient of decay      KD    = 0 /s
-----------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
 Discharge (volume flux)   q0    = 0.003358 m^2/s
 Momentum flux             m0    = 0.009051 m^3/s^2
 Buoyancy flux             j0    = 0.000217 m^3/s^3
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
 LQ  = 0.00 m       Lm  = 0.23 m       LM  = 2.28 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    = 346.94
```

```
  Port/nozzle Froude number      FRD0    = 39.06
  Velocity ratio                 R       = 13.48
-------------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = no
  Water quality standard specified       = yes
  Water quality standard         CSTD    = 10 ppb
  Regulatory mixing zone                 = no
  Region of interest                     = 700 m downstream
*******************************************************************************
HYDRODYNAMIC CLASSIFICATION:
   *-----------------------*
   | FLOW CLASS   = MU9 |
   *-----------------------*
   This flow configuration applies to a layer corresponding to the full water
   depth at the discharge site.
   Applicable layer depth = water depth = 13.70 m
*******************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-------------------------------------------------------------------------------
X-Y-Z Coordinate system:
   Origin is located at the BOTTOM below the port/diffuser center:
     2723.35 m from the left bank/shore.
   Number of display steps NSTEP = 50 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 = 62.189 ppb
  Dilution at edge of NFR              s = 133.1
  NFR Location:                        x = 6.84 m
     (centerline coordinates)          y = 0 m
                                       z = 13.70 m
  NFR plume dimensions:  half-width (bh) = 1.13 m
                         thickness (bv) = 13.51 m
Cumulative travel time:        68.4061 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.
-------------------------------------------------------------------------------
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 has been specified.
However:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard                = 10  ppb
  Corresponding dilution              s = 827.9
  Plume location:                     x = 529.73 m
     (centerline coordinates)          y = 0 m
                                       z = 13.70 m
  Plume dimensions:       half-width (bh) = 38.54 m
                          thickness (bv) = 2.47 m
```

```
********************** 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.
  -----------------------------------------------------------------------
DIFFUSER DESIGN DETAILS:  Because of the alternating arrangement
  of the opposing nozzles/ports, the AVERAGE VERTICAL ANGLE (THETA)
  has been set to 90 deg.  This represents a ZERO NET HORIZONTAL
  MOMENTUM FLUX for the entire diffuser.
  -----------------------------------------------------------------------
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.
```

Appendix D2

Osprey Platform
CORMIX Session Report for Copper (Cu)
By the Discharger

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                         CORMIX Version 10.0G
                      HYDRO2:Version-10.0.2.0  April,2017
SITE NAME/LABEL:              Osprey
 DESIGN CASE:                 Metals MZ (Cu)
 FILE NAME:                   U:\PSO\Projects\Clients\7784-Glacier Oil and Gas\553-7784-001
Osprey Platform Mixing\02WBS\4-Modeling\MZ Summary\Metals(Cu).prd
 Using subsystem CORMIX2:     Multiport Diffuser Discharges
 Start of session:            04/27/2018--13:22:50
*******************************************************************************
SUMMARY OF INPUT DATA:
-------------------------------------------------------------------------------
AMBIENT PARAMETERS:
 Cross-section                     = unbounded
 Average depth             HA      = 13.70 m
 Depth at discharge        HD      = 13.70 m
 Ambient velocity          UA      = 0.2 m/s
 Darcy-Weisbach friction factor  F = 0.0205
   Calculated from Manning's n    = 0.025
 Wind velocity             UW      = 0 m/s
 Stratification Type       STRCND = U
 Surface density           RHOAS  = 1016.7000 kg/m^3
 Bottom density            RHOAB  = 1016.7000 kg/m^3
-------------------------------------------------------------------------------
DISCHARGE PARAMETERS:          Submerged Multiport Diffuser Discharge
 Diffuser type             DITYPE = alternating parallel
 Diffuser length           LD     = 13.70 m
 Nearest bank                     = left
 Diffuser endpoints        YB1    = 2723 m;   YB2 = 2723.70 m
 Number of openings        NOPEN  = 4
 Number of Risers          NRISER = 4
 Ports/Nozzles per Riser   NPPERR  = 1
 Spacing between risers/openings SPAC = 4.57 m
 Port/Nozzle diameter      D0     = 0.0737 m
   with contraction ratio         = 1
 Equivalent slot width     B0     = 0.0009 m
 Total area of openings    TA0    = 0.0171 m^2
 Discharge velocity        U0     = 2.70 m/s
 Total discharge flowrate  Q0     = 0.046 m^3/s
 Discharge port height     H0     = 0.5 m
 Nozzle arrangement        BETYPE = alternating without fanning
 Diffuser alignment angle  GAMMA  = 3 deg
 Vertical discharge angle  THETA  = 90 deg
 Actual Vertical discharge angle THEAC = 90 deg
 Horizontal discharge angle SIGMA = 0 deg
 Relative orientation angle BETA  = 90 deg
 Discharge density         RHO0   = 1010 kg/m^3
 Density difference        DRHO   = 6.7000 kg/m^3
 Buoyant acceleration      GP0    = 0.0646 m/s^2
 Discharge concentration   C0     = 180.074000 ppb
 Surface heat exchange coeff. KS  = 0 m/s
 Coefficient of decay      KD     = 0 /s
-------------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
 Discharge (volume flux)   q0     = 0.003358 m^2/s
 Momentum flux             m0     = 0.009051 m^3/s^2
 Buoyancy flux             j0     = 0.000217 m^3/s^3
-------------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
 LQ  = 0.00 m        Lm  = 0.23 m        LM  = 2.28 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    = 346.94
```

```
  Port/nozzle Froude number      FRD0   = 39.06
  Velocity ratio                 R      = 13.48
--------------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                       = yes
  CMC concentration              CMC    = 4.854 ppb
  CCC concentration              CCC    = 2.804 ppb
  Water quality standard specified      = given by CCC value
  Regulatory mixing zone                = no
  Region of interest                    = 700 m downstream
********************************************************************************
HYDRODYNAMIC CLASSIFICATION:
   *----------------------*
   | FLOW CLASS  = MU9 |
   *----------------------*
   This flow configuration applies to a layer corresponding to the full water
   depth at the discharge site.
   Applicable layer depth = water depth = 13.70 m
********************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

--------------------------------------------------------------------------------
X-Y-Z Coordinate system:
   Origin is located at the BOTTOM below the port/diffuser center:
     2723.35 m from the left bank/shore.
   Number of display steps NSTEP = 50 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 = 1.3527 ppb
   Dilution at edge of NFR              s = 133.1
   NFR Location:                        x = 6.84 m
     (centerline coordinates)           y = 0 m
                                        z = 13.70 m
   NFR plume dimensions:  half-width (bh) = 1.13 m
                          thickness (bv) = 13.51 m
Cumulative travel time:       68.4061 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.
--------------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
   Plume in unbounded section does not contact bank in this simulation.
*********************** TOXIC DILUTION ZONE SUMMARY ***********************
Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA
  Technical Support Document (TSD) for Water Quality-based Toxics Control,
  1991 (EPA/505/2-90-001).
   Criterion maximum concentration (CMC) = 4.854  ppb
Corresponding dilution                   = 37.098063
The CMC was encountered at the following plume position:
   Plume location:                      x = -6.57 m
     (centerline coordinates)           y = -0.34 m
                                        z = 13.70 m
   Plume dimension:       half-width (bh) = 0.37 m
                          thickness (bv) = 0.81 m
```

Computed distance from port opening to CMC location = 14.75 m.
==CRITERION 1: This location is beyond 50 times the discharge length scale of==
==   Lq = 0.07 m.==
==+++++ The discharge length scale TEST for the TDZ has FAILED. +++++==

 Computed horizontal distance from port opening to CMC location = 6.58 m.
 CRITERION 2: This location is within 5 times the ambient water depth of
             HD = 13.70 m.
 ++++++++++ The ambient depth TEST for the TDZ has been SATISFIED. ++++++++++

 ==CRITERION 3: No RMZ has been defined. Therefore, the Regulatory Mixing zone==
 ==   test for the TDZ cannot be applied.==

 ==The diffuser discharge velocity is equal to 2.70 m/s.==
 ==This is below the value of 3.0 m/s recommended in the TSD.==

 ==*** This discharge DOES NOT SATISFY all three CMC criteria for the TDZ. ****==
 **** This MAY be caused by the low discharge velocity for this design. *****
*********************** REGULATORY MIXING ZONE SUMMARY ***********************
No RMZ has been specified.
However:
The CCC was encountered at the following plume position:
The CCC for the toxic pollutant was encountered at the following
  plume position:
  CCC   = 2.804 ppb
Corresponding dilution   = 132.1
  Plume location: x = -6.57 m
    (centerline coordinates)   y = -0.34 m
                                   z = 13.70 m
 Computed horizontal distance from port opening to CCC location = 14.75
  Plume dimensions: half-width (bh) = 0.37 m
                        thickness (bv) = 0.82 m
********************** 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.

DIFFUSER DESIGN DETAILS: Because of the alternating arrangement
  of the opposing nozzles/ports, the AVERAGE VERTICAL ANGLE (THETA)
  has been set to 90 deg. This represents a ZERO NET HORIZONTAL
  MOMENTUM FLUX for the entire diffuser.

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.

Appendix D3

Furie Platform
CORMIX Session Report by the Discharger
Commingled flows [003 &004}
For total residual chlorine (TRC)

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXX
                         CORMIX MIXING ZONE EXPERT SYSTEM
                              CORMIX Version 8.0G
                          HYDRO1:Version-8.0.0.0  April,2012
SITE NAME/LABEL:                   Comingled 003/004 Discharge
  DESIGN CASE:                     200 BBL/day, 2.3 m/s current
  FILE NAME:                       U:\Bell\Projects\Clients\7144-
FurieOperatingAlaska\553-7144-001 FuriePetroleumMixStdy\03General\APDES
Draft Permit\Modeling\ADEC Response Runs\200BBL 2.3.prd
  Using subsystem CORMIX1:    Single Port Discharges
  Start of session:                02/14/2013--12:55:44
********************************************************************************
****
SUMMARY OF INPUT DATA:
--------------------------------------------------------------------------------
----
AMBIENT PARAMETERS:
  Cross-section                      = unbounded
  Average depth                HA    = 27 m
  Depth at discharge           HD    = 27 m
  Ambient velocity             UA    = 2.3 m/s
  Darcy-Weisbach friction factor F   = 0.0164
    Calculated from Manning's n      = 0.025
  Wind velocity                UW    = 0 m/s
  Stratification Type          STRCND = U
  Surface density              RHOAS = 1018 kg/m^3
  Bottom density               RHOAB = 1018 kg/m^3
--------------------------------------------------------------------------------
----
DISCHARGE PARAMETERS:            Single Port Discharge
  Nearest bank                       = right
  Distance to bank             DISTB = 1000 m
  Port diameter                D0    = 0.1524 m
  Port cross-sectional area    A0    = 0.0182 m^2
  Discharge velocity           U0    = 0.02 m/s
  Discharge flowrate           Q0    = 0.000368 m^3/s
  Discharge port height        H0    = 9 m
  Vertical discharge angle     THETA = 90 deg
  Horizontal discharge angle   SIGMA = 0 deg
  Discharge density            RHO0  = 998.2000 kg/m^3
  Density difference           DRHO  = 19.8000 kg/m^3
  Buoyant acceleration         GP0   = 0.1907 m/s^2
  Discharge concentration      C0    = 1 mg/l
  Surface heat exchange coeff.  KS   = 0 m/s
  Coefficient of decay         KD    = 0 /s
--------------------------------------------------------------------------------
----
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.14 m       Lm  = 0.00 m         Lb  = 0.00 m
  LM  = 0.02 m       Lm' = 99999 m         Lb' = 99999 m
--------------------------------------------------------------------------------
----
```

```
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0    = 0.12
  Velocity ratio                  R      = 0.01
---------------------------------------------------------------------------
----
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                        = yes
  CMC concentration               CMC    = 0.013 mg/l
  CCC concentration               CCC    = 0.0075 mg/l
  Water quality standard specified       = given by CCC value
  Regulatory mixing zone                 = no
  Region of interest                     = 1350 m downstream
****************************************************************************
****
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS  = V1 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full
water
  depth at the discharge site.
  Applicable layer depth = water depth = 27 m
****************************************************************************
****
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

---------------------------------------------------------------------------
----
X-Y-Z Coordinate system:
  Origin is located at the bottom below the port center:
    1000 m from the right bank/shore.
  Number of display steps NSTEP = 50 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 mg/l
  Dilution at edge of NFR               s = 0
  NFR Location:                         x = 0 m
    (centerline coordinates)            y = 0 m
                                        z = 0 m
  NFR plume dimensions:  half-width (bh) = 0 m
                          thickness (bv) = 0 m
Cumulative travel time:       0 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.

PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section does not contact bank in this simulation.
************************* TOXIC DILUTION ZONE SUMMARY
****
Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA
  Technical Support Document (TSD) for Water Quality-based Toxics
Control,
  1991 (EPA/505/2-90-001).
  Criterion maximum concentration (CMC) = 0.013 mg/l
Corresponding dilution   = 76.923077
The CMC was encountered at the following plume position:
    Plume location: x = 9.43 m
      (centerline coordinates)   y = 0 m
                                           z = 9.03 m
   Plume dimension: half-width (bh) = 0.04 m
                            thickness (bv) = 0.04 m

 Computed distance from port opening to CMC location = 9.43 m.
 CRITERION 1: This location is beyond 50 times the discharge length scale
of
            Lq = 0.14 m.
 +++++ The discharge length scale TEST for the TDZ has FAILED. ++++++

 Computed horizontal distance from port opening to CMC location = 9.43 m.
 CRITERION 2: This location is within 5 times the ambient water depth of
             HD = 27 m.
 ++++++++++ The ambient depth TEST for the TDZ has been SATISFIED.
++++++++++

 CRITERION 3: No RMZ has been defined. Therefore, the Regulatory Mixing
zone
             test for the TDZ cannot be applied.

 The diffuser discharge velocity is equal to 0.02 m/s.
 This is below the value of 3.0 m/s recommended in the TSD.

 *** This discharge DOES NOT SATISFY all three CMC criteria for the TDZ.
****
 **** This MAY be caused by the low discharge velocity for this design.
*****
********************* REGULATORY MIXING ZONE SUMMARY
****
No RMZ has been specified.
However:
The CCC was encountered at the following plume position:
The CCC for the toxic pollutant was encountered at the following
  plume position:
  CCC   = 0.0075 mg/l
Corresponding dilution   = 133.3
    Plume location: x = 18.29 m
      (centerline coordinates)   y = 0 m

```
                                    z = 9.05 m
  Plume dimension:        half-width (bh) = 0.07 m
********************* FINAL DESIGN ADVICE AND COMMENTS
*********************
```

INTRUSION OF AMBIENT WATER into the discharge opening will occur!

For the present discharge/environment conditions the discharge
densimetric Froude number is well below unity. This is an UNDESIRABLE
operating condition.

To prevent intrusion, change the discharge parameters (e.g. decrease the
discharge opening area) in order to increase the discharge Froude number.

```
In a future iteration, change the discharge parameters (e.g. decrease
port diameter) in order to increase the Froude number.
------------------------------------------------------------------------
----
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.
```

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXX
                        CORMIX MIXING ZONE EXPERT SYSTEM
                            CORMIX Version 8.0G
                         HYDRO1:Version-8.0.0.0  April,2012
SITE NAME/LABEL:                   Comingled 003/004 Discharge
  DESIGN CASE:                     200 BBL/day, 0.2 m/s current
  FILE NAME:                       U:\Bell\Projects\Clients\7144-
FurieOperatingAlaska\553-7144-001 FuriePetroleumMixStdy\03General\APDES
Draft Permit\Modeling\ADEC Response Runs\200BBL 0.2.prd
  Using subsystem CORMIX1:    Single Port Discharges
  Start of session:               02/14/2013--12:55:08
*********************************************************************************
****
SUMMARY OF INPUT DATA:
-------------------------------------------------------------------------------
----
AMBIENT PARAMETERS:
  Cross-section                      = unbounded
  Average depth               HA     = 27 m
  Depth at discharge          HD     = 27 m
  Ambient velocity            UA     = 0.2 m/s
  Darcy-Weisbach friction factor  F  = 0.0164
    Calculated from Manning's n     = 0.025
  Wind velocity               UW     = 0 m/s
  Stratification Type         STRCND = U
  Surface density             RHOAS  = 1018 kg/m^3
  Bottom density              RHOAB  = 1018 kg/m^3
-------------------------------------------------------------------------------
----
DISCHARGE PARAMETERS:            Single Port Discharge
  Nearest bank                       = right
  Distance to bank            DISTB  = 1000 m
  Port diameter               D0     = 0.1524 m
  Port cross-sectional area   A0     = 0.0182 m^2
  Discharge velocity          U0     = 0.02 m/s
  Discharge flowrate          Q0     = 0.000368 m^3/s
  Discharge port height       H0     = 9 m
  Vertical discharge angle    THETA  = 90 deg
  Horizontal discharge angle  SIGMA  = 0 deg
  Discharge density           RHO0   = 998.2000 kg/m^3
  Density difference          DRHO   = 19.8000 kg/m^3
  Buoyant acceleration        GP0    = 0.1907 m/s^2
  Discharge concentration     C0     = 1 mg/l
  Surface heat exchange coeff. KS    = 0 m/s
  Coefficient of decay        KD     = 0 /s
-------------------------------------------------------------------------------
----
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.14 m      Lm  = 0.01 m          Lb  = 0.01 m
  LM  = 0.02 m      Lm' = 99999 m          Lb' = 99999 m
-------------------------------------------------------------------------------
----
```

```
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0    = 0.12
  Velocity ratio                  R      = 0.10
---------------------------------------------------------------------------
----
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                       = yes
  CMC concentration               CMC   = 0.013 mg/l
  CCC concentration               CCC   = 0.0075 mg/l
  Water quality standard specified      = given by CCC value
  Regulatory mixing zone                = no
  Region of interest                    = 1350 m downstream
***************************************************************************
****
HYDRODYNAMIC CLASSIFICATION:
   *------------------------*
   | FLOW CLASS  = V1 |
   *------------------------*
   This flow configuration applies to a layer corresponding to the full
water
   depth at the discharge site.
   Applicable layer depth = water depth = 27 m
***************************************************************************
****
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

---------------------------------------------------------------------------
----
X-Y-Z Coordinate system:
  Origin is located at the bottom below the port center:
    1000 m from the right bank/shore.
  Number of display steps NSTEP = 50 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 mg/l
  Dilution at edge of NFR              s = 57559.5
  NFR Location:                        x = 416.21 m
    (centerline coordinates)           y = 0 m
                                       z = 27 m
  NFR plume dimensions:  half-width (bh) = 7.28 m
                          thickness (bv) = 7.28 m
Cumulative travel time:      2078.4543 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.
--------------------------------------------------------------------------
----
PLUME BANK CONTACT SUMMARY:
  Plume in unbounded section does not contact bank in this simulation.
*********************** TOXIC DILUTION ZONE SUMMARY
***********************
Recall: The TDZ corresponds to the three (3) criteria issued in the USEPA
  Technical Support Document (TSD) for Water Quality-based Toxics
Control,
  1991 (EPA/505/2-90-001).
  Criterion maximum concentration (CMC)  = 0.013  mg/l
Corresponding dilution                   = 76.923077
The CMC was encountered at the following plume position:
  Plume location:                        x = 3.88 m
    (centerline coordinates)             y = 0 m
                                         z = 9.55 m
  Plume dimension:        half-width (bh) = 0.04 m
                            thickness (bv) = 0.04 m

 Computed distance from port opening to CMC location = 3.92 m.
 CRITERION 1: This location is within 50 times the discharge length scale
of
            Lq = 0.14 m.
 +++++ The discharge length scale TEST for the TDZ has been SATISFIED.
++++++

 Computed horizontal distance from port opening to CMC location = 3.88 m.
 CRITERION 2: This location is within 5 times the ambient water depth of
            HD = 27 m.
 ++++++++++ The ambient depth TEST for the TDZ has been SATISFIED.
++++++++++

 CRITERION 3: No RMZ has been defined. Therefore, the Regulatory Mixing
zone
              test for the TDZ cannot be applied.

 The diffuser discharge velocity is equal to 0.02 m/s.
 This is below the value of 3.0 m/s recommended in the TSD.

 *** All three CMC criteria for the TDZ are SATISFIED for this discharge.
***
********************** REGULATORY MIXING ZONE SUMMARY
**********************
No RMZ has been specified.
However:
The CCC was encountered at the following plume position:
The CCC for the toxic pollutant was encountered at the following
  plume position:
  CCC                                    = 0.0075  mg/l
Corresponding dilution                   = 133.3
  Plume location:                        x = 6.03 m
    (centerline coordinates)             y = 0 m
                                         z = 9.77 m
```

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXX
                        CORMIX MIXING ZONE EXPERT SYSTEM
                           CORMIX Version 8.0G
                        HYDRO1:Version-8.0.0.0  April,2012
SITE NAME/LABEL:                Comingled 003/004 Discharge
  DESIGN CASE:                  200 BBL/day, 2.3 m/s current
  FILE NAME:                    U:\Bell\Projects\Clients\7144-
FurieOperatingAlaska\553-7144-001 FuriePetroleumMixStdy\03General\APDES
Draft Permit\Modeling\ADEC Response Runs\200BBL 2.3.prd
  Using subsystem CORMIX1:     Single Port Discharges
  Start of session:            02/14/2013--12:55:44
*********************************************************************
****
SUMMARY OF INPUT DATA:
----------------------------------------------------------------------
----
AMBIENT PARAMETERS:
  Cross-section                    = unbounded
  Average depth             HA     = 27 m
  Depth at discharge        HD     = 27 m
  Ambient velocity          UA     = 2.3 m/s
  Darcy-Weisbach friction factor  F = 0.0164
    Calculated from Manning's n    = 0.025
  Wind velocity             UW     = 0 m/s
  Stratification Type       STRCND = U
  Surface density           RHOAS  = 1018 kg/m^3
  Bottom density            RHOAB  = 1018 kg/m^3
----------------------------------------------------------------------
----
DISCHARGE PARAMETERS:           Single Port Discharge
  Nearest bank                     = right
  Distance to bank          DISTB  = 1000 m
  Port diameter             D0     = 0.1524 m
  Port cross-sectional area  A0    = 0.0182 m^2
  Discharge velocity        U0     = 0.02 m/s
  Discharge flowrate        Q0     = 0.000368 m^3/s
  Discharge port height     H0     = 9 m
  Vertical discharge angle  THETA  = 90 deg
  Horizontal discharge angle SIGMA = 0 deg
  Discharge density         RHO0   = 998.2000 kg/m^3
  Density difference        DRHO   = 19.8000 kg/m^3
  Buoyant acceleration      GP0    = 0.1907 m/s^2
  Discharge concentration   C0     = 1 mg/l
  Surface heat exchange coeff. KS  = 0 m/s
  Coefficient of decay      KD     = 0 /s
----------------------------------------------------------------------
----
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.14 m      Lm  = 0.00 m        Lb  = 0.00 m
  LM  = 0.02 m      Lm' = 99999 m        Lb' = 99999 m
----------------------------------------------------------------------
----
```

```
   Plume dimension:          half-width (bh) = 0.23 m
********************** FINAL DESIGN ADVICE AND COMMENTS
**********************
```

INTRUSION OF AMBIENT WATER into the discharge opening will occur!

For the present discharge/environment conditions the discharge
densimetric Froude number is well below unity. This is an UNDESIRABLE
operating condition.

To prevent intrusion, change the discharge parameters (e.g. decrease the
discharge opening area) in order to increase the discharge Froude number.

In a future iteration, change the discharge parameters (e.g. decrease
port diameter) in order to increase the Froude number.

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.

Appendix D4

Sabre MODU
CORMIX Session Report by the Discharger
Mud, Cuttings and Cement at the Seafloor
[Discharge Number 013]

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                    CORMIX MIXING ZONE EXPERT SYSTEM
                       CORMIX Version 10.0GTS
                    DYDRO:Version-10.0.1.0  October,2016
SITE NAME/LABEL:              Sabre
  DESIGN CASE:                Drilling Fluids
  FILE NAME:                  G:\Water\WQ\WPC\2339.48.057 - Sabre Oil and Gas Project -
Trading Bay\Permits\2 Development Documents\Supporting Documentation\Mixing Zone Analysis\001
KCL 0.3 1.11.17 .prd
  Using subsystem DCORMIX1:   Single Port Sediment Discharges
  Start of session:           01/24/2017--11:22:42
****************************************************************************
SUMMARY OF INPUT DATA:
---------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                    = unbounded
  Average depth           HA     = 14 m
  Depth at discharge      HD     = 14.01 m

  Near-shore zone:
  Bottom slope            SLOPE1 = 10 deg
  Ambient velocity        UA1    = 0.3 m/s
  Darcy-Weisbach friction factor  F1   = 0.025
  Distance to slope breakpoint  YBREAK = 79.4500 m
  Depth at slope breakpoint     ZBREAK = 14.0092 m

  Far-shore zone:
  Bottom slope            SLOPE2  = 0 deg
  Ambient velocity        UA2     = 0.3 m/s
  Darcy-Weisbach friction factor  F2     = 0.025

  Wind velocity           UW     = 0 m/s
  Ambient Density Stratification with 1 subsurface level:
  Surface density         RHOAS  = 1016 kg/m^3
  Level 1 Submergence     LEVEL1 = 14 m
  Density at Level 1      RHOA1  = 1017 kg/m^3
---------------------------------------------------------------------------
DISCHARGE PARAMETERS:            Single Port Discharge
  Nearest bank                   = right
  Distance to bank        DISTB  = 4828 m
  Port diameter           D0     = 0.0135 m
  Port cross-sectional area A0   = 0.0001 m^2
  Discharge velocity      U0     = 15.41 m/s
  Discharge flowrate      Q0     = 0.002208 m^3/s
  Discharge port height   H0     = 14.01 m
  Vertical discharge angle THETA = -90 deg
  Horizontal discharge angle SIGMA = 0 deg
  Discharge density       RHO0   = 1258 kg/m^3
  Density difference      DRHO   = -242 kg/m^3
  Buoyant acceleration    GP0    = -2.3358 m/s^2
  Discharge concentration C0     = 96000 mg/l
  Surface heat exchange coeff.  KS = 0 m/s
  Coefficient of decay    KD     = 0 /s
---------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.01 m       Lm  = 0.61 m        Lb  = 0.19 m
  LM  = 1.10 m       Lm' = 2.65 m        Lb' = 4.11 m
---------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0  = 86.72
  Velocity ratio          R      = 51.35
---------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                       = no
  Water quality standard specified    = yes
  Water quality standard      CSTD    = 40000 mg/l
  Regulatory mixing zone                = yes
  Regulatory mixing zone specification = distance
  Regulatory mixing zone value        = 100 m (m^2 if area)
  Region of interest                  = 2000 m
```

```
*************************************************************************
HYDRODYNAMIC CLASSIFICATION:
   *-----------------------*
   | FLOW CLASS  = IS4 |
   *-----------------------*
   This flow configuration applies to a layer corresponding to the linearly
   stratified density layer at the discharge site.
   Applicable layer depth = water depth = 14 m
*************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-------------------------------------------------------------------------
X-Y-Z Coordinate system:
   Origin is located at the SURFACE:
 1) directly above the port/diffuser center for submerged discharges, OR:
 2) at the point of entry into the water for above surface discharges,
 4828 m from the right bank/shore.
   Number of display steps NSTEP = 100 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 = 41.167700 mg/l
   Dilution at edge of NFR              s = 2331.9
   NFR Location:                        x = 25.56 m
      (centerline coordinates)          y = 0 m
                                        z = -5.61 m
   NFR plume dimensions:  half-width (bh) = 2.93 m
                          thickness (bv) = 2.93 m
Cumulative travel time:       73.0966 sec.
-------------------------------------------------------------------------
Buoyancy assessment:
   The effluent density is greater than the surrounding ambient water
   density at the discharge level.
   Therefore, the effluent is NEGATIVELY BUOYANT and will tend to sink towards
   the bottom.
-------------------------------------------------------------------------
Stratification assessment:
   The specified ambient density stratification is dynamically important.
   The discharge near field flow is trapped within the linearly stratified
   ambient density layer.
-------------------------------------------------------------------------
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 *********************
The plume conditions at the boundary of the specified RMZ are as follows:
   Pollutant concentration              c = 26.423454  mg/l
   Corresponding dilution               s = 3633.1
   Plume location:                      x = 100 m
      (centerline coordinates)          y = 0 m
                                        z = -4.23 m
   Plume dimensions:      half-width (bh) = 10.81 m
                          thickness (bv) = 1.24 m
Cumulative travel time:       321.2287 sec.

Note:
Plume concentration c and dilution s values are reported based on prediction
file values - assuming linear interpolation between predicted points just
before and just after the RMZ boundary has been detected.

Please ensure a small step size is used in the prediction file to account
for this linear interpolation. Step size can be controlled by increasing
(reduces the prediction step size) or decreasing (increases the prediction
```

step size) the - Output Steps per Module - in CORMIX input.

At this position, the plume is NOT IN CONTACT with any bank.
Furthermore, the specified water quality standard has indeed been met
  within the RMZ. In particular:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard   = 40000 mg/l
  Corresponding dilution   s = 2.4
  Plume location: x = 0.00 m
    (centerline coordinates)   y = 0 m
                                   z = -0.17 m
  Plume dimension: half-width (bh) = 0.02 m
********************* FINAL DESIGN ADVICE AND COMMENTS **********************
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.

Appendix D5

Alaska LNG Jack-up Platform
CORMIX Session Report by the Discharger
Mud, Cuttings and Cement at the Seafloor
[Discharge Number 013]

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                    CORMIX MIXING ZONE EXPERT SYSTEM
                       CORMIX Version 9.0GTS
                    DYDRO:Version-9.0.0.0  September,2014
SITE NAME/LABEL:              AKLNG Cook Inlet G&G - Nikiski Area
  DESIGN CASE:                G&G Drill Mud & Cutting - Nikiski  Low Current - 9 inch
  FILE NAME:                  C:\Users\KLIAK \Dropbox\EXP Alaska LNG Project\Cook Inlet
APDES\Cormix\Model Runs\AKLNG Drilling Muds & Cutting-Nikiski Low Current.prd
  Using subsystem DCORMIX1:   Single Port Sediment Discharges
  Start of session:           03/21/2015--13:49:31
*********************************************************************************
SUMMARY OF INPUT DATA:
--------------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                    = unbounded
  Average depth              HA    = 5 m
  Depth at discharge         HD    = 5 m


  Near-shore zone:
  Bottom slope               SLOPE1 = 5 deg
  Ambient velocity           UA1   = 0.229 m/s
  Darcy-Weisbach friction factor  F1    = 0.025
  Distance to slope breakpoint  YBREAK = 57.2000 m
  Depth at slope breakpoint  ZBREAK = 5.0044 m


  Far-shore zone:
  Bottom slope               SLOPE2  = 0 deg
  Ambient velocity           UA2   = 0.229 m/s
  Darcy-Weisbach friction factor  F2    = 0.025


  Wind velocity              UW    = 0 m/s
  Stratification Type        STRCND = U
  Surface density            RHOAS = 1015.87 kg/m^3
  Bottom density             RHOAB = 1015.87 kg/m^3
--------------------------------------------------------------------------------
DISCHARGE PARAMETERS:            Single Port Discharge
  Nearest bank                     = left
  Distance to bank           DISTB = 200 m
  Port diameter              D0    = 0.2286 m
  Port cross-sectional area  A0    = 0.0410 m^2
  Discharge velocity         U0    = 0.99 m/s
  Discharge flowrate         Q0    = 0.040748 m^3/s
  Discharge port height      H0    = 0.30 m
  Vertical discharge angle   THETA = -45 deg
  Horizontal discharge angle SIGMA = 270 deg
  Discharge density          RHO0  = 1348.8 kg/m^3
  Density difference         DRHO  = -332.9300 kg/m^3
  Buoyant acceleration       GP0   = -3.2139 m/s^2
  Discharge concentration    C0    = 48000 mg/l
  Surface heat exchange coeff.  KS    = 0 m/s
  Coefficient of decay       KD    = 0 /s
--------------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.20 m        Lm  = 0.88 m        Lb  = 10.91 m
  LM  = 0.25 m        Lm' = 99999 m        Lb' = 99999 m
--------------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
  Port densimetric Froude number  FR0   = 1.16
  Velocity ratio             R     = 4.34
--------------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                  = no
  Water quality standard specified  = yes
  Water quality standard     CSTD  = 32 mg/l
  Regulatory mixing zone           = no
  Region of interest               = 1000 m downstream
*********************************************************************************
HYDRODYNAMIC CLASSIFICATION:
```

```
  *----------------------*
  | FLOW CLASS  = NH1A5 |
  *----------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 5 m
****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

--------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the SURFACE:
 1) directly above the port/diffuser center for submerged discharges, OR:
 2) at the point of entry into the water for above surface discharges,
 200 m from the left bank/shore.
  Number of display steps NSTEP = 200 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 = 7124.0508 mg/l
  Dilution at edge of NFR              s = 6.7
  NFR Location:                        x = 2.39 m
     (centerline coordinates)          y = -2.24 m
                                       z = -5 m
  NFR plume dimensions:  half-width (bh) = 0.78 m
                          thickness (bv) = 0.78 m
Cumulative travel time:        8.1069 sec.
--------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is greater than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is NEGATIVELY BUOYANT and will tend to sink towards
  the bottom.
--------------------------------------------------------------------------
Benthic attachment:
  For the present combination of discharge and ambient conditions, the
  discharge plume becomes attached to the channel bottom within the NFR
  immediately following the efflux.  High benthic concentrations may occur.
--------------------------------------------------------------------------
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 has been specified.
However:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard               = 32  mg/l
  Corresponding dilution               s = 1500
  Plume location:                      x = 689.52 m
     (centerline coordinates)          y = -2.24 m
                                       z = -5 m
  Plume dimensions:      half-width (bh) = 43.84 m
                          thickness (bv) = 3.07 m
******************** FINAL DESIGN ADVICE AND COMMENTS *********************
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).
```

Appendix E

Curriculum Vitae (CV)
David M. LaLiberte, Principal Engineer

David M. LaLiberte, P.E.
Principal Engineer

Summary:

Mr. LaLiberte's qualifications comprise over 25 years of experience in surface water quality analysis and evaluation, hydrology and hydraulics, stormwater system analysis, biological criteria for water and sediments, environmental quality control, sewage and industrial pollution abatement, effluent treatment alternatives and design, discharge requirements for NPDES wastewater and stormwater permits, mixing zone assessment, water intake and thermal discharges and environmental design. He has managed and performed on many environmental project teams assisting state and federal agencies, as well as municipal and industrial facilities, and non-governmental organizations in Oregon, California, Washington, Alaska and throughout the USA.

Education: M.S., Civil Engineering, Portland State University, 1990
                        B.S., Civil Engineering, Portland State University, 1988

Registration: Professional Engineer, Oregon (Civil and Environmental)

Liberte Environmental Associates, Inc. Experience:

Review of the Medford STP Nutrient Related Discharges, for CRAG Law Center in Portland, Oregon. Evaluation of treatment facility and nutrient discharges from the Medford Sewage Treatment Plant (STP) into the Rogue River in Jackson County, Oregon. Existing discharges were evaluated for nutrient concentrations based on the discharger's CORMIX mixing zone analysis. Facility costs to upgrade for nutrient removal, including nitrogen and phosphorus, were developed. This project was performed in 2015 through 2017.

Evaluation of Sewage Treatment Plant Discharges to the Illinois River, Oregon, for the City of Cave Junction. Mixing zone analysis using EPA CORMIX was performed to determine the effects of temperature and other discharge parameters on river quality. Hydraulic analysis of river flow conditions was conducted to support the MZ analysis particularly for critical summertime conditions. This project was performed in 2013 through 2014.

Draper Valley Farms, Inc. Chicken Processing Industrial Discharge to Municipal Sewage System, for Smith and Lowney, PLLC representing the plaintiff Waste Action Project Citizens Suit. The effects on sewage treatment processes were evaluated relative to high biochemical oxygen demand (BOD) from Draper Valley Farms (DVF). A key focus of this analysis was the operational consequences of excess BOD on treatment in the aeration basins of the Mt. Vernon, WA municipal facility. The pass-through impact on the Skagit River was assessed for increased BOD from the industrial discharge. This project was conducted in 2014 and 2015.

Coal Discharge Investigation for the Columbia River and Selected Tributaries, for the Sierra Club supported by the Columbia Riverkeepers. Prospective coal samples were collected from

sediments along 18 miles of the Columbia River located at the confluences of selected tributaries from Rock Creek (RM 150.0) to the White Salmon River (RM 168.3). Sampling locations corresponded to Burlington Northern Santa Fe (BNSF) railroad crossings at or near tributaries. The distribution of coal discharges into the Columbia River were mapped. Samples were analyzed by a third party laboratory. Sample parameters were: moisture content, fixed carbon, volatile matter, ash and total sulfur. This was based on ASTM Proximate Analysis plus sulfur. Coal identification, to determine potential sources of coal, was completed for this investigation with the support of supplemental analysis advised by the laboratory. Supplemental analysis included ASTM D-388 requirements for heating value, sulfur in ash, free swelling index (carbonization physical characteristic) and classification of coal by rank. A deposition was provided in 2016 to defend the results of coal report. This project was performed in 2012 through 2013 and 2016.

NPDES Mixing Zone and Water Quality Evaluations for Trident Seafoods Corporation, Alaska – Effluent characterization, discharge system configuration, receiving waterbody consideration, biological criteria and mixing zone evaluations were performed. Acting as subconsultant for Steigers Corporation. Facility operations generating wastewater discharges include: stormwater runoff inflow, seafood-processing wastewater, non-contact cooling water, treated sanitary effluent and other sources of industrial effluents. The MZ evaluations conformed to NPDES permit requirements and mixing zone guidelines for Trident facilities in Alaska at Akutan and Sandpoint. This project was performed from 2010 through 2012.

Water Quality Evaluation of the Stormwater Management Plan (SWMP) Proposed for The Dalles, Oregon Wal-Mart Super Center for Karl Anuta, Attorney representing the plaintiff Citizens for Responsible Development in The Dalles. The effect on receiving water quality from stormwater discharges from a large retail facility was assessed in a report submitted to the Circuit Court of the State of Oregon. The detailed Expert Report was developed identifying the discharge conditions, storm flows based on local precipitation, storm flow mapping and routes, potential treatment levels using mechanical filtration and swales and other WQ issues. Water quality effects on receiving wetlands and tributaries of the Columbia River were investigated because of increased solids, toxics and bacterial loadings to be released from the proposed facility. Expert Testimony was provided in court supporting the evaluation report. This project was conducted in 2012 and 2013.

NPDES Water Quality Technical Assistance and Alternative Design Evaluations for North Slope Borough, Alaska – Evaluation of US Environmental Protection agency NPDES permit for discharges from oil and gas facilities including discharges from: stormwater system, drilling operations, cooling water intake and discharge, storage facilities, pipelines, gravel pits, treated sewage discharges, maintenance requirements, and other types of discharges. These discharges include stormwater affected deck drainage, cooling water intake and thermal discharges, treated sewage discharges and drill cuttings disposal to marine sediments. Water quality evaluation of the Camden Bay Exploration Plan for the Beaufort Sea of the Arctic Ocean was conducted for discharge impacts on the marine aquatic environment and relative to BOEMRE/MMS EIS. Analysis of the Chukchi Sea Exploration Plan of the Arctic Ocean was conducted for discharge impacts on the marine aquatic environment and relative to BOEMRE/MMS EIS. These evaluations were based on water quality and treatment alternatives assessment, and comparison to biological criteria. This project was conducted in 2010 through 2011.

Aurora STP NPDES Assessment for CRAG Law Center - Review of documents related to the design, operation and monitoring of the Aurora, Oregon Sewage Treatment Plant. Documents include: NPDES permit; stormwater inflow and infiltration, design related plans and specifications including recent headworks unit design; discharge monitoring reports, irrigation using effluent reuse, biosolids monitoring reports; effluent reuse plan and additional information relating to the design and operation of the Aurora STP. The review provided a basis for assessing potential causes of facility underperformance and discharge violations. An STP site visit was performed during this project to investigate facility aeration treatment, reuse equipment and capacities. This project was conducted from 2008 through 2010.

Field Survey Report on the Willamette River West Linn Paper Company Outfall for Sierra Club including sampling. In coordination with staff and volunteers, water and sediment samples were collected in the vicinity of the paper mill outfall diffuser for laboratory analysis. To locate the outfall, in-situ Hydrolab water quality measurements were taken with depth for temperature, dissolved oxygen, pH, conductivity, and turbidity. Laboratory samples were analyzed for potentially toxic concentrations of metals including aluminum, arsenic, cadmium, chromium, copper, lead, nickel, silver and zinc. Laboratory analytical results for sediments were compared to available criteria and substantial toxic contamination was revealed. The *WLPC Mixing Zone Modeling Study* (2003) submitted by the discharger was evaluated relative to the distribution of contaminates at the outfall site. Additional information sources were investigated using the Oregon DEQ permit file and including the mill's NPDES permit, compliance schedule for repairing the damaged WLPC outfall, and the related NOAA Fisheries Biological Opinion (BP). This project was performed in 2007 and 2008.

Oregon Department of Environmental Quality - WQ Technical Assistance: Industrial discharge effluent evaluation of the Port of St. Helens, Oregon ethanol and power generating plants. Outfall mixing zone analysis with design assessment was developed. Provided water quality evaluation and environmental engineering assistance to the Oregon DEQ. Work included receiving WQ analysis, operations review, thermal discharge evaluation, biological criteria comparison and mixing zone analysis. NPDES requirements were based on EPA *Quality Criteria for Water*, EPA *Technical Support Document for Water-based Toxics Control* (TSD) and State Administrative Rules. The mixing zone models CORMIX and PLUMES were evaluated relative to the cases at hand. Potential discharge chlorine residual and temperature requirements were evaluated. The effect of potential temperature Total Maximum Daily Loads (TMDLs) in the Columbia River was also evaluated. This project was performed in 2003 through 2004.

Wauna Pulp and Paper Mill Outfall 003 and Columbia River Field Survey Locations and Sampling Results for Columbia Riverkeeper including sampling. In coordination with staff and volunteers, water samples were collected in the vicinity of the paper mill outfall for laboratory analysis. The physical outfall mixing zone was mapped using in-situ Hydrolab water quality measurements taken with depth for temperature, dissolved oxygen, pH, conductivity and turbidity. Laboratory samples were analyzed for potentially toxic concentrations of dioxins, total residual chlorine (TRC) and metals including aluminum, arsenic, copper, iron, lead, mercury and zinc. Additional information sources were investigated using the Oregon DEQ

permit file and including the mill's NPDES permit and the mutual agreement and order (MAO) compliance schedule. This project was conducted in 2004.

Aurora STP NPDES Assessment for CRAG Law Center - Review of documents related to the design, operation and monitoring of the Aurora, Oregon Sewage Treatment Plant (2008-09). Documents include: NPDES permit; stormwater inflow and infiltration, design related plans and specifications including recent headworks unit design; discharge monitoring reports, irrigation using effluent reuse, biosolids monitoring reports; effluent reuse plan and additional information relating to the design and operation of the Aurora STP. The review provided a basis for assessing potential causes of facility underperformance and discharge violations. An STP site visit was performed during this project to investigate facility aeration treatment, reuse equipment and capacities. This project was conducted from 2009 through 2010.

Review of Draft and Final NPDES General Permit Cook Inlet, Alaska Oil and Gas Operators for Cook Inletkeeper - Evaluation of the draft National Pollutant Discharge Elimination System (NPDES) permit proposed by the U.S. Environmental Protection Agency (EPA) authorizing wastewater discharges from oil and gas exploration, development, and production facilities into Cook Inlet, Alaska. There are 18 existing facilities discharging into Cook Inlet with new facilities capable of being brought on line under the draft permit. Technical analysis of these discharges, which can contain toxic and bioaccumulating contaminants, was performed relative to the potential to adversely affect Cook Inlet water quality and sediments. This project was conducted from 2007 through 2009.

Water Quality Evaluations and NPDES Permit Requirements for the four (4) WES publicly owned treatment works (POTW) discharges (2000-2004, 1999) performed for Water Environment Services, Clackamas County, Oregon. These included evaluation of discharge effects on the Willamette River (2 outfalls), Sandy River and a tributary of the Clackamas River. Field water quality sampling including detailed outfall mixing zone investigations. Water quality assessment was conducted relative to effluent temperature, disinfection and ammonia requirements to protect fish and aquatic organisms. Effluent mixing zone simulation and analysis was performed. Treatment alternatives analysis and costing were undertaken to ensure existing and future discharge conditions were protective of river WQ. River outfall piping alignment and diffuser design was provided including construction management of river installation.

Expert Analysis of Surimi and Seafood Industrial Wastewater Discharge into the Skipanon and Columbia Rivers, Oregon (2003-2006) was conducted for the National Environmental Law Center. Water quality analysis evaluating the effects of seafood and surimi wastewater discharges on the Skipanon and Columbia Rivers, Oregon. Field data collection was performed to support water quality technical analysis. Investigation included mixing zone analysis of historic seafood and surimi wastewater discharges into the Skipanon River, and new discharges to the Columbia River. Evaluations were performed for various discharge scenarios, monitoring and sampling requirements, potential treatment options, and alternative outfall pipeline alignments. Effluent and instream dissolved oxygen (DO), biochemical oxygen demand (BOD), ammonia, hydrogen sulfide, nutrients nitrogen and phosphorus, oil and grease, and total suspended solids (TSS) were evaluated in detail. Expert witness analysis and reporting was provided.

Westport Sewer Service District, Clatsop County, Oregon - MZ Evaluation with Alternative Disinfection (2003-2004). This project assessed water quality and mixing zone effects of disinfected treated wastewater discharged to Westport Slough, a segment of the Columbia River. Chlorine residual reduction or elimination was a key evaluation concern to satisfy Oregon DEQ requirements. Comparisons of alternative disinfection treatment scenarios and costs were performed that would allow the discharger to continue to meet WQ requirements. Ultraviolet disinfection, chlorination-dechlorination, and outfall diffuser feasibility were all investigated with comparison costs. In particular, the existing chlorination system was evaluated relative to how easily it could be retrofitted to function with dechlorination. The alternatives analysis aided the discharger in making a determination as to course of action.

Public Employees for Environmental Responsibility preparation of report Effect On Puget Sound Chinook Salmon of NPDES Authorized Toxic Discharges as Permitted by Washington Department of Ecology (2005-2006). Industrial, municipal, stormwater and general facility NPDES permits were reviewed and analyzed relative to the presence of toxic contaminants in Puget Sound. Toxic contaminants evaluated included metals, hydrocarbons, and chlorinated hydrocarbons.

Citizens for Responsibility v. Izaak Walton League, Circuit Court of the State of Oregon for Lane County, Expert Analysis for Plaintiff evaluating the effects of lead contamination from shooting range into South Fork Spencer Creek (2004-2005). Sediment sampling was conducted for metals including lead, arsenic, copper and polynuclear aromatic hydrocarbons (PAH). This information was evaluated for pollutant distribution and transport from the contaminated site and relative to upstream and downstream properties. Expert testimony was given at trial in 2004. Expert analysis and testimony was also provided in the subsequent equitable relief phase. Participation in the settlement conference was also provided.

Canby Utility Board - Industrial Discharge from Water Treatment Plant Study and Predesign (1999-2000) addressing Molalla River water quality issues with Oregon DEQ including treatment alternatives: filter backwash sedimentation basin, disinfected effluent de-chlorination, river infiltration gallery design, intake piping system, and sediment and riparian effects mitigation.

Water Environment Services of Clackamas County Hoodland WWTP Outfall Project Descriptions and Costs (2000); FEMA engineering, budgeting and negotiations is intended to reimburse Clackamas County for flood damage to their wastewater treatment plant outfall on the Sandy River. Numerous regulatory issues affected costs including an ACE 404 permit for instream construction work, NMFS ESA Section 7 Consultation, and NEPA documentation including environmental and biological assessments.

City of Bremerton, CSO Projects --A comprehensive review of the City of Bremerton, Washington collection system model was performed (2000). Hydraulic modeling was used to update information for the main sewer lines, combined sewer overflows and discharge conditions. Selected CSO reduction alternatives were evaluated and implemented. The purpose of the CSO reduction alternatives was accomplished and potential early action projects were identified. These projects yielded substantial CSO reductions while being quickly implemented

at reasonable cost. Revised CSO baselines were produced conforming to Washington Department of Ecology requirments for Bremerton's 17 CSO outfalls. Expert witness testimony supporting the findings of the CSO baselines was provided in a hearing at the Federal Court in Seattle.

Previous Experience (Montgomery Watson Americas)
In addition, I have performed as project manager and/or project engineer on the following undertakings:

- Project Manager/Engineer evaluating stormwater hydrologic, hydraulic and quality conditions in Balch Creek Basin for the City of Portland, Bureau of Environmental Services, Oregon. The Army Corps of Engineers (COE) hydrographic model, (HEC-1) and hydraulic model (HEC-2) were applied to establish design criteria for flood magnitude, stormwater detention, water quality facility hydraulics and fish passage culvert hydraulics.

- Project Engineer evaluating stormwater hydrologic, hydraulic and quality conditions in Clackamas County for the CCSD#1. The graphically enhanced model, XP-SWMM, was used to develop the hydrology and hydraulics for the Kellogg and Mt. Scott Creeks basins in CCSD#1.

- *City of Portland, Bureau of Environmental Services* included Water Quality Evaluations and Diffuser Designs (2000-2001, 1997,1994) for wet and dry weather flows with chlorine residual discharges, and wet weather stormwater runoff for suspended solids and metals with potentially affected agencies including US Corps of Engineers, Oregon Division of State Lands, NOAA Fisheries, Oregon Dept. of Fish and Wildlife and US Fish and Wildlife.

- Project Manager/Engineer for the Kensington Mine in Alaska. PLUMES mixing zone modeling was used to evaluate the conditions affecting this industrial outfall. Sedimentation basin design for removal of mine tailings prior to discharge to Lynn Canal.

- City of Bremerton Corrosion and Fluoridation Facility detention facility design. An on-site detention facility was designed pursuant to Washington Department of Ecology's requirements as specified in the *Puget Sound Stormwater Management Manual*.

- Project Engineer for Water Environment Services of Clackamas County Kellogg Creek WWTP Odor Control Project. Participated as team engineer to design malodorous air collection system for headworks, primary clarifiers, secondary clarifiers, and dissolved air floatation thickening (DAFT) building. Malodorous air was passed through a biofilter for treatment.

- Project Engineer for Crescent City, California WWTP outfall mixing zone analysis. A major consideration of this project was developing alternative outfall pipeline alignments and an effective discharge location to optimize mixing.

- Project Manager/Engineer for the Hoodland WWTP Outfall project, which includes outfall diffuser design and construction (1998) in a sensitive Sandy River corridor.

- Project Task Manager—Jefferson County (Birmingham, Alabama) stream water quality analysis was performed relating to recommended NPDES permit limits for dry and wet weather conditions. Collection system analysis and treatment plant design constraints are also considerations in this potentially very large project.

- Project Engineer using Pizer's HYDRA, data compatible with the City of Portland, Oregon's XP-SWMM format, to evaluate gravity flow conditions in the proposed dual outfall system consisting of two connected parallel outfall systems over one mile each and including wet weather (CSO) hydraulic structures such as flow control structures, mix boxes and outfall diffusers.

- *City of Madison, Wisconsin* - stream water quality modeling analysis of POTW discharge relative to NPDES permitting requirements (1995-1996). A key objective of this study was restoration of base flows to the Sugar River Basin using high quality POTW effluent. An EPA QUAL2E model was developed for Badger Mill Creek and the Sugar River. Physical, chemical and biological simulation included temperature, algae, dissolved oxygen (DO), biochemical oxygen demand (BOD), total suspended solids (TSS) and ammonia. Particular attention was focused on the inter-relationships between temperature, climatological conditions, stream shading and channel conditions, DO, BOD and algal activity. Temperature and discharge point design alternatives were investigated using the model. It was demonstrated that, with minimal WWTP facility upgrading and cost, the City could beneficially discharge high quality effluent to surface streams. This assurance was primarily accomplished through detailed modeling analysis and model approach consensus building with regulators (WDNR). Some keys to the success of this project were in identifying important NPDES permitting issues, evaluating them with the model, recommending permit effluent limits and negotiating with regulators.

- *Washington Beef, Incorporated* in Toppenish, Washington – Development of an NPDES permit under the direction of the EPA (1993-94). The project objective was development of receiving water based permit effluent limits for this food-products industry discharger using dissolved air floatation (DAF) treatment. Important project elements were: interfacing with regulatory (EPA Region 10 and Washington Ecology) and public agencies; evaluation of the effect of effluent parameters on receiving water using modeling analysis (EPA QUAL2E and EPA CORMIX); and providing long-term treatment system design recommendations. Fishery issues were of key concern for this project. Receiving water modeling was used to analyze the discharge effects of on stream dissolved oxygen and temperature on the aquatic environment. The inter-relationship between temperature, climatological conditions, stream shading and channel conditions, DO and algal activity were thoroughly investigated. Temperature and discharge design alternatives were evaluated using the water quality model.

Previous Experience (Brown and Caldwell)
- *Oregon Department of Environmental Quality and Oregon Department of State Land Conservation and Development* - Non-point Source Pollution Control Guidebook for Local

Government (1994) evaluation of non-point runoff pollution and control measures including detention facilities, sedimentation basins, water quality ponds and marshes; City of Portland, Bureau of Environmental Services (1989-90) - evaluated effects of combined sewer overflows and stormwater discharges on the Columbia Slough of the Columbia River. Hydrologic and water quality modeling support was provided including sampling.

- Project Engineer for NPDES waste discharge permit review and support related to permit effluent limits for the City of Vancouver, Washington. Two tracer dye studies were performed at their two municipal WTP outfalls. The key project objective was to determine actual outfall dilution and provide a physical, receiving water basis for setting permit effluent limits. The mixing zone evaluations showed that actual dilution was greater than estimated by the regulatory agency (Washington Department of Ecology) and higher permit effluent limits were recommended.

- Project Task Manager and Engineer for a comprehensive hydraulic and water quality compliance evaluation and recommendations. The City of Portland's Columbia Boulevard WTP, the largest municipal discharger in Oregon (300 MGD), required assistance in meeting their water quality compliance needs. A highly detailed Columbia River tidal flow evaluation was performed in the outfall vicinity to serve as the basis for the mixing zone simulation and diffuser design. EPA CORMIX, and the EPA supported PLUME model family (including UDKHDEN), were used in the modeling analysis. A thorough investigation of water quality compliance options led to regulatory (ODEQ) approval of the multi-port diffuser design, the lowest cost compliance option.

- Project Engineer for Kehei, Hawaii Water Reuse Facility (1992). Participated as team engineer to design upgrades to the facility's aeration basin including aeration blower design and aeration basin air piping with small bubble diffusion.

- Project Engineer for the Columbia Slough flow augmentation project for the City of Portland Bureau of Environmental Services, Oregon. Dynamic water quality modeling (COE CE-QUAL-W2), water quality sampling, and hydrodynamic sampling were performed for this dynamic "freshwater" estuary. This project was driven by the City's need to evaluate the impact of water quality limited conditions on the Columbia Slough and was coupled to the City's EPA SWMM model. The objective was to propose best management practices (BMP) and evaluate design alternatives. The effect of temperature on the aquatic environment was examined in detail. The sophisticated two-dimensional (vertical and longitudinal) dynamic model evaluated temperature regimes and their effect on in-stream water quality. In-stream temperature design alternatives were investigated via simulation of climatological conditions, stream shading and channel conditions, algal processes and kinetics, and instream DO.

- Project Engineer conducting stormwater hydrologic and hydraulic simulation to evaluate flood effects for the City of Beaverton, Oregon. HEC-1 hydrographic modeling was conducted to generate peak flow values from surface runoff for existing and future conditions. HEC-1 model results for 2, 5, 10, 25, 50 and 100-year storm events were supplied to the HEC-2 model for detailed hydraulic analysis. The HEC-2 modeling was required as part of a cost assessment that included potential flood damage of key storms.

David M. LaLiberte (Continued)

- Project Manager and Engineer for a mixing zone evaluation and diffuser design for the City of Albany, Oregon. An outfall pipeline and 40 MGD capacity multi-port diffuser was designed for this municipal discharger using EPA CORMIX. Simulation was performed to optimize the diffuser design. The DEQ approved design will meet water quality compliance needs for chlorine and ammonia.

- Project Engineer mixing zone modeling and design for the City of Gresham, Oregon. Alternative disinfection and multiport diffuser design were evaluated. Modeling (EPA CORMIX) was utilized to optimize multiport diffuser design for this WWTP outfall. Simulation offered the flexibility to test numerous design conditions.

- Project Manager and Engineer for a mixing zone evaluation and diffuser design for the Unified Sewerage Agency, Washington County, Oregon. Analysis of four municipal treatment facility outfalls was conducted according to DEQ NPDES requirements. Model simulation was performed to determine revised wet weather chlorine residual effluent limits. The models were calibrated to dye study results. Wet weather stream surveys were also performed at two sites, Hillsboro and Forest Grove. Alternative disinfection was evaluated and diffuser design recommendations were also made.

- Project Manager and Engineer for outfall mixing zone simulation and water quality compliance evaluation for the Oak Lodge Sanitary District, Oregon. As part of NPDES permit requirements, model simulation was performed to characterize the municipal discharge-mixing zone. Available dilution values and recommended permit effluent limits for chlorine, ammonia and metals were derived from the study.

- Project Manager for a mixing zone evaluation and diffuser recommendations for Electronic Controls Devices, Incorporated. A mixing zone field evaluation of this circuit board manufacturer's discharge was performed. Very low amounts of organics and metals from the facility discharge needed to be discharged to a small stream in a responsible manner. This study illustrated that the discharge was well within compliance requirements.

Previous Experience (Portland State University Research Assistant)
City of Portland, Bureau of Environmental Services (1989-90) - evaluated effects of combined sewer overflows and stormwater discharges on the Columbia Slough of the Columbia River. Hydrologic and water quality modeling support was provided including field sampling.

- Project Engineer for evaluation of fish screen approach velocities and hydraulic design analysis for the Eugene Water and Electric Board, Leaburg, Oregon. The effects of downstream baffles on velocities through fish screens at the Leaburg Power Canal Facility were evaluated for fish passage.

- Project Engineer evaluating combined sewer overflows (CSO) and stormwater discharges on the Columbia Slough. Hydrologic and water quality modeling, using the City's EPA SWMM model data, of urban runoff from sub-basins discharging to the Columbia Slough was supplied as input to the Army Corps of Engineers in-stream surface water model, CE-

David M. LaLiberte (Continued)

QUAL-W2. This study was performed for the City of Portland, Bureau of Environmental Services in Oregon.

- Project Engineer for the South Slough National Estuarine Reserve Hydrodynamic and Water Quality Study, State of Oregon, Division of State Lands, Charleston, Oregon. Dynamic water quality modeling, water quality sampling, and hydrodynamic sampling were performed for this southern section of the Coos Bay estuary. Tracer (rhodamine) dye study results were used to calibrate the Army Corps of Engineers CE-QUAL-W2 model.

- Project Engineer for design of stream flow measurement structures on two tributaries of the South Slough National Estuarine Reserve (State of Oregon, Division of State Lands) in Charleston, Oregon. Analysis and design of stream flow measurement structures was required as part of a study assessing the hydrology and hydraulics of this pristine estuary.

- Project Engineer for a hydrologic, hydraulic and water quality assessment of Smith and Bybee Lakes in Portland, Oregon. Lake sampling and modeling was performed. The objective of the study was to evaluate the potential for water quality impairment due to the close proximity of St. John's municipal landfill and Columbia (North) Slough inflow. A hydraulic model of possible flow control structures was incorporated into the Army Corps of Engineers CE-QUAL-W2 hydrodynamic and water quality model. Recommended actions were advanced for improving lake water quality based on simulation scenarios. This study was conducted as part of a larger study for the Port of Portland, Metropolitan Service District, and City of Portland, Bureau of Environmental Services, Portland, OR.

- Project Manager and Engineer assessing the water quality impact of urban runoff from the Leadbetter storm outfall discharge to Bybee Lake. This study was conducted for the Port of Portland, Portland, Oregon.

- Project Engineer assisting in initial field work and model development for assessing impact of landfill leachate on surrounding surface waters. Conducted for the Metropolitan Service District (METRO) as part of the St. Johns Landfill closure.

Publications and Presentations

Stream Temperature Trading, Presented at the Pacific Northwest Pollution Control Annual Conference, 2001, Bend, Oregon.

Winter Temperature Gradients in Circular Clarifiers (January 1999), *Water Environment Research*, **70**, 1274.

Wet Weather River Diffuser Port Velocities: The Energetic Debate, Presented at the Pacific Northwest Pollution Control Annual Conference 1998, Portland, Oregon.

Near Field Mixing and Regulatory Compliance Implications Presented at Portland State University, February, 1998.

Whither the Wet Weather Flow, Presented at the Pacific Northwest Pollution Control Annual Conference 1997, Seattle, Washington.