# TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

*Protecting Texas by Reducing and Preventing Pollution*

April 15, 2010

LaDonna Castañuela
Texas Commission on Environmental Quality
Attention: Docket Clerk, MC 105
P.O. Box 13087
Austin, Texas 78711-3087

Re: In the Matter of the Application by Farmersville Investors, LP. for a new TPDES Permit No.WQ0014778001;
TCEQ Docket No. 2008-1305-MWD; SOAH Docket No. 582-09-2895

Dear Ms. Castañuela:

Enclosed is the original and 7 copies of the Executive Director's Exceptions to the Administrative Law Judge's Proposal For Decision in the above-named and numbered cause. If you have any questions, please do not hesitate to contact me at (512) 239-3417.

Sincerely,

Kathy J. Humphreys
Staff Attorney
Environmental Law Division

Enclosure

cc: Mailing List

# TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

*Protecting Texas by Reducing and Preventing Pollution*

April 15, 2010

The Honorable Sharon Cloninger
Administrative Law Judge
State Office of Administrative Hearings
P.O. Box 13025
Austin, Texas 78711-3025

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**SOAH DOCKET NO. 582-09-2895**
**TCEQ DOCKET NO. 2008-1305-MWD**

| | | |
|---|---|---|
| **IN THE MATTER OF THE APPLICATION OF FARMERSVILLE INVESTORS, LP FOR A NEW TEXAS POLLUTANT DISCHARGE ELIMINATION SYSTEM (TPDES) PERMIT NO. WQ0014778001** | § § § § § § | **BEFORE THE STATE OFFICE OF ADMINISTRATIVE HEARINGS** |

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## EXECUTIVE DIRECTOR' S EXCEPTIONS TO THE ADMINISTRATIVE LAW JUDGE'S PROPOSAL FOR DECISION

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**TO THE COMMISSIONERS OF THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY:**

The Executive Director of the Texas Commission on Environmental Quality (TCEQ) submits the following specific exceptions (Exceptions) to the Proposal for Decision (PFD) filed by the Administrative Law Judge (ALJ) relating to the application by Farmersville Investors, L.P. (Farmersville) for Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ0014778001.

## I. INTRODUCTION

In consideration of the exceptions and policy arguments set forth herein, the Executive Director respectfully requests that the ALJ amend the PFD to support the approval of the Application and the issuance of Draft TPDES Permit No. WQ0014778001 (Draft Permit). Should the ALJ decide not to amend the PFD, the Executive Director requests that the Commission: (1) not adopt the ALJ's Order as presently proposed and attached to the PFD, and (2) adopt a Revised Order approving the Application and the issuance of the Draft Permit. The Executive Director supports the ALJ's findings of fact and conclusions of law not specifically excepted to in these exceptions at this time.

## II. STANDARD OF REVIEW

ALJs have the regulatory authority to amend their PFDs in response to exceptions, replies, or briefs filed by the parties.[1] Should the ALJ decide not to amend the PFD, the Commission may modify the ALJ's order or change an ALJ's finding of fact or conclusion of law if the Commission determines that: (1) the ALJ improperly applied or interpreted the law, agency rules or policies, or prior administrative decisions; (2) the ALJ based her decision on a prior administrative decision that is incorrect; or (3) a finding of fact contains a technical error requiring correction.[2] Any amendment to the PFD and the accompanying order must be based solely on the record made before the ALJ, and must include an explanation of the basis of the amendment.[3]

## III. EXCEPTIONS TO FINDINGS OF FACT, CONCLUSION OF LAW, AND ORDERING PROVISIONS

The Executive Director files exceptions to the Findings of Fact 24, 32, 35-37 Conclusion of Law 8, 10 and 13, and Ordering Provision 1. These findings of fact and conclusions of law are against the great weight of the evidence in the record, and are contrary to the Rules, Implementation Procedures (IPs) and policy. As such, they should be modified by the ALJ or revised by the Commission.

### *A. The Executive Director Properly Modeled Dissolved Oxygen.*

Ms. Murphy testified on behalf of the Executive Director that the Farmersville discharge would be to an unnamed tributary; thence to the Elm Creek Arm of Lavon Lake in

[1] 30 TEX. ADMIN. CODE § 80.259.
[2] TEX. GOV'T. CODE § 2001.058(e).
[3] *Id.* at § 2003.047(m).

Segment 0821 of the Trinity River Basin.[4] The ALJ, however, concurred with OPIC's argument that Farmersville did not present sufficient evidence to show by a preponderance of the evidence that the discharge will not be directly into Lavon Lake when the lake is high.[5] Therefore, the ALJ recommended that the Executive Director perform additional modeling to "address occasional discharge directly into Lavon Lake."[6] The Executive Director respectfully contends that the ALJ improperly applied the TCEQ's rules and guidelines regarding modeling for dissolved oxygen. The ALJ's recommendation that additional modeling be done to address occasional discharges directly to the lake, is not practical, nor is it supported by TCEQ rules or procedures.

1. <u>The Administrative Law Judge Improperly Interpreted TCEQ's Modeling Procedures.</u>

According to the US Army Corps of Engineers website, the historical high elevation of Lavon Lake is 504.93 feet above mean sea level;[7] normal pool elevation is 492 above mean sea level.[8] Therefore, if the Commission adopts the PFD as drafted, the Executive Director will be required to develop multiple models – a daunting and dangerous precedent.

Mr. Michalk, the modeler who testified on behalf of the Executive Director, testified that when a discharge is entering a lake via a stream channel, the lake is assumed to begin at the farthest upstream extent of the lake at normal pool elevation.[9] The Texas Surface Water Quality Standards define the boundary of Lavon Lake as extending *up to* the normal pool

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[4] Ex. ED-10 11:1-9 (Prefiled Testimony of Ms. Murphy) and Ex. ED-14 10-11:20-10 (Prefiled Testimony of Mr. Michalk).
[5] Proposal For Decision at 13.
[6] *Id.* at 17.
[7] http://www.swf-wc.usace.army.mil/maxmin.pdf. Attachment A.
[8] Ex. ED-14 12:3. Hr'g Tr. 195-196:25-6; 285:21-25; Hr'g Tr. 358:2-4.
[9] Ex. ED-14 11-12:20-1.

elevation of 492 above mean seal level.[10] *Emphasis added.* Water levels of lakes in Texas are not static; at times the dam forming Lavon Lake will impound water above the normal pool elevation, at times the water level will be lower than normal pool elevation.[11] So, even if the dam occasionally causes water to rise above the normal pool elevation, these additional impounded waters are not part of the classified portion of Lavon Lake, but rather part of the unnamed tributary. The uses and water quality criteria assigned these above normal pool, occasionally impounded waters, would not necessarily be the same as those assigned to the lake.

Mr. Michalk testified he used the QUAL-TX model for the unnamed tributary and the Elm Creek system and the Continuously Stirred Tank Reactor (CSTR) model (also known as simplified pond model) for the arm of Lavon Lake.[12] The CSTR model is used to assess DO impacts in ponds, small lakes, and portions of larger lakes and bays.[13] Dr. Jonathan Young, P.E., who testified on behalf of Farmersville, verified the Executive Director's modeling and performed additional modeling using QUAL-TX and CSTR, but changed some of the parameters.[14] Dr. Young was able to reproduce the Executive Director's results, however he noticed that the Executive Director used a lower reaeration rate than is sometimes used resulting in a conservative (i.e. more protective) prediction of the impact of the Farmersville discharge on the water quality of Lavon Lake.[15]

[10] 30 TEX. ADMIN. CODE § 307.10.
[11] Hr'g Tr. 184:7-13; Hr'g Tr. 275:6-9; Hr'g Tr. 291-292:20-24.
[12] Ex. ED-14 5:10-12.
[13] Ex. ED-14 5:17-18.
[14] Ex. APP-6 17-18:5-12.
[15] Ex. APP-6 18-19:18-7.

The Executive Director respectfully asserts that the ALJ's proposal does not account for the complexity of designing and running a model, even when data on the receiving waters is known. Modelers using the CSTR model are guided by a Standard Operating Procedure (SOP).[16] According to the SOP, there are at least seven discrete steps necessary for a CSTR analysis, including:

- defining the model segmentation (i.e. the discharge route must be divided into cells);
- determining the area and depth for each cell;
- verifying that the default rates and constants are used;
- setting the wastewater and incremental flow quality at "no-load" values;
- initializing the model by adjusting the sediment oxygen demand;
- estimating necessary effluent limits (and refining the model if data are available);
- evaluating the results; and
- issuing a recommendation.[17]

Dr. Young's CSTR models are found on pages 24-28 of Ex. JY-5. By comparing the models on pages 24-28 to one another, it is evident that even if the same basic model is used, the input parameters are different, resulting in different DO predictions. Of particular importance is the data input in columns B-N, rows 21-22 that characterize water body dimensions. Row 21 is the surface area and row 22 is the depth.[18] Each column is a computational cell, or segment representing a portion of the receiving water. According to the SOP for the CSTR model, each cell should not exceed 10 surface acres, but may be

[16] *See, Water Quality Assessment Team – Evaluation TPDES Permit Applications Using a Continuously Stirred Tank Reactor (CSTR) Model*, Reviewed/Updated 6/20/07. Attachment B.
[17] *Id.* at 7.
[18] JY-5 25

smaller depending on the water body geometry.[19] The number of cells needed depends on the water body geometry, cell sizing guidelines and the size of the discharge.[20] To determine the cell area the modeler uses tools included with the GIS software, and cell depth is estimated using topographic maps, information in the permit application or other resources.[21] As the level of Lavon Lake rises, the dimensions of the cove formed by the impoundment of the water in the unnamed tributary will change. Data necessary to describe model cell dimensions for all elevation possibilities may not be available to determine the dimensions of each cell for hypothetical lake elevations.

As one can tell from the above discussion, the development of a model for a single pool elevation where data on the water body is known is complex and time-consuming. To develop a model for various pool elevations where data on the water body is unavailable would be extremely time consuming and would cumulate in results of questionable value because of the transitory nature of lake elevations. For these reasons, the standardized analytical approach described in the SOPs for the CSTR model, that incorporates conservative assumptions, is a practical and efficient approach for developing protective effluent limits for discharge permits.

2. <u>The Administrative Law Judge's Recommendation That the Executive Director Perform Additional Modeling is not Supported by the TCEQ's Rules or Guidance</u>

The approach suggested by the Administrative Law Judge is not supported by TCEQ's rules or guidance and would set a dangerous precedent. There are many domestic wastewater treatment plants (WWTPs) that discharge into tributaries of lakes in Texas. In fact out of the

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[19] *See, Water Quality Assessment Team – Evaluation TPDES Permit Applications Using a Continuously Stirred Tank Reactor (CSTR) Model*, Reviewed/Updated 6/20/07, at 2. Attachment B.
[20] *Id.* at 3
[21] *Id.* at *3*.

17 permits the Protestants submitted in their prefiled testimony, nine discharge into a tributary, while the remaining eight discharge directly to Lavon Lake.[22] It would quickly become unwieldy if the Executive Director were required to evaluate every discharge near lakes at several pool elevations; this is not the approach contemplated by the IPs, nor SOPs. Moreover, modeling at multiple intervals is not supported by either the *Procedures to Implement the Texas Surface Water Quality Standards* (IPs)[23] or the SOPs for the CSTR. The IPs state "[A]n uncalibrated QUAL-TX model is normally used to evaluate streams and rivers upstream of the normal pool elevation of the reservoir."[24] The SOPs provide:

> If using DOQQs [layers of aerial photos] of reservoirs, determine the pool elevation (using USGS or other resources) for the date on which the aerial was shot to see *whether a correction to cell area is needed due to a difference from normal pool elevation. . . . Be sure to use the normal pool elevation* that is contained in Chapter 307 of the TCEQ rules for classified segments"[25] *Emphasis added.*

Because modeling at multiple intervals is not supported by the IPs or SOPs and would set a dangerous precedent, the Executive Director respectfully recommends the following changes to the Order:

Findings of Fact:

24. Existing water quality uses will be maintained and protected and no significant degradation of Lavon Lake will occur if the Draft Permit is issued with ~~a modified~~ DO requirement of 4.0 mg/L ~~to protect Lavon Lake when the water backs into the intermittent stream and discharge is directly into the lake~~.

[22] Ex. Martin 15
[23] Ex. ED-12.
[24] Ex. ED-12 21:Tributaries of lakes and reservoirs.
[25] See, *Water Quality Assessment Team – Evaluation TPDES Permit Applications Using a Continuously Stirred Tank Reactor (CSTR) Model*, Reviewed/Updated 6/20/07, at 3. Attachment B.

32. The correct discharge route is reflected in both the Standards Memo and the Draft Permit ~~except that when the lake is above normal pool elevation, discharge could be directly into Lavon Lake~~.

35. At the proposed Final Phase permitted discharge of 0.5 MGD, an effluent set of 10 mg/L $CBOD_5$, 3 mg/L $NH_3$-N and 4.0 mg/L DO will ~~be adequate to~~ ensure that ~~5.0 mg/L DO criterion for Lake Lavon will be maintained and its existing water quality use will be protected~~ the dissolved oxygen levels will be maintained above the criteria for the unnamed tributary (2.0 mg/L) and Lavon Lake (5.0 mg/L).

37. The discharges under the terms of the Draft Permit will meet the requirements of 30 TAC ch. 307 and will protect the water quality of the unnamed tributary and Lavon Lake ~~when the discharge is directly into the lake~~.

Conclusions of Law:

8. The Draft Permit will ~~a modified to~~ protect the water quality of Lavon Lake ~~when discharge is directly into the lake~~ and the proposed Farmersville discharge will ~~would~~ satisfy the requirements of the Commission's numerical stream standards. 30 TEX. ADMIN. CODE ch. 307.

10. The discharges under the terms of the Draft Permit will meet the requirements of 30 TEX. ADMIN. CODE ch. 307 because the DO ~~requirement~~ effluent limit of 4.0 mg/L will protect the water quality of the unnamed tributary and Lavon Lake.

Ordering Provisions:

1. The application of Farmersville, LP, for Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ001478001 is granted. ~~with the aforementioned~~

~~change to the DO requirement.~~

## *B. Design Plans and Specifications Review*

TCEQ's rules require owners of WWTP submit a "summary transmittal letter" for each collection and treatment facility,[26] then if requested by the Executive Director the owner must submit a complete set of plans and specifications.[27]

The draft permit requires:

> Prior to construction of the wastewater treatment facilities interim I, interim II, and final phases, the permittee shall submit to the TCEQ Wastewater Permitting Section (MC 148) a summary submittal letter in accordance with the requirements in 30 TAC Section 217.1. If requested by the Wastewater Permitting Section, the permittee shall submit plans, specifications and a final engineering design report which comply with 30 TAC Chapter 217, Design Criteria for Sewerage Systems. The permittee shall clearly show how the treatment system will meet the final permitted effluent limitations required on Page 2, 2a, and 2b of the permit.[28]

There was no testimony offered at the hearing that a full plans and specifications review is necessary. Mr. Trede testified that the final plans and specifications are not required until the permit is final and that he does not perform the review.[29] Additionally, the plans and specification review, whether by a summary transmittal letter or by a full plans and specification review, is governed by 30 TEX. ADMIN. CODE ch. 217, not 30 TEX. ADMIN. CODE ch. 307. The Executive Director, therefore, respectfully recommends the following clarificatons to the Order:

Findings of Fact:

36. If the Draft Permit is approved, Farmersville will be obligated to then submit a summary transmittal letter ~~its design plans and specifications~~ for review by the ED to

[26] 30 TEX. ADMIN. CODE § 217.6(c)
[27] 30 TEX. ADMIN. CODE § 217.6(f).
[28] Ex. ED-5 25:Paragraph 7.
[29] Ex. ED-1 18-19:13-2.

ensure compliance with requirements set out in 30 TEX. ADMIN. CODE ch. 217, Design Criteria For Domestic Wastewater Systems ~~307, the Texas Surface Water Quality Standards.~~

Conclusion of Law:

13. Applicant is not required to prove compliance with 30 TEX. ADMIN. CODE ch. 217 prior to the issuance of a TPDES permit, but must submit a summary submittal letter ~~the plans and specifications~~ for the WWTP to the ED ~~TCEQ~~ for approval prior to construction of the facility.

***C. Relationship between the Application and Permit.***

The Administrative Law Judge stated that "[t]he ALJ further recommends that the Commission adopt OPIC's suggestions regarding amending the Application to conform to the Draft Permit specifications and adding language to the Draft Permit stating the provisions of the Draft Permit supersede the terms of the Application when the two are inconsistent."[30] This recommendation was not included in the Order. The Executive Director respectfully notes that this provision is in the permit submitted as exhibit ED-5. According to the Draft Permit, "[t]he application pursuant to which the permit has been issued is incorporated herein; provided, however, that in the event of a conflict between the provisions of this permit and the application, the provisions of the permit shall control."[31] Therefore, the Executive Director recommends that a provision requiring the permit to control over the application not be added to the Order.

[30] Proposal For Decision 27:1st paragraph.
[31] Ex. ED-5 11:Item 10.

## III. CONCLUSION

The Executive Director concludes that Farmersville has satisfied all applicable statutory and regulatory requirements in its application for Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ0014778001, and that Draft TPDES Permit No. WQ0014778001 meets all applicable statutory and regulatory requirements and can be issued without any additional provisions.

Respectfully submitted,
Texas Commission on Environmental Quality

Mark R. Vickery, P.G.
Executive Director

Robert Martinez, Director
Environmental Law Division

By ______________________
Kathy J. Humphreys, Staff Attorney
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**CERTIFICATE OF SERVICE**

I certify that on April 15, 2010, the original and 7 copies of the foregoing Executive Director's Exceptions to the Administrative Law Judge's Proposal For Decision was filed with the Office of the Chief Clerk and sent by first class, agency mail and/or facsimile to the persons listed in the mailing list below.

______________________

Kathy J. Humphreys, Staff Attorney
Environmental Law Division

**MAILING LIST**
**APPLICATION OF FARMERSVILLE INVESTORS, L.P.**
**TPDES PERMIT NO. WQ0014778001**
**TCEQ DOCKET NO. 2008-1305-MWD**
**SOAH DOCKET NO. 582-09-2895**

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# Attachment A

FORT WORTH DISTRICT
TABULATION OF MAX AND MIN LAKE ELEVATIONS
PERIOD OF RECORD

| LAKE NAME | MAXIMUM | DATE | MINIMUM | DATE |
|---|---|---|---|---|
| COOPER | 446.96 | 12-18-2001 | 421.98 | 12-29-2006 |
| WRIGHT PATMAN | 252.64 | 05-09-1966 | 219.78 | 09-14-1958 |
| LAKE O'THE PINES | 245.41 | 05-05-1966 | 222.88 | 12-20-2006 |
| | | | | |
| SAM RAYBURN | 175.13 | 03-10-1992 | 150.74 | 08-10-1996 |
| B.A. STEINHAGEN | 85.21 | 05-22-1953 | DRY 9-18-54 TO 10-13-54 | |
| | | | | |
| BENBROOK | 717.54 | 05-03-1990 | 680.07 | 01-19-2006 |
| JOE POOL | 533.21 | 05-20-1990 | 516.77 | 10-20-1996 |
| RAY ROBERTS | 644.44 | 05-03-1990 | 615.41 | 10-13-2000 |
| LEWISVILLE | 536.73 | 05-04-1990 | 498.65 | 09-26-1980 |
| Minimum since last pool raise | | | 507.03 | 10-15-2000 |
| GRAPEVINE | 563.50 | 11-01-1981 | 520.67 | 02-26-1979 |
| LAVON | 504.93 | 05-03-1990 | 465.96 | 04-17-1976 |
| Minimum since last pool raise | | | 474.88 | 10-14-2006 |
| NAVARRO MILLS | 440.36 | 05-18-1968 | 415.73 | 12-20-2006 |
| BARDWELL | 434.68 | 03-19-2001 | 416.80 | 01-19-2006 |
| | | | | |
| WHITNEY | 570.25 | 05-29-1957 | 509.52 | 11-01-1956 |
| Minimum since last pool raise | | | 520.34 | 08-03-1978 |
| AQUILLA | 551.89 | 12-23-1991 | 528.79 | 12-28-2006 |
| WACO | 488.48 | 12-24-1991 | 445.10 | 10-06-1984 |
| Minimum since last pool raise | | | 450.63 | 12-23-2006 |
| PROCTOR | 1197.62 | 05-02-1990 | 1142.20 | 10-28-2000 |
| BELTON | 634.36 | 03-06-1992 | 553.06 | 12-16-1956 |
| Minimum since last pool raise | | | 582.78 | 12-27-1978 |
| STILLHOUSE | 667.97 | 03-04-1992 | 610.31 | 12-05-1988 |
| GEORGETOWN | 835.86 | 03-04-1992 | 767.71 | 11-02-2000 |
| GRANGER | 530.11 | 03-05-1992 | 498.54 | 10-06-1984 |
| SOMERVILLE | 259.60 | 03-06-1992 | 230.70 | 10-05-1984 |
| | | | | |
| TWIN BUTTES | 1942.20 | 05-12-1975 | 1878.80 | 04-15-1971 |
| O.C. FISHER | 1916.47 | 10-14-1957 | DRY 7-16-70 TO 4-15-71 | |
| HORDS CREEK | 1907.67 | 06-23-1997 | 1878.01 | 09-02-1984 |
| MARSHALL FORD | 710.44 | 12-26-1991 | 614.20 | 08-13-1951 |
| | | | | |
| CANYON | 950.32 | 07-06-2002 | 899.70 | 12-12-1984 |

Note: Revised 4 January 2008

# Attachment B

# Water Quality Assessment Team

## Evaluating TPDES Permit Applications Using a Continuously Stirred Tank Reactor (CSTR) Model

### Purpose/Scope

Effluent limits for TPDES discharges that contain significant concentrations of oxygen-demanding constituents are routinely evaluated using mathematical models. It is important to select the model that not only best describes the water body's dissolved oxygen response but can also be constructed in a minimum amount of time with little site-specific information. The goal of this Standard Operating Procedure (SOP) document is to provide guidance to TCEQ water quality modelers on the Water Quality Assessment Team on selecting and consistently applying the Continuously Stirred Tank Reactor (CSTR) model. The analytical techniques described are designed to provide estimates of satisfactory permitted effluent limitations for 5-day carbonaceous biochemical oxygen demand ($CBOD_5$), ammonia-nitrogen ($NH_3$-N), and dissolved oxygen (DO).

### Responsibilities

It is the responsibility of the modelers on the Water Quality Assessment Team to ensure that CSTR model analyses adhere to the guidance provided in this SOP.

### Summary of Procedure

The procedures for performing CSTR modeling analyses involve specific technical guidance for performing default evaluations while allowing some latitude to exercise professional judgment. In addition, the methodology prescribes a higher level of effort and scrutiny if the initial modeling analysis requires effluent limits more stringent than those contained in the existing permit for renewals or proposed limits for new or amendment applications. A flowchart outlining the basic steps in the analysis is presented in Appendix 1.

### Limitations

CSTR models fill an important but limited modeling niche. In general, this type of model should only be applied to small ponds and reservoirs and coves or portions of larger, open water bodies when water body geometry makes the use of a QUAL-TX model questionable and no calibrated model exists.

Linear shaped impoundments should be evaluated with a QUAL-TX model, whereas, those with wider and/or irregular geometries should be considered for a CSTR modeling approach. QUAL-

TX is not suitable in these cases because it is a one-dimensional model with algorithms developed assuming flow in one direction only. The CSTR model, as the name implies, was developed assuming a well-mixed parcel of water. While few natural waters fully comply with this assumption, judicious use of the model can reliably provide conservative DO predictions and hence adequately protective effluent limits for wastewater permits.

Appendix 2 provides examples of water bodies receiving discharges and a discussion of the correct model to apply to each of them.

## Procedures/Method

### *Segmentation of the Water Body*

A fundamental premise of the CSTR model is complete mixing; therefore, cell sizes should be chosen wisely as they can have a large effect on the DO predictions and resulting effluent limit recommendations. Cell size influences the DO predictions because the model distributes the impact of a discharge over the entire cell. The predicted impact more or less represents the average response of the water quality within the cell to a discharge. Also, as cell size increases, deviation from the complete mixing assumption becomes greater, and the ability to predict potential small-scale, localized impacts decreases.

In light of the relationship between cell size and model predictions, a standardized approach needs to be followed to ensure that effluent limit recommendations are consistent, fair, and adequately protective of the environment. Two primary factors were considered in the development of guidelines for cell size: 1) water body geometry plays an important role in the degree of mixing and circulation in a cell, and 2) the CSTR model does not account for dispersion and circulation between cells.

Because of these considerations, cell size should not exceed 10 surface acres, and water body geometry can dictate sizes that are smaller. In addition, a cell representing the mixing zone, if applicable, can be added if desired. It is not appropriate to include a mixing zone cell unless the discharge is directly to the impounded water body. In no case should the initial cell be smaller than the mixing zone.

### *Default Initialization/Parameter Estimation*

In order to have confidence that the model will reasonably predict DO once a wasteload is included, it must first be initialized. The initialization process is intended to create a model that predicts reasonable background levels of DO in the absence of a significant waste load input. This can be done without site-specific data because background conditions are reasonably well known and can be assumed. This process does not amount to calibration of the model but does constrain it to some degree. The principle is that unless the model can provide reasonable predictions in the absence of a discharge, it cannot be relied on to yield reliable results with a significant waste load input. Step-by-step instructions for initialization are provided below:

1. **Segment the model into cells.** It is helpful in many cases to develop a GIS project to aid in the documentation and analysis of the model segmentation and estimation of various physical parameters. Typically, layers of aerial photos (DOQQs) and topographic maps (DRGs) are obtained for the water body and graphic and labeling tools are used to denote the CSTR cell arrangement and water flow path. The number of cells needed will depend on water body geometry, cell sizing guidelines, and the size of the discharge. Enough of the water body needs to be modeled so that there is confidence that the segmented area encompasses the impact zone of the discharge.

2. **Estimate cell area and average depth.** Cell area can be estimated using tools that are included with the GIS software (recommended) or can be derived using a planimeter and paper map resources. Areas needed for the model should be calculated in or converted to units of square meters. If using DOQQs of reservoirs, determine the pool elevation (using USGS or other resources) for the date on which the aerial was shot to see whether a correction to cell area is needed due to a difference from normal pool elevation. Topographic maps can help with this correction. Be sure to use the normal pool elevation that is contained in Chapter 307 of the TCEQ rules for classified segments.

   Cell depth should be estimated using topographic maps, information in the permit application, or other resources. As a last resort, use depths from other similar water bodies or professional judgment.

   Using surface area and average depth, the model will automatically calculate cell volume.

3. **Verify that default rates and constants are used.** Ensure that the model includes the following default values:

| | |
|---|---|
| Temperature | 30.5°C (for all-season effluent limits) |
| Salinity | 0.5 ppt (freshwater), site-specific (saltwater) |
| Secchi depth | 1.0 m |
| $K_L$ (20°C) | 1 m/day, inland waters |
| | 1.25 m/day- 1.50 m/day, open coastal environment |
| $K_s$ (20°C) | 0.0 1/day |
| $K_d$ (20°C) | 0.1 1/day |
| $K_n$ (20°C) | 0.3 1/day |
| $CBOD_u/CBOD_5$ | 2.3 |
| $NBOD_u/NH_3$-N | 4.33 |
| aop | 0.133 mg DO/μg Chl a |
| Gmax | 2 1/day |
| P | 0.0 (Chl a in μg/L) |
| Photo period | 0.58 days |
| la | 750 L/day |
| ls | 300 L/day |

4. **Set wastewater flow and quality at "no-load" values.** For freshwater systems, enter a wastewater flow of 0.1 cfs or 0.1 MGD into the first cell and set the quality at 1.3 mg/L

$CBOD_5$, 0.05 mg/L $NH_3$-N, and 6 mg/L DO. Flow may be set at higher values in some cases if the model will be used to simulate large discharges. Make sure incremental flow is set at 0.0 cfs. Alternatively, zero out the wastewater flow and set incremental flow and quality as described above. In cases where 7Q2 flow entering the water body exceeds the flow value mentioned, use the 7Q2 flow.

For saltwater systems, set incremental flow equivalent to the tidal exchange during a 24 hour period. To calculate this flow, determine an approximate average summertime tidal amplitude in meters (sources of this information are available on the Internet), and multiply this value by the surface area of the cell. Set background quality as described in the section for freshwater systems with the exception of DO. DO should be set at 80% saturation as determined by temperature and salinity. Be sure to set salinity in the model at a value appropriate for the water body being evaluated.

5. **Adjust sediment oxygen demand (SOD).** Adjust the SOD value until the predicted DO is approximately 6 mg/L for freshwater systems or 80% saturation for saltwater bodies. A good starting value for SOD is 0.8 gm/m$^2$-day (20°C). If multiple cells are used, it may not be possible to get all the cells close to the desired "no-load" DO. Should this be the case, try to attain the desired DO value in the cell(s) where the bulk of the wastewater impact occurs. Check the final SOD value for consistency with accepted literature values. In general, 20°C values in the range of 0.5 - 1.5 gm/m$^2$-day are considered acceptable. If the required SOD value to initialize the model falls outside the acceptable range, try to refine the model as described below. If this still does not solve the problem, consider minor adjustment of the algae oxygen production rate in the model.

### *Effluent Limit Alternatives Analysis*

Once initialized, the model can be used to develop effluent limit predictions. Prepare the initialized model for alternatives analysis by adjusting the incremental flow to critical conditions (if warranted) and including wastewater related inputs. Incremental flow in the model can represent background sources of flow from perennial tributaries, other nearby discharges, or bulk water exchange due to tidal action. Run various effluent limit cases to develop an initial estimate of necessary limits. An example CSTR alternatives analysis file is presented in Appendix 3.

### *Interpretation of Model Results*

Model results need to be interpreted considering regulatory mixing zones, dissolved oxygen criteria transitions, and the inherently conservative representation of waste loadings.

**Mixing zones.** Dissolved oxygen criteria do not apply within mixing zones. Therefore, model predictions provided within the mixing zone should not be compared with the criteria for determination of standards attainment. Consult the *Procedures to Implement the Texas Surface Water Quality Standards* (RG-194) for default mixing zone sizes and configurations.

**DO criteria transitions.** Pay special attention to dissolved oxygen criteria transitions, for example, the point at which an intermittent stream (2 mg/L criterion) confluences with a perennial stream or creek channel impounded by a reservoir (typically a 5 mg/L criterion ). It is not necessary for the intermittent stream to attain the criteria of the perennial water body prior to the confluence; however, after confluence the predicted dissolved oxygen in the next model element should be consistent with the higher criterion.

**Conservative representation.** The model is set up to simulate low base flow conditions with the discharge at full permitted flow and effluent concentrations. This combination of conditions, while possible, are highly unlikely to occur simultaneously. As a result, actual water body dissolved oxygen is likely to be higher than what the model predicts. Therefore, it is acceptable to consider a model predicted dissolved oxygen that is up to a 0.20 mg/L below the criteria as consistent with the criteria.

*Model Refinement*

If the initial modeling analysis requires effluent limits more stringent than those contained in the existing permit for renewals or proposed limits for new or amendment applications, then investigate whether other sources of data are available to refine the analysis. If the water body under scrutiny is a classified segment (as defined in Chapter 307, TCEQ Rules), routine TCEQ monitoring data may be available and can be used to refine the model temperature, chlorophyll a, secchi depth, or no-load initialization DO target.

If chlorophyll 'a' is included, also set photo period and solar radiation (la) consistent with the part of the State where the water body is located. Values for these parameters are readily available from internet sources for a number of historical monitoring stations throughout the State. The current version of the model allows the user to specify key parameters on a cell by cell basis. This flexibility may be useful if the model spans an area with widely varying properties. Care should be taken to use data collected as close to the portion of the water body being evaluated as possible and that it is extensive enough to enable a meaningful statistical analysis. If insufficient data is available at a nearby station, begin including data from farther stations. If data from a surrogate water body is used, explain why you think the two are comparable and include your explanation in the modeling file.

For all-season permit limits, use the median values for aggregated data from the three hottest months (typically June, July, and August) to develop model inputs for chlorophyll a and secchi depth. Model analyses are usually performed with summer temperatures. The temperature is normally assumed to be 30.5°C for year round permit limits unless critical low-flows reliably occur only at other temperatures. Alternative critical temperatures can be used if justifiable based on analysis of measured temperatures. After refinement, re-initialize the model and set it up to determine effluent limits necessary to meet the 24-hour DO criterion of the water body.

*Seasonal Temperatures*

For analysis of seasonal permit limits, the following temperatures/derivation methodologies should be used:

*Non-Summer Months:* Use the ninetieth percentile temperature for each month for assessing compliance with general dissolved oxygen criteria.

*Summer Season (three hottest months):* Use the mean of the average monthly temperatures for each of the three hottest months of the year plus the average of the standard deviations for these months for assessing compliance with general dissolved oxygen criteria.

*Spawning Season:* Use 22.8°C or the ninetieth percentile temperature, whichever is lower, for assessing compliance with spawning season DO criteria contained in Table 4 of the Water Quality Standards. Use monthly average temperatures for determining months when spawning criteria apply. Also evaluate compliance with the general dissolved oxygen criteria during the spawning month(s) using appropriate ninetieth percentile temperatures.

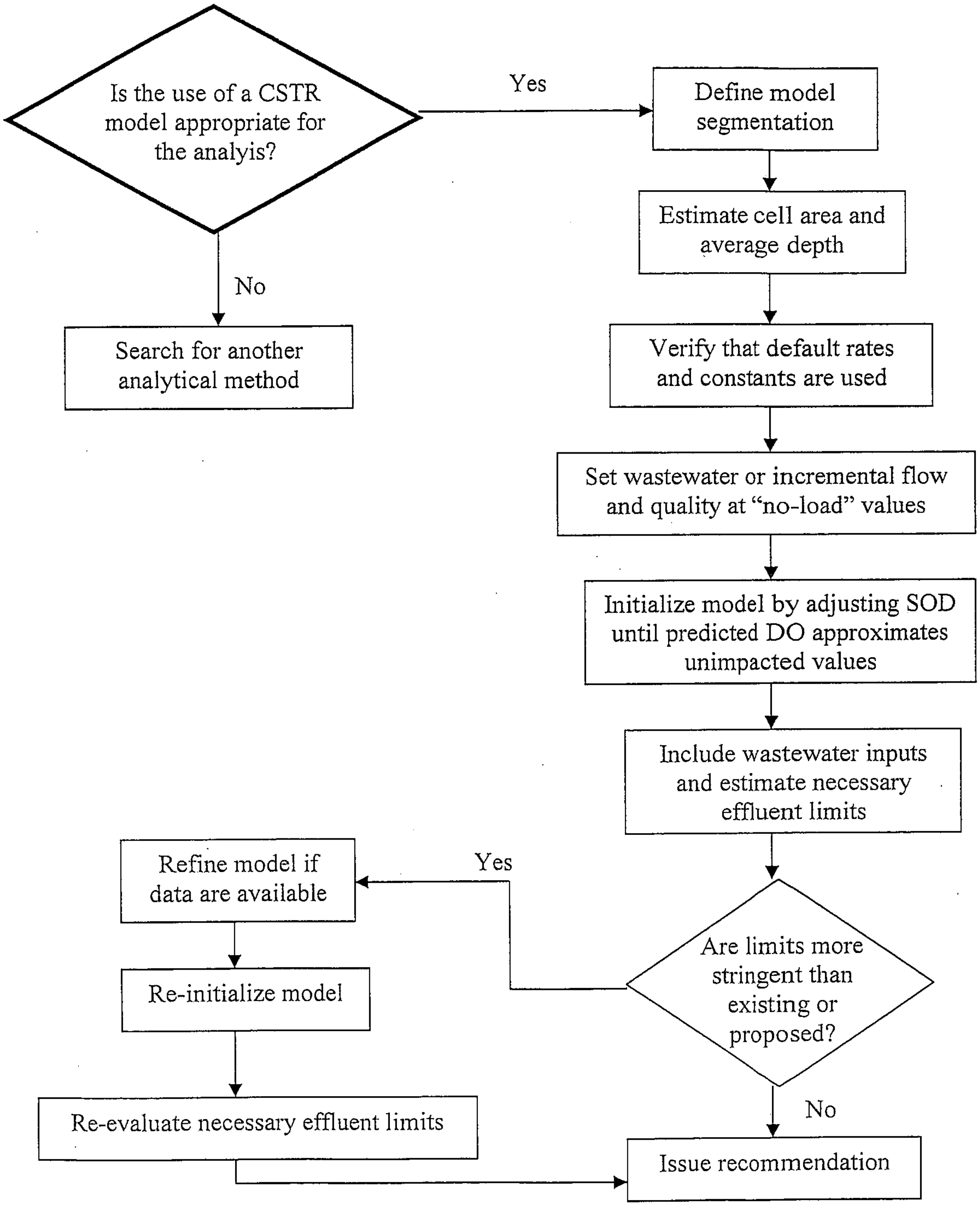
## *Person/Date*

SOP Developer: Mark A. Rudolph
SOP Version: June 20, 2007

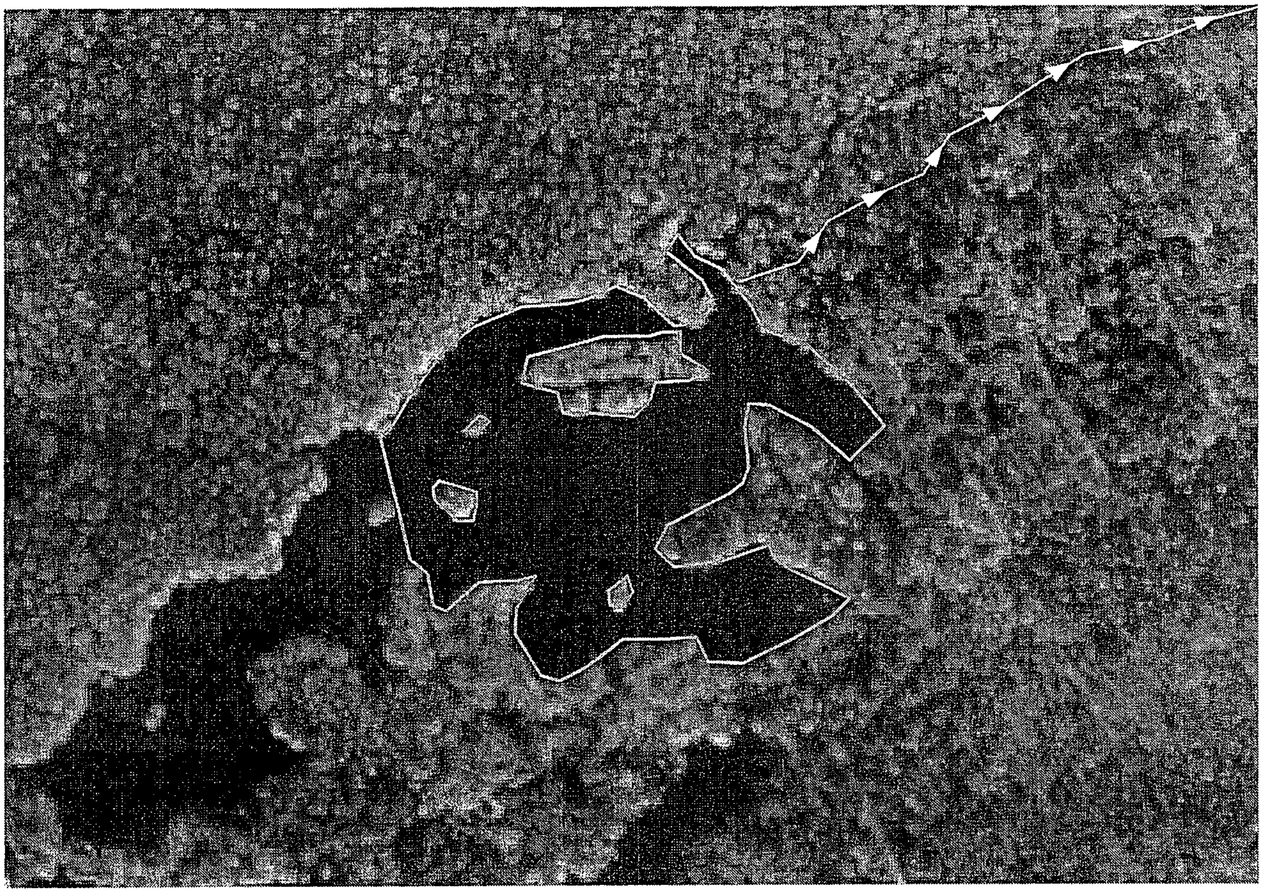
Supervisor Signature/Date:

Appendix 1

# CSTR Analysis Flowchart



## Appendix 2
## Model Application Examples



**Case:** Intra-wetland pond draining to a slough

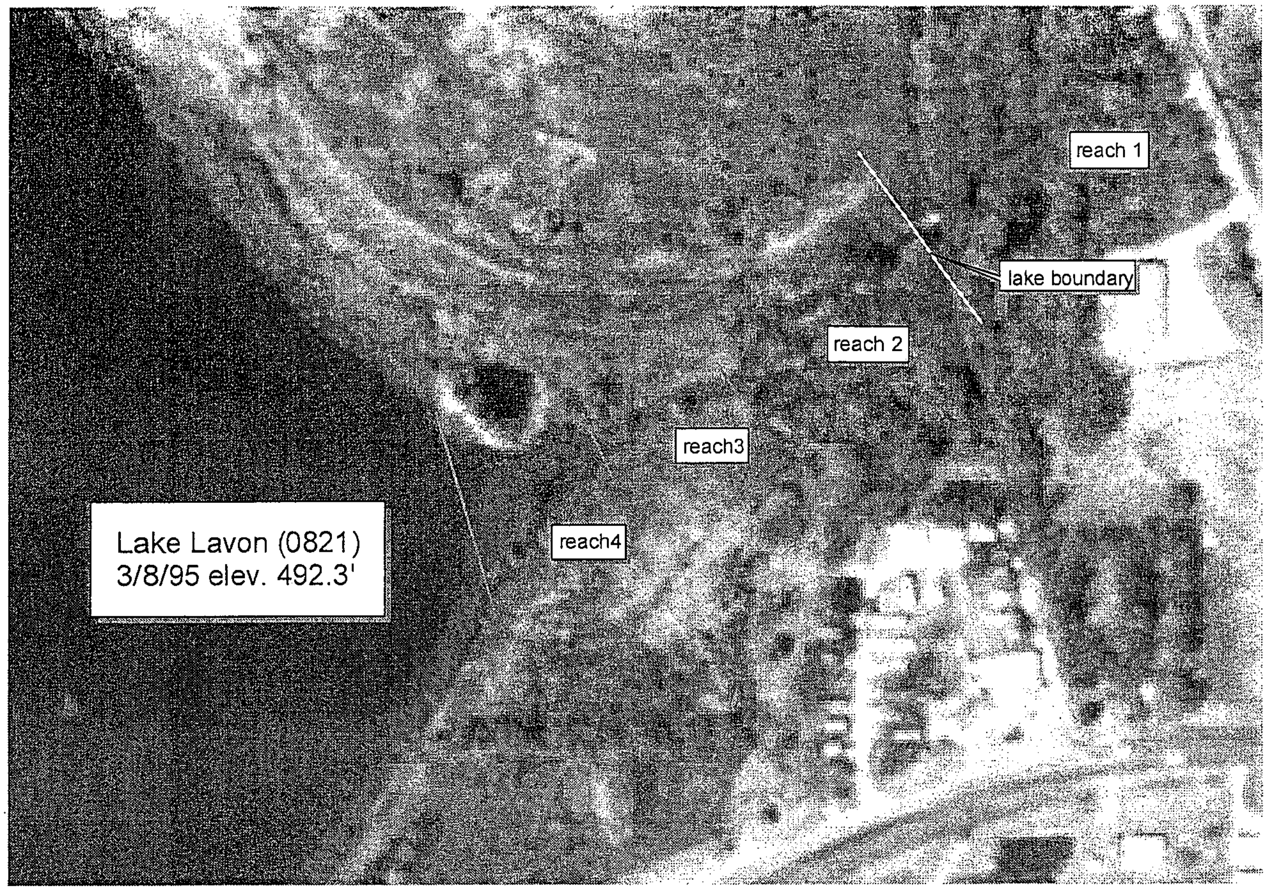
**Model Application:** CSTR model (pond), QUAL-TX model (slough, if necessary)

**Discussion:** This pond is an acceptable application of the CSTR modeling approach because it is small and non-linear in shape. Depending on where the outfall enters the pond, the CSTR model may need to be segmented into multiple cells so that potential localized water quality impacts are accounted for. Also, note that only a portion of the pond has been identified for modeling based on modeler judgment. The downstream slough may need to be evaluated using a QUAL-TX model if the water exiting the pond contains significant concentrations of $CBOD_5$ or $NH_3$-N or the DO concentration predicted to be leaving the pond is below the criterion set for the slough.

**Case:** Upland stream transitioning to a moderate sized pond

**Model Application:** QUAL-TX model (tributary and flooded creek portion of the pond)
CSTR (more open water portions of the pond, if necessary)

**Discussion:** The upland tributary and the linear headwater portion of the pond should be modeled with QUAL-TX. The QUAL-TX model should not include any dispersive phenomena requiring the use of lower boundary condition cards. This also makes the quality of the water exiting the QUAL-TX more appropriate for importation to a CSTR model of the main body of the pond. The CSTR model should include the remainder of the pond unless cell size limitations dictate splitting it up into multiple cells. The water quality leaving the pond should be scrutinized to determine whether the analysis should be extended downstream.




**Case:** Upland stream entering a creek channel impounded by a large reservoir

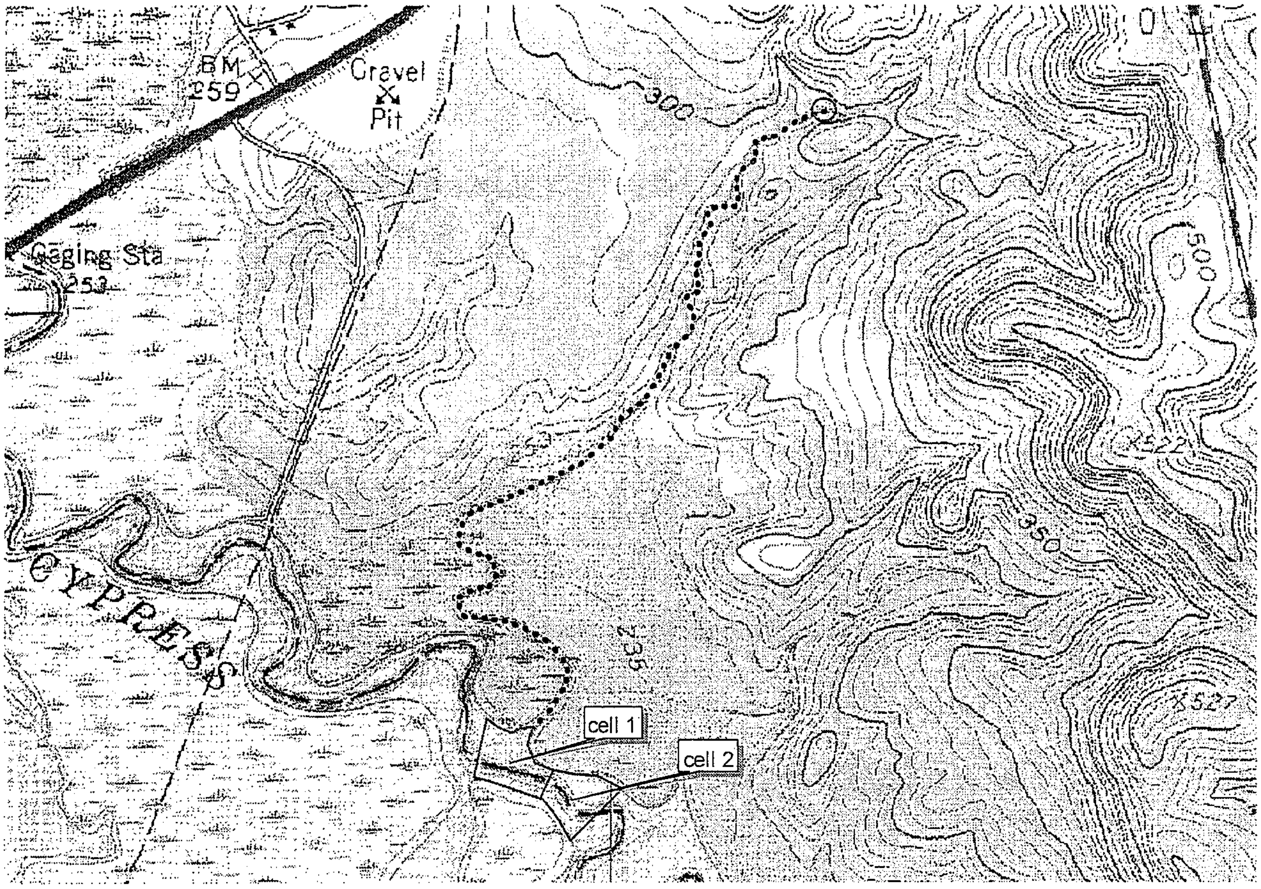
**Model Application:** QUAL-TX model (stream and impounded creek channel)

**Discussion:** The upland stream and impounded channel should be evaluated using a QUAL-TX model. This is appropriate due to the relatively linear shape of the flooded creek. Modeling beyond the flooded creek reach is not usually warranted because wind action and large scale water movements in the reservoir would tend to dilute any potential DO impact in the open waters. In rare instances, such as a very large discharge, the analysis could be extended into the more open waters using a CSTR model of a portion of the reservoir.

**Case:** Tidal slough entering a tidal lake that drains into a large coastal bay

**Model Application:** QUAL-TX model (slough and tidal lake) or
QUAL-TX model (slough) and CSTR (tidal lake)

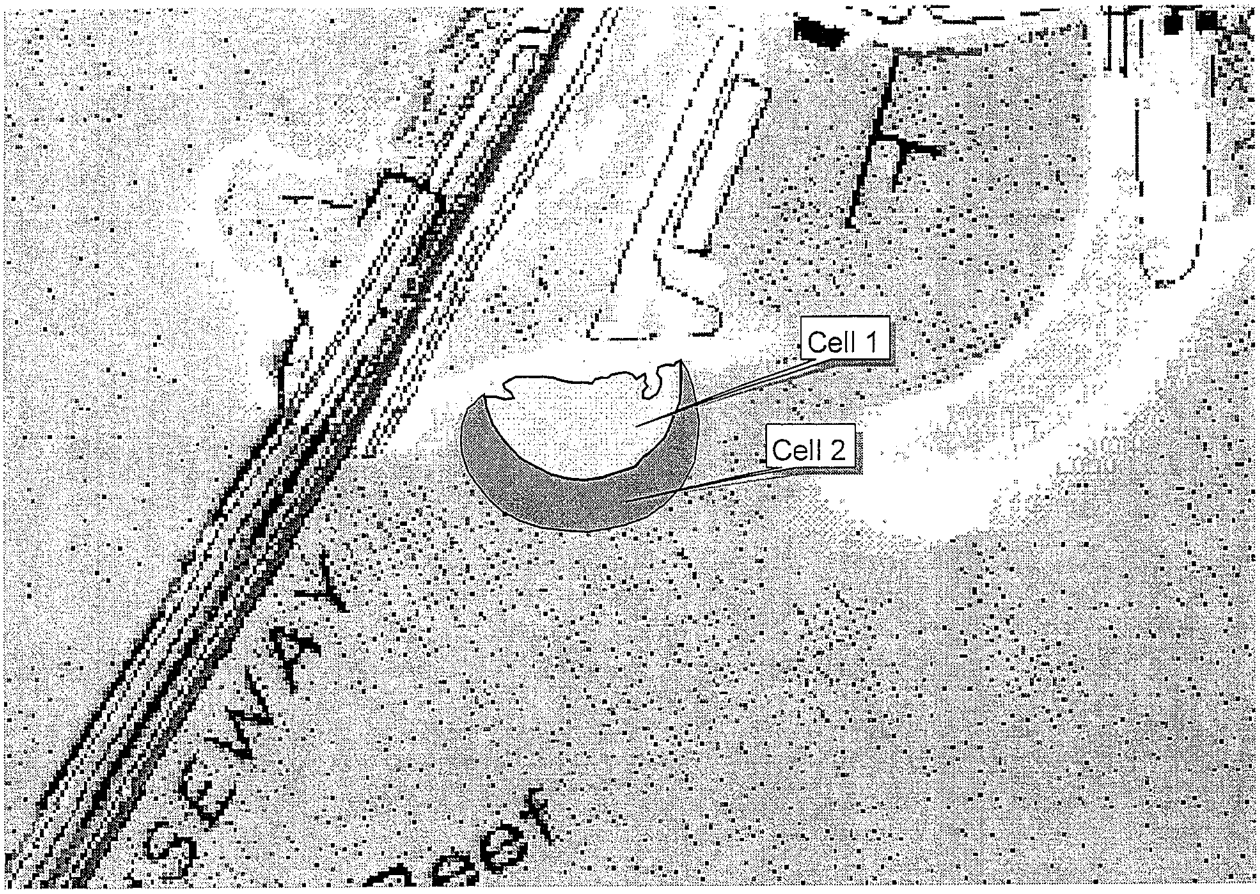
**Discussion:** This combination of environments presents some model application challenges. Based on geometry alone, it would seem logical to model the slough with QUAL-TX and the lake with a CSTR model. However, since tidal systems are so dispersive in nature, this may result in a model that understates the assimilative capacity of the tidal stream. This may tend to favor the use of QUAL-TX in both water bodies even though the lake is not particularly linear in shape. This is a case where either approach has its potential pitfalls, yet no other readily available simple analytical techniques are available. The choice of models for this scenario is left to the discretion of the modeler. A potential strategy would be to use the more restrictive approach (QUAL-TX+CSTR) initially, then, if extraordinarily stringent limits are suggested, model the entire system with QUAL-TX and compare the results.




**Case:** Stream entering a large irregularly shaped bayou

**Model Application:** QUAL-TX model (stream), CSTR (portion of the bayou)

**Discussion:** The stream is a logical candidate for the use of a QUAL-TX model. A CSTR model would be chosen for the bayou because of the extreme irregularity of its shape. The cell configuration represented in the graphic was chosen because the flow in the bayou is generally to the southeast. The number of cells chosen and their size will be dictated by water body shape, cell size limitation guidelines, and the size of the discharge. Incremental background flow may be appropriate in CSTR cell 1 in this case; however, development of a precise value will probably be challenging due to the effect of bifurcations on flow routing.




**Case:** Direct discharge into an open portion of a coastal bay

**Model Application:** CSTR (portion of the bay)

**Discussion:** The use of the CSTR model in this application is chosen because no other simplified approach is feasible and the CSTR modeling results are likely to over-predict the impact of a discharge and therefore result in a protective effluent set. The two cells indicated in the graphic represent 10-acre parcels of the bay. In order to make model predictions more realistic, incremental flow equivalent to the daily tidal fluctuation should be included. It is important to realize that predictions from this application of the CSTR model will contain significant uncertainty.

# Appendix 3
# Example of a CSTR Model

Kinetics use temperature adjusted values; Sequential CSTRs
Underlined cells are for data entry; others cannot be changed.
FACILITY: Big Swirly MUD
0.95 MGD @ 7/2/6

**Effluent Characteristics:**

| | | | | |
|---|---|---|---|---|
| Q (MGD) = | 0.95 | MGD , or | 0.04163 | cms (Qw) |
| CBOD5 (mg/L) = | 7.00 | mg/L , or | 25.18 | kg/d CBOD5 (Wbw) |
| NH3 (mg/L) = | 2.00 | mg/L , or | 7.19 | kg/d NH3-N (Wnw) |
| DO (mg/L) = | 6.00 | mg/L , or | 21.58 | kg/d DO (Cw) |

**Model Characteristics :**

| | | | | | |
|---|---|---|---|---|---|
| Temperature= | 30.5 | °C | = | 303.65 | °K |
| Salinity = | 0.5 | ppt | | Sat. DO = 7.47 | mg/L |
| Secchi Depth= | 0.65 | meters | | | |
| SOD (g/m^2/d)= | 1.1 | becomes | 2.33 | g/m2·d @ model temperature | |
| KL (m/d) = | 1 | becomes | 1.24 | m/d @ model temperature | |
| Ks (1/day) = | 0 | becomes | 0.00 | 1/day @ model temperature | |
| Kd (1/day) = | 0.1 | becomes | 0.16 | 1/day @ model temperature | |
| Kr (1/day) = | 0.1 | becomes | 0.16 | 1/day @ model temperature | |
| Kn (1/day) = | 0.3 | becomes | 0.69 | 1/day @ model temperature | |
| CBODU/CBOD5= | 2.3 | Ia (L/d) | = | 750 | |
| NBODU/NH3-N= | 4.33 | Is (L/d) | = | 300 | |
| aop(mg DO/µg Chla)= | 0.133 | Ke (1/m) | = | 2.92308 | |
| Gmax (1/d)= | 2 | Ps (mg/L·d)= | | 7.80591 | |
| P (Chla in ug/L)= | 15 | Alpha 0 | = | 2.5 | |
| photo period= | 0.58 | | | | |

**ELEMENT PARAMETERS AND RESULTS :**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Element characteristics: | | | | | | | | | | | |
| Element number = | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Surface Area (m^2) = | 3565 | 21128 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Depth (m) = | 0.3 | 0.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Volume (m^3) = | 1069.5 | 19015.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Incremental inflow: | | | | | | | | | | | |
| Q (cms) = Qu = | 0 | 0 | | | | | | | | | |
| CBODU (mg/L) = Cbu = | 3.00 | 3 | | | | | | | | | |
| NH3 (mg/L) =Cnu = | 0.05 | 0.05 | | | | | | | | | |
| DO (mg/L) = Cou = | 7.04 | 7.04 | | | | | | | | | |
| Net input/loading: | | | | | | | | | | | |
| Q (cms) = Qt = | 0.041629 | 0.041629 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CBODU (kg/d) = Wbt = | 57.91 | 55.25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NH3 (kg/d) = Wnt = | 7.19 | 5.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| DO (mg/L) = Cot = | 6.00 | 5.23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Computed variables: | | | | | | | | | | | |
| Detention time,Td (days) = | 0.29735 | 5.28678 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Qt + KL*A(i), (m^3/d) = | 8031.09 | 29876.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Alpha 1 (no units) = | 1.04015 | 0.18006 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| G(Ia) (no units) = | 0.48774 | 0.45130 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pa (mg/L·d) = | 3.80728 | 3.52283 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| R (mg/L·d) = | -0.4476 | -0.4476 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Effluent DO due to : | | | | | | | | | | | |
| DO in (mg/L) = | 2.69 | 0.63 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| DO KL (mg/L) = | 4.13 | 6.57 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| DO Kd (mg/L) = | -0.33 | -0.85 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| DO SOD (mg/L) = | -1.03 | -1.65 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| DO Kn (mg/L) = | -0.66 | -0.68 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| DO P/R (mg/L) = | 0.45 | 1.96 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Results: | | | | | | | | | | | |
| Outflow DO (mg/L) = | 5.23 | 5.98 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Outflow CBODU (mg/L) = | 15.36 | 8.27 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Outflow CBOD5 (mg/L) = | 6.68 | 3.60 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Outflow NBODU (mg/L) = | 7.18 | 1.54 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Outflow NH3-N (mg/L) = | 1.66 | 0.36 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Reference:
Thomann R.V. and J. A. Mueller. 1987. Principles of Surface Water Quality Modeling and Control. Harper & Row, Publishers, New York. Chapter 6.