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NPDES Permit Limitation Creation & Discharge Monitoring Rationale in NYS

Conventionals, Toxics, and Discharge Modeling

February 5, 2019
New York Water Environmental Association
Annual Meeting – New York City

Good Morning!

Today I plan to discuss SPDES Permit Limitations in NY and where, or how, we come up with them. In the interest of time, I decided to not touch on EPA/DEC regulatory justification and source literature, as I assume that is nothing new to you all.

In New York State, when a SPDES permit expires, it is generally either administratively renewed (most minors) or SAPA extended (majors). At some point, when DEC subsequently modifies the permit, often limits may change, and likely become more stringent. This leaves many operators and permittees asking questions like: "Why does TRC need to be non-detect now at a lower level than we could even detect before?" "Why have ammonia limits changed so much?" "Where did the previously available dilution go?"

I'm hoping this discussion today, will help you all understand why or how this happens.

Agenda

- Categories of Pollutants
- TBELs vs. WQBELs
- Reasonable Potential Determination
- Oxygen Demand Modeling
- Advanced WQ Modeling

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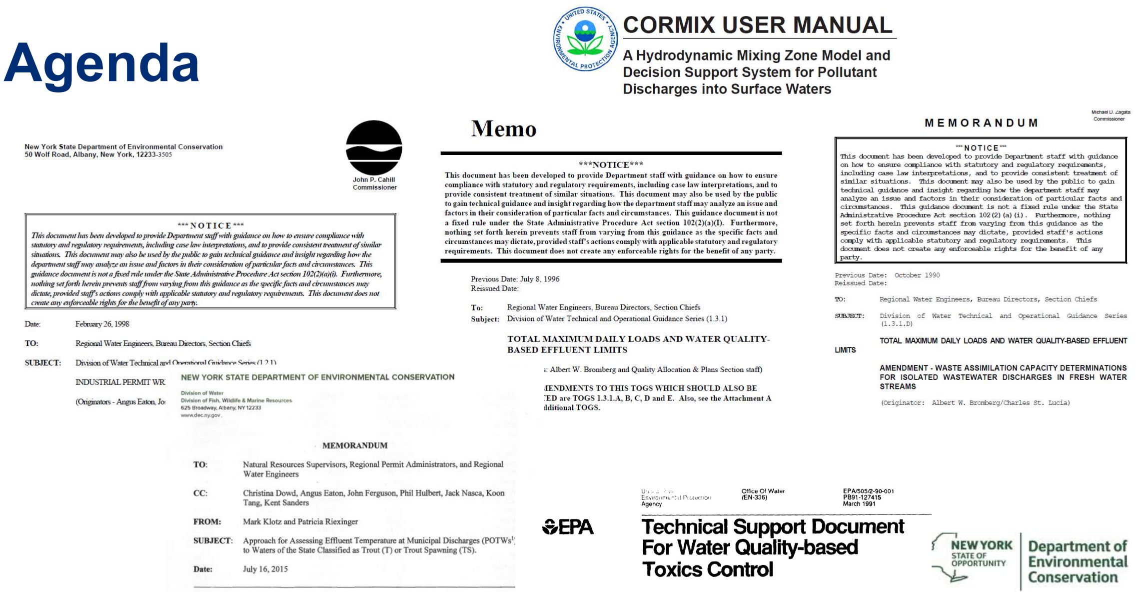
Today's agenda, we will discuss:
- the categories of pollutants evaluated;
- the sources and differences between TBELs, or technology-based effluent limits, and WQBELs, or water quality-based effluent limits;

RPD, or reasonable potential determinations for toxic pollutants
Oxygen demand modeling for discharges of BOD
Dilution modeling of discharges, both complete and incompletely mixed and how these affect a permit's stringency

Agenda



Some, not all, of the documents we will refer to today are:
TOGS 1.2.1 Industrial Permit Writing
TOGS 1.3.1 TMDL and WQBEL Development
TOGS 1.3.1.D Waste Assimilative Capacity analyses
July 2015 Memorandum for Thermal Discharges from POTW’s to Trout Waters
1991 EPA Technical Support Document for WQBELs for Toxics Control
And the CORMIX user Manual

Objectives

1. Determine minimum TBELs applicable to a discharge

2. Understand concepts of oxygen-demand modeling

3. Calculate RPD of a toxic pollutant

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The objectives or takeaways I'd like for everyone to have today are:

1. Be able to determine what minimum TBELs are applicable to a discharge.
2. Be able to understand the general concepts of oxygen-demand modeling, how it is performed, and how we use it to determine conventional limits.
3. Finally, I'd hope that you will know what RPD is, how it is conducted, and how it affects the determination for applying toxic limits.

To help preface our discussion, I thought it'd be helpful to briefly review what categories of pollutants are evaluated and could potentially be included in a permit. The pollutants to be analyzed/assessed are highly dependent on the type of facility, whether POTW or Industrial, but even more specific to the type of industrial waste stream being discharged.

Discharge Characterization

- Treatment System Design
  - POTWs → Flow = Average Daily (as Monthly Average)
  - Industries → Flow = Design Flow (MA or DM)

- Projected/Existing Effluent Quality
  - 95^{th}-LN Percentile → Monthly Averages
  - 99^{th}-LN Percentile → Daily Maximums
  - Permit Application Data

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The discharge will be characterized by both the design of the treatment system and the effluent quality. Critical effluent flow is very important. In accordance with USEPA and DEC guidance, POTWs should be permitted and assessed for SPDES permit limits at the average daily design flow of the facility. Industrial dischargers are typically assessed at either the design capacity of the treatment system, or when this is unknown, at the long-term average flow that is expected to occur during the permit term.

Generally, for pollutants, we will characterize using existing data. We use the 95^{th}-LN percentile for MA data and 99^{th}-LN percentile for DM data. We will discuss this a bit more later.

Discharge Characterization

Outfall #	001	**Description of Wastewater:** Sanitary Sewage													
		Type of Treatment: Screening, primary settling, rotating biological contactors (RBCs), coagulation and settling, sand filtration, UV disinfection, microfiltration, and re-aeration													
Effluent Parameter	Units	Averaging Period	Existing Discharge Data			TBELs		Water Quality Data & WQBELs						ML	Basis for Permit Requirement
			Permit Limit	Existing Effluent Quality	# of Data Points (non-detects)	Limit	Basis	Ambient Bkgd. Conc.	WQ Std. or GV	WQ Type	Projected Instream Conc.	Calc. WQBEL	Basis for WQBEL		
5-day	mg/L	Monthly Avg	5.0 – DM	5.6 (max)	61	30	TOGS 1.3.3	3.0 (assumed)	7.0 – DO (minimum)	Narrative	7.0 - DO	5.0 - DM	RSAT	-	WQBEL
Carbonaceous		7 Day Avg				45	TOGS 1.3.3							-	
Biochemical	lbs/d	Monthly Avg	*No Reporting Previously Required*			200	TOGS 1.3.3	4.0 (assumed)	9.3 - DO (minimum)	Narrative	56 – DO	33 - DM	RSAT	-	WQBEL
Oxygen		7 Day Avg				300	TOGS 1.3.3							-	
Demand	% Rem	Monthly Avg	85	> 90	61	85	TOGS 1.3.3	*No WQS*						-	TBEL
($CBOD_5$)	Only 1 detection of $CBOD_5$ reported on DMR since 2013 (5.6 mg/L, Aug. 2016) The existing permit required ISEL $CBOD_5$ = 5.0 mg/L, which supersedes the secondary treatment TBEL. The downstream DO concentration was modeled using the Streeter-Phelps equations. The following assumptions were used in the model: Effluent DO = 7.0 mg/L, Effluent $CBOD_5$ = 5.0 mg/L, Effluent NOD = 6.6 mg/L = 1.1 mg/L (Ammonia, as NH_3). Downstream DO is satisfied under these typical conditions (Effluent flow < 0.8 MGD), thus $CBOD_5$ must continue to be limited as ISEL = 5.0 mg/L. No further stringency can be placed on $CBOD_5$ limit.														
Total	mg/L	Monthly Avg	10 – DM	<2.3	61	30	TOGS 1.3.3	UNK	Narrative: *None from sewage, industrial wastes or other wastes that will cause deposition or impair the waters for their best usages.*			10 - DM	703.2	-	WQBEL
Suspended		7 Day Avg				45	TOGS 1.3.3							-	WQBEL
Solids (TSS)	lbs/d	Monthly Avg	*No Reporting Previously Required*			200	TOGS 1.3.3	UNK				67 - DM	TOGS 1.3.3	-	WQBEL
		7 Day Avg				300	TOGS 1.3.3							-	WQBEL
	% Rem	Monthly Avg	85	> 97	61	85	TOGS 1.3.3	*No WQS*						-	TBEL
	All months since 2013 have DMR reported values as “less than” indicating at most 1 detection per month (only 2 samples collected per month). Smallest reported % removal is 97%. Given that adequate dilution is not available an effluent limitation equal to 10 mg/l daily max is appropriate and consistent with TOGS 1.3.3 for discharges to intermittent streams.														
Dissolved Oxygen	mg/L	Daily Min	7.0		61	7.0	Antibacksliding	7.7	7.0	Narrative	7.0	7.0	703.3	-	WQBEL
(DO)	The downstream DO concentration was modeled using the Streeter-Phelps equations. The downstream DO concentration was modeled using the Streeter-Phelps equations. The following assumptions were used in the model: Effluent DO = 7.0 mg/L, Effluent $CBOD_5$ = 5.0 mg/L, Effluent NOD = 6.6 mg/L = 1.1 mg/L (Ammonia, as NH_3). Downstream DO is satisfied under typical conditions (Effluent flow < 0.8 MGD). The RSAT model showed that a WQBEL for DO of 7.0 mg/L is necessary to maintain adequate downstream water quality.														
Nitrogen,	mg/l	Monthly Avg	*No Reporting Previously Required*			Monitor	BPJ	0	0.90	A (C)	0.32	No RP	40CFR 144 (RSAT)	-	Monitor
Ammonia		Daily Max	1.1 (as NH_3)	0.43 (as NH_3)	2 (23)	1.1 (as NH_3)	Antibacksliding	0	6.9	A (A)	3.4	No RP		-	TBEL
(as N)	lb/d	Monthly Avg	*No Reporting Previously Required*			Monitor	BPJ	0	1.2	A (C)	2.6	No RP		-	Monitor
Summer		Daily Max				Monitor	BPJ	0	9.2	A (A)	27	No RP		-	Monitor

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We are improving our detail in factsheets, by providing all our analysis data in a Pollutant Summary Table. This is our new table, which has just begun to be included this year. It’s an improvement on our old tables. We show the existing permit limit and the EEQ on the left, then the TBELs, the WQBELs, and what is being used in the permit on the right.

Who	What	Why
MUNICIPALs (POTWs)	• **CONVENTIONALS** • **126 PRIORITY POLLUTANTS** • **OTHERS**	• **NY-2A** • **TABLE NY-2A**
INDUSTRIALs/PCIs	• DEPENDS ON INDUSTRY • TABLE 6-10	• NY-2C • TABLE 1 (ORGANIC)

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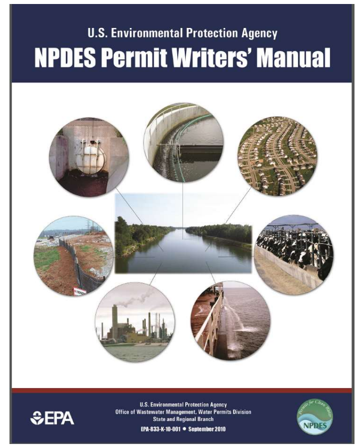
I've provided this table to help breakout how pollutants are determined. This is essentially following the Form NY-2C and NY-2A application process. We have continued to notice there is some confusion with these application sampling requirements. For Department initiated modifications, we typically have been including an "additional instructions" page to specifically identify which pollutants we need analyzed and submitted with the application. Each of these will be assessed for water quality impacts. For POTWs, Table NY-2A, toward the back of the application, lists all pollutants needed to be sampled for in a priority pollutant scan. There are a few noted parameters that are no longer listed by EPA that may still be on this form, those are okay to not be analyzed. A typically missed pollutant is Cyanide, which we do like to have. Outside of conventionals, these permits don't commonly include anything more than Ammonia, Disinfection requirements, and perhaps some metals.

For industries, it is a little more complicated. Table 1 of the NY-2C indicates which categories of organic pollutants must be analyzed for. Each facility should also provide the summary of all currently permitted pollutants and any pollutants in Tables 6-10 of the NY-2C that you believe may be present. Remember, the permit shield concept from CWA 402(k) does not allow pollutants to be discharged that are not specifically listed in the permit or the application.

NYSDEC is developing a similar,
NY specific SPDES PWM

TBELs vs. WQBELs

References, Differences, and Implications



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So now we can move forward with TBELs and WQBELS. Their sources, differences, and implications. I've added the EPA NPDES PWM here, as this is a useful narrative for most of what we will cover today.

As an aside, I wanted to point out that we are working to develop a NYS Permit Writer's Manual. This manual will help update some guidance and consolidate information into one source to help staff work more efficiently.

Technology-based Effluent Limitations

- Minimum requirements set forth under the CWA and 40CFR
- Set a threshold for wastewater discharges to meet as minimum treatment requirements
- Can be concentration, loading, and/or % removal limits
- Industrial limits can be production based

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TBELs are the minimum treatment requirements for WWTPs, both municipal and industrial. These come in many forms, as concentrations, loadings, or % removals. For industrial facilities, some TBELs may be production based.

Types of TBELs

Title 40 → Chapter I → Subchapter N
www.ecfr.gov

- Secondary Treatment Standards – BOD/TSS/pH
  (30/45 mg/L, 85% Removal & 6.0 – 9.0 su)
- Best Practicable Control Technology Currently Available (BPT)
- Best Conventional Pollutant Control Technology (BCT)
- Best Available Technology Economically Achievable (BAT)
- New Source Performance Standards (NSPS)
- NYS TOGS 1.2.1 BPJ Attachment C

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TBELs for POTWs are few, simply the secondary treatment standards for BOD & TSS of 30/45 and 85% removal and a pH of 6.0 – 9.0 su. In NYS, we also treat settleable solids as a TBEL, based solely on the presence, or not, of filtration technology and a TRC range of 0.5 - 2 mg/L as adequate for sufficient disinfection.

For other dischargers, TBELs come from primarily two sources, either EPA's Effluent Limitation Guidelines or DEC's TOGS 1.2.1 Attachment C, which provides minimum treatment standards for technologies by pollutant removed.

To find applicable ELGs, head to the eCFR website, under Title 40, Chapter I, Subchapter N. Then look for the Part that represents type of process applicable. Under each part, there may be subparts to further categorize the process. Once chosen, each ELG will have a description of applicability, possibly specialized definitions, then limitations or requirements. The first is commonly BPT, or Best Practicable Control Technology Currently Available limits. BPT covers all pollutants, but only for existing dischargers. Note "currently" in this sense means when the ELG was published. Existing dischargers are those facilities and processes which already existed at the time the regulation was promulgated.

Following BPT you may also find BCT, or Best Conventional Pollutant Control Technology. As one might expect, BCT only covers conventional pollutants and is also only for existing dischargers.

Then you'll find BAT, or Best Available Technology Economically Achievable. Note that BAT limits are essentially the minimum treatment required nowadays. Each ELG had a specific compliance period for when BAT limits had to be met, however that period usually lasted less than 3 years and has since passed. BAT only covers the EPA priority pollutants and other non-conventional pollutants.

You will also see NSPS limits, or New Source Performance Standards. These apply to any new discharger, that commenced the discharge after the ELG was originally published. This also incorporates theoretically "existing" dischargers that changed a process or substantially expanded a process stream.

Now, it is also important to note that several ELG categories include PSES or PSNS limitations, which are Pretreatment Standards for Existing or New Sources. Industrial facilities must meet these standards if they send their process wastewater to a POTW for treatment. For municipalities, these standards should be incorporated into your sewer use law to protect your POTW.

ELG – Part 428

practicable control technology currently available (BPT):

(a) The following limitations establish the quantity or quality of pollutants or pollutant properties, controlled by this section, which may be discharged by a point source subject to the provisions of this subpart after application of the best practicable control technology currently available:

Effluent characteristic	Effluent limitations	
	Maximum for any 1 day	Average of daily values for 30 consecutive days shall not exceed—
	Metric units (kg/kkg of raw material)	
Oil and grease	0.42	0.15
TSS	0.80	0.40
pH	([1])	([1])
	English units (lb/1,000 lb of raw material)	
Oil and grease	0.42	0.15
TSS	0.80	0.40
pH	([1])	([1])

[1]Within the range 6.0 to 9.0.

I prepared a couple examples using the more recent ELGs I have reviewed for SPDES permits.

Part 428 Subpart F Medium-Sized General Molded, Extruded, and Fabricated Rubber Plants. This is an example of a production-based ELG. Using multipliers and the total amount of raw material consumed. When applying this type of standard, we use a long term average, typically over 3-5 years worth of data. This value is determined as a –per day average and then converted for daily maximum and monthly average limits. Months here are assumed as 30 days.

These are the BPT standards. Which are then superseded by the BAT standards.

ELG – Part 428

(a) The following limitations establish the quantity or quality of pollutants or pollutant properties, controlled by this section, which may be discharged by a point source subject to the provisions of this subpart after application of the best available technology economically achievable:

Effluent characteristic	Effluent limitations	
	Maximum for any 1 day	Average of daily values for 30 consecutive days shall not exceed—
	Metric units (kg/kkg of raw material)	
Oil and grease	0.42	0.15
TSS	0.80	0.40
pH	([1])	([1])
	English units (lb/1,000 lb of raw material)	
Oil and grease	0.42	0.15
TSS	0.80	0.40
pH	([1])	([1])

[1]Within the range 6.0 to 9.0.

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In this case, BPT and BAT are actually equivalent.

ELG – Part 467

Except as provided in 40 CFR 125.30 through 125.32, any existing point source subject to this subpart must achieve the following effluent limitations representing the degree of effluent reduction attainable by the application of the best available technology economically achievable. The discharge of process wastewater pollutants from the core shall not exceed the values set forth below:

Subpart B

Core

Pollutant or pollutant property	BAT effluent limitations	
	Maximum for any 1 day	Maximum for monthly average
	mg/off-kg (lb/million off-lbs) of aluminum rolled with emulsions	
Chromium	0.057	0.024
Cyanide	0.038	0.016
Zinc	0.19	[illegible]
Aluminum	0.84	0.42

Except as provided in 40 CFR 125.30 through 125.32, any existing point source subje the following effluent limitations representing the degree of effluent reduction attainabl practicable control technology currently available.

Subpart B

Core

Pollutant or pollutant property	BPT effluent limitations	
	Maximum for any 1 day	Maximum for monthly average
	mg/off-kg (lb/million off-lbs) of aluminum rolled with emulsions	
Chromium	0.057	0.024
Cyanide	0.038	0.016
Zinc	0.19	[illegible]
[illegible]	0.84	0.416
Oil and grease	2.60	[illegible]
Suspended solids	5.33	2.53
pH	([1])	([1])

[1]Within the range of 7.0 to 10.0 at all times.

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Another example, is Part 467 Subpart B Aluminum Forming – Rolling With Emulsions. Another production based ELG, but in this case, BPT and BAT are both calculated and the most stringent is applied to the permit as a TBEL.

So BPT and BAT calculate identically, except for Aluminum DM, where BPT is slightly more stringent. Also, BPT has some parameters that are not covered by BAT, so these BPT limits would also be established.

TOGS 1.2.1 Att. C – Model Technology BPJ

Parameter	(A) L&S	(B) L,S&F	(C) S,S&F	(D) Chemical	(E) Biological	(F) OCPSF-Bio	(G) OCPSF-Nonbio	(H) Carbon	(I) Air Strip	(J) Misc	(K) LDRs	(L) MDL/PQL
mg/l												mg/l
Ammonia (N)	130/59	130/59								20/10, 20		0.02/0.06
BOD					45/30	48/18, 160/65	48/18, 160/65	**		20		2/2
CBOD					40/25			**				2/2
Oil & Grease	20/12	10						**		15		3/10
pH (su)					(6.0-9.0)					(6.0-9.0)		
Settleable Solids (ml/l)					0.30					0.10		0.2/0.8
Surfactants (MBAS)										17/11, 20		0.1/0.4
TKN												0.02/0.06
Total Dissolved Solids												10/40
Total Suspended Solids	41/20	15/12			45/30	120/36, 220/67	120/36, 220/67	**		20, 40/20		4/20
ug/l												ug/l
Aluminum	6400/3200	6100/2700		4000/2000								2/8
Antimony	2900/1300	1900/860									1900	3/10
Arsenic	2100/930	1400/620		150, 100/50							1400	1/4
Barium	5600/2500	1200/510		4000/2000							1200	0.3/1
Beryllium	1200/550	820/370									820	0.2/0.8
Boron	1800/840	1800/840										5/20
Cadmium	340/150	200/80	40/20	200/100							690	0.1/0.4
Cesium	510/230	510/230										
Chlorine, Free Available										500/200		
Chlorine, Total Residual					2000					200		3/10
Chromium, Hexavalent				200, 100/50				100				8/30
Chromium	440/180	370/150	210/90	500		2800/1100	2800/1100				2800	1/4
Cobalt	210/90	140/70										1/4
Copper	1900/1000	1300/610	210/90	500		3400/1500	3400/1500				1300	1/4
Cyanide, Free (amen. or wad)				200, 100/50							860	20/60
Cyanide	290/120	200/80		1100, 800/400		1200/420	1200/420			4500/2000	1200	20/60
Fluoride	35/20 mg/l	35/20 mg/l		30/15 mg/l						60/26 mg/l		30/100
Gallium	440/180	370/150										
Germanium	440/180	370/150										

A – Lime & Settle
B – Lime, Settle, & Filter
C – Sulfide, Settle & Filter
D – Chemical Treatment
E – Activated Sludge
F – Biological E-O-P Treatment
G – No Biological E-O-P Treatment
H – Carbon Adsorption
I – Air Stripping
J – Miscellaneous
K – Land Disposal

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As mentioned before, NYS also can implement additional TBELs from this table (TOGS 1.2.1 Attachment C), based on the treatment that either exists, or is commonly used for treatment. These are sorted by types of pollutants in each row and by treatment type across each column. The types of treatment technologies range from basic lime and settle, to activated sludge, to carbon adsorption, and others. Note that Column L (the PQL/MDL) is slightly outdated for some pollutants, which is why we refer to 40 CFR Part 136 for approved analytical technologies.

Water Quality-based Effluent Limitations

- Established for protection of water quality
- May supersede the TBELs
- Utilize the state water quality standards
- Can be set as concentration, loading, or both
- Simple calculation from WQS to WQBEL

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Moving on to WQBELs. These are established to protect water quality and will supersede TBELs, when necessary. For instance, if the TBEL is 20 mg/L DM and WQBEL is 16 mg/L DM, then the WQBEL will be written in the permit. These are calculated considering dilution ratios and the state water quality standards. Like TBELs, these can be concentrations, loadings, or both.

These are usually relatively simple calculations, just multiplying the WQS by the appropriate dilution. However, for BCCs, or Bioaccumulative Chemicals of Concern, we do not allow for dilution; the standard becomes an end-of-pipe limit.

Water Quality-based Effluent Limitations

Cyanide	A, A-S, AA, AA-S	200		H(WS)	H
(CAS No. Not Applicable)	GA	200		H(WS)	H
	A, A-S, AA-S, B, C, D	9,000		H(FC)	B
	SA, SB, SC, I, SD	9,000		H(FC)	B
	A, A-S, AA, AA-S, B, C	5.2*		A(C)	
	A, A-S, AA, AA-S, B, C, D	22*		A(A)	
	SA, SB, SC	1.0*		A(C)	
	I		1.0*	A(C)	
	SD	1.0*		A(A)	

Remark: * As free cyanide: the sum of HCN and CN^- expressed as CN.

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There are three types of standards, These are Aquatic (acute), Aquatic (Chronic), and Human Health/Aesthetic/Wildlife, or the HEW standard. All use the critical effluent flow we discussed earlier, but different ambient stream flows, which we will discuss next.

Water Quality-based Effluent Limitations

Chlorine, Total Residual (CAS No. Not Applicable)	A, A-S, AA, AA-S, B, C	5	A(C)
	D	19	A(A)
	SA, SB, SC, I	7.5	A(C)
	SD	13	A(A)

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I've brought up Total residual chlorine, as this has been a common question for permittees recently. You can see based on classification of the receiving water, the standard applicable may be acute or chronic. This numbers have units of ppm, or ug/L. So, when we calculate a TRC limit, it is simply the applicable standard time dilution. If dilution is 30:1 or more, we will apply a decay factor of times 5, per TOGS 1.3.1.

Low-Flows & Dilution

MA7CD10 (7Q10) – Minimum Average 7-consecutive day flow, with a statistical recurrence interval of 10 years

MA30CD10 (30Q10) – Minimum Average 30-consecutive day flow, with a statistical recurrence interval of 10 years

MA1CD10 (1Q10) – Minimum Average 1 day flow, with a statistical recurrence interval of 10 years

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It is important to remember that we model under conservative design conditions, to be protective at water quality in all instances. Thus, the low flows are based on a statistical recurrence interval of 10 years. The flows we use for analysis in NY and many other NPDES states are the 7Q10, 30Q10, and 1Q10.

Low-Flows & Dilution

Flow	7Q10	30Q10	1Q10
Standard Criteria	Chronic	HEW	Acute
Source(s)	• Bulletin 74 • Basin WQMP • DFLOW • DB Ratio	=1.2*(7Q10)	=0.5*(7Q10)

$$Dilution = \frac{(Critical\ Effluent\ Flow + Critical\ Ambient\ Flow)}{Critical\ Effluent\ Flow}$$

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The most widely known ambient flow is the 7Q10, which is used for Chronic dilution. The acute dilution is calculated using either the 1Q10, or in NYS we use ½ of the 7Q10. For the HEW dilution, we use the 30Q10, which is commonly unknown and assumed to be equal to 1.2 x 7Q10. We come up with the 7Q10 from a variety of sources. We have documented 7Q10 flows in the DEC/USGS Bulletin 74 from 1978, it could be estimated in the basin's water quality management plan, we also can use existing USGS Gauge data to calculate a 7Q10 using DFLOW, which estimates the flow using the Log-Pearson Type III method, or we can estimate ungauged stream flows using a known reference gauge flow and drainage area that is in the same or similar watershed, and do a proportional ratio.

For dischargers where we assume complete mixing, dilution can be calculated simply by using this equation. The effluent flow, plus ambient flow, divided by the effluent flow. It is important to note that for large rivers, like the St. Lawrence and Niagara Rivers, when complete mixing is assumed, are given dilutions of 100:1. Ponded waters where complete mixing is assumed, a standard dilution of 10:1 is applied. Unless a site-specific analysis has been performed or provided, typically dilutions will be capped at 100:1 for flowing waters and at 10:1 for ponded waters.

Oxygen Demand Modeling

Streeter-Phelps DO Model

Dissolved Oxygen Deficit Formula

Stream Modeling: Streeter Phelps

$$D = \frac{k_1 L_0}{k_2 - k_1}\left[exp(-k_1 t) - exp(-k_2 t)\right] + D_0 exp(-k_2 t)$$

D – dissolved oxygen deficit in mg/L
k_1 – deoxygenation rate constant in base e ($days^{-1}$)
L_0 – initial BOD ultimate in mixing zone in mg/L
k_2 – reaeration rate, base e ($days^{-1}$)
t – time in days
D_0 – initial dissolved oxygen deficit in mixing zone in mg/L

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Our first major permit WQ evaluation step is performing an analysis of the discharge's oxygen demand on to the receiving waterbody. Like most, we use a Streeter-Phelps analysis to determine whether or not the critical DO concentration is at or above the standard. This assuming that the discharge exhibits characteristics of rapid and complete mixing.

As I'm sure you are aware the Streeter-Phelps equation looks similar to this. Where K1 and K2 are the biggest assumptions for a model we develop. We take these assumptions from TOGS 1.3.1, where K1 (decay) is 0.1828 @ 20 deg C and K2 (reaeration) is 0.23 @ 20 deg C. These are conservative assumptions, however provides the Department a sense of consistency that will air on the side of protection.

When the historic BOD discharge has been adequately evaluated, these analyses typically come back with no changes. However, we have grown to see more and more discharges that perhaps have changed circumstances or were not adequately evaluated previously, likely due to lesser technology and tools for determining these loadings.

DEC Modeling Tool – Example 1

			Notes	Source
	Reach	P		
Reach Description:	Discharge to Lake Erie			
Watershed Area :	447.0			
PRIMARY REACH INPUT				
MODEL SETUP			Notes	Source
Main Stem:	Yes	-		
Discharge Present:	Yes	-		
Linear or Branched System:	Linear	-		
Upstream Reaches:	None	-		
Waterbody Class for DO std.:	Trout	-		
Channel Depth and Velocity Known :	No	-		
EFFLUENT CHARACTERISTICS				
Discharge :	3.40	cfs	Design Flow	
daily max 5-day CBOD :	45.00	mg/L	7DA Limit	
daily max NOD :	90.00	mg/L	WQ Based	90 is Current Limit
daily max UOD :	155.85	mg/L		
Dissolved Oxygen :	0.00	mg/L	Minimum expected from DMR data	
Temperature :	21.00	°C	Avg Eff Temp	
RECEIVING WATER CHARACTERISTICS				
Upstream Flow Rate :	67.00	cfs	7Q10	
Upstream ultimate CBOD :	3.00	mg/L		
Upstream NOD :	0.00	mg/L		
Upstream UOD :	3.00	mg/L		
Upstream Dissolved Oxygen :	7.44	mg/L		
Upstream Temperature :	24.00	°C	Assumed Trout	
Begin Elevation :	745.00	ft	Google Earth	
End Elevation :	580.00	ft	Google Earth	
Reach Length :	16.40	miles	Google Earth	
Width of Reach :	140.00	ft	Google Earth	
Mannings N :	0.035	-	Assumed	
Predicted Downstream Conditions				
Downstream Average Channel Area :	64.17	ft^2		
Downstream Average Channel Depth :	0.46	ft		
Downstream Average Channel Velocity :	1.10	fps		
Downstream Flow :	70.40	cfs		
Downstream Average Channel Slope :	0.0019055	ft/ft		
Wetted Perimeter :	70.92	ft		
Hydraulic Radius :	0.90	ft		

Calculate Inputs

Calculate Width

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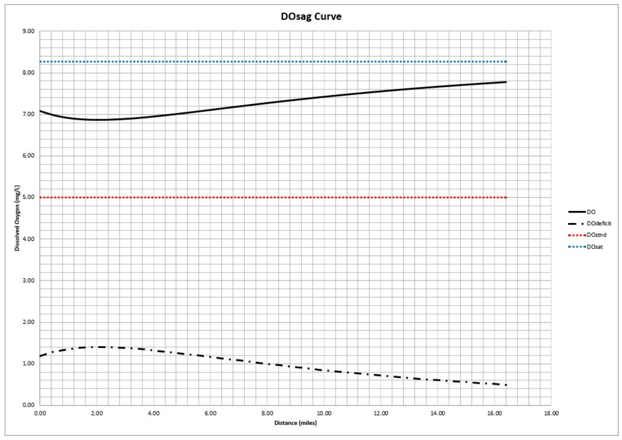
Now-a-days, we have some tools to assist us with performing these types of calculations. Our division developed a macro-excel file a few years back that pulled in all the standardized assumptions, then allowed for our permit writers to simply input our scenarios and then output our DO sag curve. This is what a snip of that sheet looks like.

In this example, you can see we placed it under relatively stringent conditions, with an effluent DO concentration of 0 mg/L and a DM BOD5 (we use our 7DA here) OF 45 mg/L. Then we also added an NOD load of 90 mg/L, based on their existing ammonia discharge, converting Ammonia as NH_3 to NOD by multiplying by 6.022. We have the flexibility that we can assume a 0 NOD and use the DM CBOD as a UOD or TOD as well.

DEC Modeling Tool – Example 1

Reach:

No Reasonable Potential to violate WQS.



Time(days)	Distance (miles)	UOD (mg/L)	DO Deficit (mg/L)	DO (mg/L)	DO saturation (mg/L)	DO standard (mg/L)
0.00	0.00	10.38	1.19	7.08	8.26	5.00
0.03	0.47	9.98	1.28	6.98	8.26	5.00

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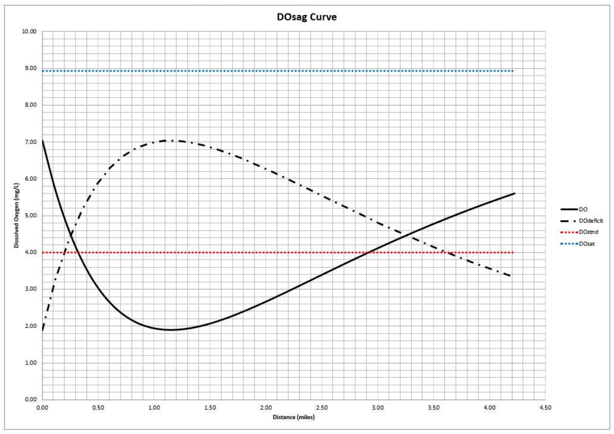
This example proved to not have a significant affect on the receiving water at all, as you'll see in the DO sag curve.

Often times, we see some discharges to smaller streams than this example, where the DO modeling truly matters.

DEC Modeling Tool – Example 2

Reach:

Discharge has reasonable potential to violate water quality.



Time(days)	Distance (miles)	UOD (mg/L)	DO Deficit (mg/L)	DO (mg/L)	DO saturation (mg/L)	DO standard (mg/L)
0.00	0.00	50.40	1.89	7.04	8.93	4.00
0.01	0.12	48.52	3.27	5.65	8.93	4.00

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This facility, had a reduction from limits of 20/30 mg/L down to 13/19 mg/L for BOD in the summer season. We chose seasonal limitations, given a historical stream flow data set that provided sufficient data to calculate a 7Q10 for each season.

You can see here that with the previously issued limits of 30 mg/L CBOD and 1.4 mg/L, that the in-stream DO fell below the standard and thus is not allowed. We looked at the performance of the facility and found that removal of CBOD was sufficient enough, that with a reduction in the limit, compliance should still not be an issue.

DEC Modeling Tool – Example 2

PRIMARY REACH INPUT

MODEL SETUP			Notes	Source
Main Stem:	Yes	-		
Discharge Present:	Yes	-		
Linear or Branched System:	Linear	-		
Upstream Reaches:	None	-		
Waterbody Class for DO std.:	Non Trout	-		
Channel Depth and Velocity Known :	No	-		

EFFLUENT CHARACTERISTICS			Notes	Source
Discharge :	0.50	cfs	Existing permitted limit	
daily max 5-day CBOD :	18.70	mg/L	Adjusted to satisfy DO Curve	
daily max NOD :	8.40	mg/L	from exisiting permitted NH3 limit of 1.4 mg/l, b/c WQBEL is 2.	
daily max UOD :	35.76	mg/L		
Dissolved Oxygen :	7.00	mg/L	Existing Limit	
Temperature :	20.00	° C	Calculated 80th %ile Operations Data 2010-2015	

Calculate Inputs

RECEIVING WATER CHARACTERISTICS			Notes	Source
Upstream Flow Rate :	0.02	cfs	Calculated 7Q10 from Title Page	
Upstream ultimate CBOD :	3.00	mg/L	Assumed (No other discharges upstream)	
Upstream NOD :	0.00	mg/L	Assumed (No other discharges upstream)	
Upstream UOD :	3.00	mg/L	Assumed (No other discharges upstream)	
Upstream Dissolved Oxygen :	8.03	mg/L	Assumed (No other discharges upstream)	
Upstream Temperature :	20.00	° C	Calculated 80th %ile Operations Data 2010-2015	
Begin Elevation :	730.00	ft	ArcGIS Base Map (Estimated)	
End Elevation :	579.00	ft	ArcGIS Base Map (Estimated)	
Reach Length :	4.23	miles	ArcGIS Base Map (Estimated)	
Width of Reach :	10.00	ft	ArcGIS Base Map (Estimated)	
Mannings N :	0.035	-		

Calculate Width

Predicted Downstream Conditions		
Downstream Average Channel Area :	0.81	ft^2
Downstream Average Channel Depth :	0.08	ft
Downstream Average Channel Velocity :	0.65	fps
Downstream Flow :	0.52	cfs
Downstream Average Channel Slope :	0.0067673	ft/ft
Wetted Perimeter :	5.16	ft
Hydraulic Radius :	0.16	ft

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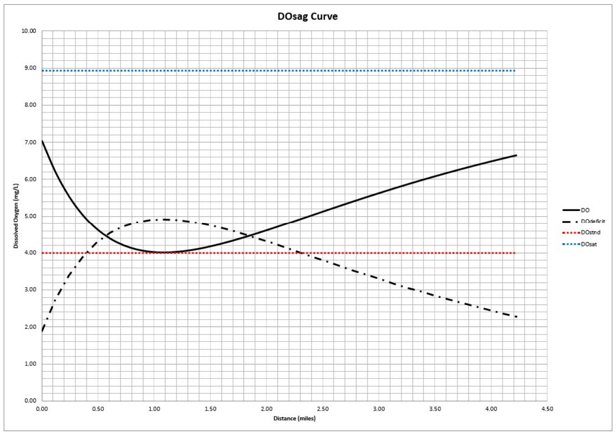
So we input a lower CBOD limit to determine compliance with the DO standard, maintaining the same 1.4 mg/L NH_3, and found that 18.7 mg/L was adequate.

DEC Modeling Tool – Example 2

Reach:

No Reasonable Potential to violate WQS.



Time(days)	Distance (miles)	UOD (mg/L)	DO Deficit (mg/L)	DO (mg/L)	DO saturation (mg/L)	DO standard (mg/L)
0.00	0.00	34.50	1.89	7.04	8.93	4.00
0.01	0.12	33.22	2.73	6.19	8.93	4.00

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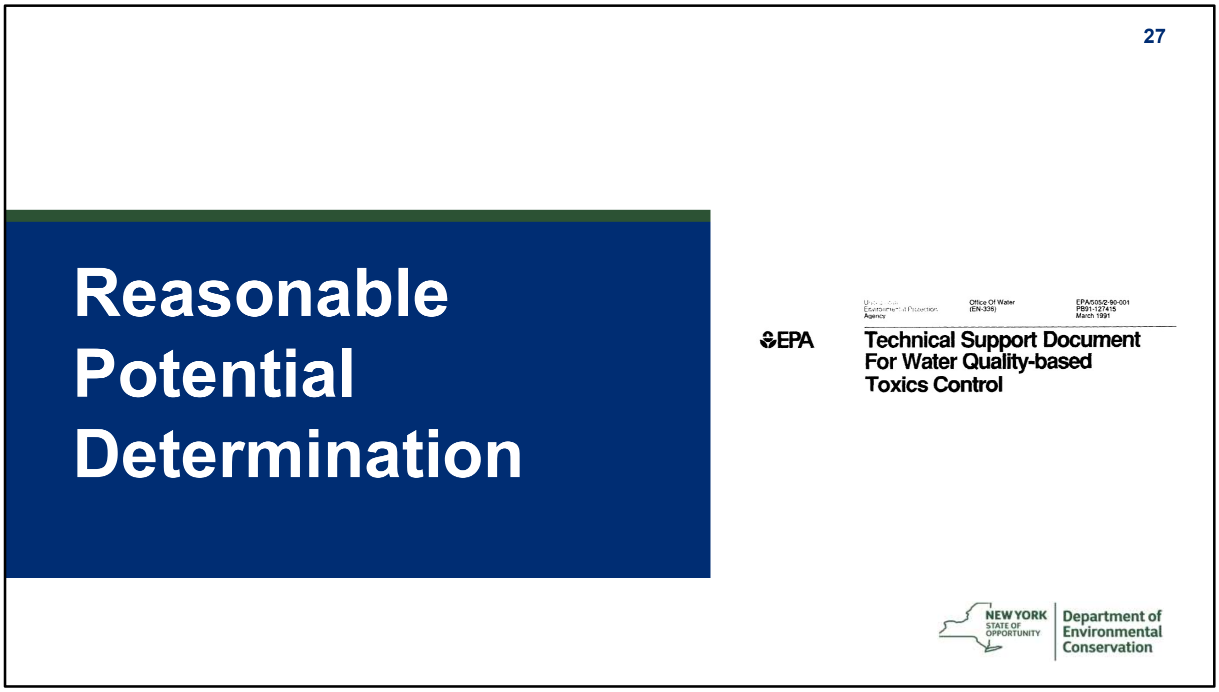
DO Sag curve resulting from the modified effluent BOD input.



WQBELs are developed when a RPD predicts the likelihood of the receiving water to meet or exceed the water quality standard. An RPD is typically run for all metal and toxic pollutants, and other non-conservative pollutants, such as ammonia. A RPD utilizes statistical methodologies (like lognormal distributions, coefficients of variation, variance multipliers) and existing effluent quality data to predict potential discharge levels. When the RPD predicts a discharge may cause the receiving water to meet or exceed the WQS, a WQBEL is required. This processes is laid out in detail in the 1991 EPA Technical Support Document for Water Quality-based Toxics Control.

Projecting Discharge Quality

$$CV = \frac{\sigma}{\mu}$$

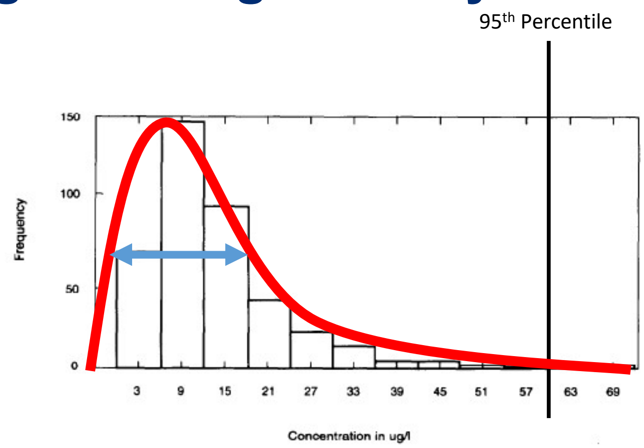


Figure E-3. BOD Frequency Distribution - Plant C

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We at DEC apply the same concepts for our toxics control, as the TSD lays out in Appendix E. This method assumes that environmental data are generally distributed lognormally, that being a biased distribution towards a lower concentration for instance BOD is more likely to be frequently lower. This plot is taken from the TSD.

When we have a limited data set, we need to predict how that data is dispersed before we can assess whether the discharge is protective of water quality or not. Say we have 1 data point and it is 20 mg/L. We have no idea where that 20 mg/L lies on this curve. It could be the highest concentration the discharge ever has, the average, or the lowest. So, we use the RPD process to predict where that point lies on the curve. Granted, the more data we have, then the better idea we have as to how this curve, or data distribution, is arranged.

RPD takes the raw reported concentration data set to determine a Coefficient of Variation (CV). The CV is just an estimate of how widespread the bulk of the data is. It is generally calculated as the standard deviation divided by the mean. For data sets of less than 10 samples, the CV used is 0.6 because of the unpredictability of variability. Then, using the CV and the number of samples, a multiplier is selected from Table 3-2 of the TSD for the 95% Confidence Interval.

Projecting Discharge Quality

Table 3-2. Reasonable Potential Multiplying Factors: 95% Confidence Level and 95% Probability Basis

Number of	Coefficient of Variation																			
Samples	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
1	1.4	1.9	2.6	3.6	4.7	6.2	8.0	10.1	12.6	15.5	18.7	22.3	26.4	30.8	35.6	40.7	46.2	52.1	58.4	64.9
2	1.3	1.6	2.0	2.5	3.1	3.8	4.6	5.4	6.4	7.4	8.5	9.7	10.9	12.2	13.6	15.0	16.4	17.9	19.5	21.1
3	1.2	1.5	1.8	2.1	2.5	3.0	3.5	4.0	4.6	5.2	5.8	6.5	7.2	7.9	8.6	9.3	10.0	10.8	11.5	12.3
4	1.2	1.4	1.7	1.9	2.2	2.6	2.9	3.3	3.7	4.2	4.6	5.0	5.5	6.0	6.4	6.9	7.4	7.8	8.3	8.8
5	1.2	1.4	1.6	1.8	2.1	2.3	2.6	2.9	3.2	3.6	3.9	4.2	4.5	4.9	5.2	5.6	5.9	6.2	6.6	6.9
6	1.1	1.3	1.5	1.7	1.9	2.1	2.4	2.6	2.9	3.1	3.4	3.7	3.9	4.2	4.5	4.7	5.0	5.2	5.5	5.7
7	1.1	1.3	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.1	3.3	3.5	3.7	3.9	4.1	4.3	4.5	4.7	4.9
8	1.1	1.3	1.4	1.6	1.7	1.9	2.1	2.3	2.4	2.6	2.8	3.0	3.2	3.3	3.5	3.7	3.9	4.0	4.2	4.3
9	1.1	1.2	1.4	1.5	1.7	1.8	2.0	2.1	2.3	2.4	2.6	2.8	2.9	3.1	3.2	3.4	3.5	3.6	3.8	3.9
10	1.1	1.2	1.3	1.5	1.6	1.7	1.9	2.0	2.2	2.3	2.4	2.6	2.7	2.8	3.0	3.1	3.2	3.3	3.4	3.6
11	1.1	1.2	1.3	1.4	1.6	1.7	1.8	1.9	2.1	2.2	2.3	2.4	2.5	2.7	2.8	2.9	3.0	3.1	3.2	3.3
12	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.0
13	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.5	2.6	2.7	2.8	2.9
14	1.1	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.3	2.4	2.5	2.6	2.6	2.7
15	1.1	1.2	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.8	1.9	2.0	2.1	2.2	2.2	2.3	2.4	2.4	2.5	2.5
16	1.1	1.1	1.2	1.3	1.4	1.5	1.6	1.6	1.7	1.8	1.9	1.9	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.4
17	1.1	1.1	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.7	1.8	1.9	1.9	2.0	2.0	2.1	2.2	2.2	2.3	2.3
18	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.6	1.6	1.7	1.7	1.8	1.9	1.9	2.0	2.0	2.1	2.1	2.2	2.2
19	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.5	1.6	1.6	1.7	1.8	1.8	1.9	1.9	2.0	2.0	2.0	2.1	2.1
20	1.1	1.1	1.2	1.2	1.3	1.4	1.4	1.5	1.5	1.6	1.7	1.7	1.8	1.8	1.8	1.9	1.9	2.0	2.0	2.0

$$M = \frac{\exp\left(NORMSINV(EV) * g - 0.5g^2\right)}{\exp\left(NORMSINV(P_n) * g - 0.5g^2\right)}$$

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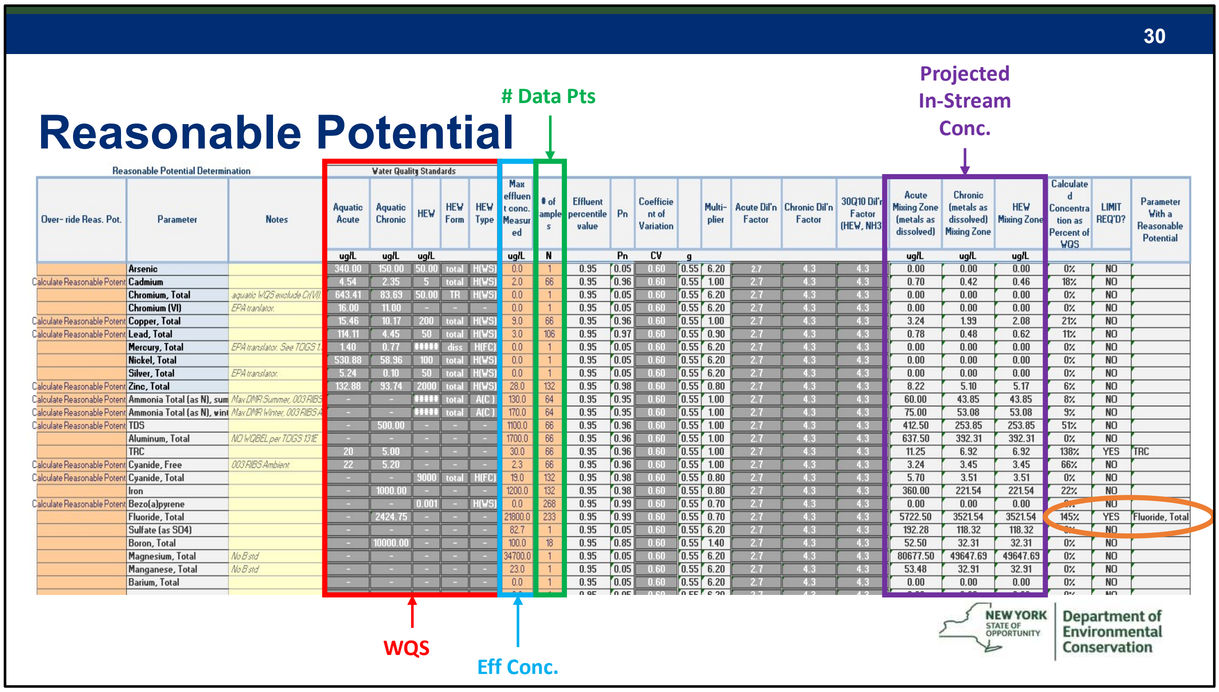
The multiplier table is developed from this formula, which looks at the percentile of the highest concentration and the log-transformed standard deviation. Then, the maximum concentration in the data set is multiplied by the multiplier. This value predicts the estimate of the maximum expected effluent concentration.

This process is followed for all datasets less than 20. For more than that, the actual 95th percentile and multiplier of 1.0 is used.



Reasonable Potential Determination

Over- ride Reas. Pot.	Parameter	Notes	Water Quality Standards: Aquatic Acute	Aquatic Chronic	HEW	HEW Form	HEW Type	Max effluent conc. Measured	# of samples	Effluent percentile value	Pn	Coefficient of Variation		Multi- plier	Acute Dil'n Factor	Chronic Dil'n Factor	30Q10 Dil'n Factor (HEW, NH3)	Acute Mixing Zone (metals as dissolved)	Chronic (metals as dissolved) Mixing Zone	HEW Mixing Zone	Calculated Concentration as Percent of WQS	LIMIT REQ'D?	Parameter With a Reasonable Potential
			ug/L	ug/L	ug/L			ug/L	N		Pn	CV	g					ug/L	ug/L	ug/L			
	Arsenic		340.00	150.00	50.00	total	H(WS)	0.0	1	0.95	0.05	0.60	0.55	6.20	2.7	4.3	4.3	0.00	0.00	0.00	0%	NO	
Calculate Reasonable Potent	Cadmium		4.54	2.35	5	total	H(WS)	2.0	66	0.95	0.96	0.60	0.55	1.00	2.7	4.3	4.3	0.70	0.42	0.46	18%	NO	
	Chromium, Total	aquatic WQS exclude Cr(VI)	643.41	83.69	50.00	TR	H(WS)	0.0	1	0.95	0.05	0.60	0.55	6.20	2.7	4.3	4.3	0.00	0.00	0.00	0%	NO	
	Chromium (VI)	EPA tranlator.	16.00	11.00	-	-	-	0.0	1	0.95	0.05	0.60	0.55	6.20	2.7	4.3	4.3	0.00	0.00	0.00	0%	NO	
Calculate Reasonable Potent	Copper, Total		15.46	10.17	200	total	H(WS)	9.0	66	0.95	0.96	0.60	0.55	1.00	2.7	4.3	4.3	3.24	1.99	2.08	21%	NO	
Calculate Reasonable Potent	Lead, Total		114.11	4.45	50	total	H(WS)	3.0	106	0.95	0.97	0.60	0.55	0.90	2.7	4.3	4.3	0.78	0.48	0.62	11%	NO	
	Mercury, Total	EPA translator. See TOGS 1.	1.40	0.77	#####	diss	H(FC)	0.0	1	0.95	0.05	0.60	0.55	6.20	2.7	4.3	4.3	0.00	0.00	0.00	0%	NO	
	Nickel, Total		530.88	58.96	100	total	H(WS)	0.0	1	0.95	0.05	0.60	0.55	6.20	2.7	4.3	4.3	0.00	0.00	0.00	0%	NO	
	Silver, Total	EPA translator.	5.24	0.10	50	total	H(WS)	0.0	1	0.95	0.05	0.60	0.55	6.20	2.7	4.3	4.3	0.00	0.00	0.00	0%	NO	
Calculate Reasonable Potent	Zinc, Total		132.88	93.74	2000	total	H(WS)	28.0	132	0.95	0.98	0.60	0.55	0.80	2.7	4.3	4.3	8.22	5.10	5.17	6%	NO	
Calculate Reasonable Potent	Ammonia Total (as N), sum	Max DMR Summer, 003 RIBS	-	-	#####	total	A(C)	130.0	64	0.95	0.95	0.60	0.55	1.00	2.7	4.3	4.3	60.00	43.85	43.85	8%	NO	
Calculate Reasonable Potent	Ammonia Total (as N), wint	Max DMR Winter, 003 RIBS A	-	-	#####	total	A(C)	170.0	64	0.95	0.95	0.60	0.55	1.00	2.7	4.3	4.3	75.00	53.08	53.08	9%	NO	
Calculate Reasonable Potent	TDS		-	500.00	-	-	-	1100.0	66	0.95	0.96	0.60	0.55	1.00	2.7	4.3	4.3	412.50	253.85	253.85	51%	NO	
	Aluminum, Total	NO WQBEL per TOGS 1.3.1E	-	-	-	-	-	1700.0	66	0.95	0.96	0.60	0.55	1.00	2.7	4.3	4.3	637.50	392.31	392.31	0%	NO	
	TRC		20	5.00	-	-	-	30.0	66	0.95	0.96	0.60	0.55	1.00	2.7	4.3	4.3	11.25	6.92	6.92	138%	YES	TRC
Calculate Reasonable Potent	Cyanide, Free	003 RIBS Ambient	22	5.20	-	-	-	2.3	66	0.95	0.96	0.60	0.55	1.00	2.7	4.3	4.3	3.24	3.45	3.45	66%	NO	
Calculate Reasonable Potent	Cyanide, Total		-	-	9000	total	H(FC)	19.0	132	0.95	0.98	0.60	0.55	0.80	2.7	4.3	4.3	5.70	3.51	3.51	0%	NO	
	Iron		-	1000.00	-	-	-	1200.0	132	0.95	0.98	0.60	0.55	0.80	2.7	4.3	4.3	360.00	221.54	221.54	22%	NO	
Calculate Reasonable Potent	Bezo(a)pyrene		-	-	0.001	-	H(WS)	0.0	268	0.95	0.99	0.60	0.55	0.70	2.7	4.3	4.3	0.00	0.00	0.00	[illegible]	NO	
	Fluoride, Total		-	2424.75	-	-	-	21800.0	233	0.95	0.99	0.60	0.55	0.70	2.7	4.3	4.3	5722.50	3521.54	3521.54	145%	YES	Fluoride, Total
	Sulfate (as SO4)		-	-	-	-	-	82.7	1	0.95	0.05	0.60	0.55	6.20	2.7	4.3	4.3	192.28	118.32	118.32	[illegible]	NO	
	Boron, Total		-	10000.00	-	-	-	100.0	18	0.95	0.85	0.60	0.55	1.40	2.7	4.3	4.3	52.50	32.31	32.31	0%	NO	
	Magnesium, Total	No B std	-	-	-	-	-	34700.0	1	0.95	0.05	0.60	0.55	6.20	2.7	4.3	4.3	80677.50	49647.69	49647.69	0%	NO	
	Manganese, Total	No B std	-	-	-	-	-	23.0	1	0.95	0.05	0.60	0.55	6.20	2.7	4.3	4.3	53.48	32.91	32.91	0%	NO	
	Barium, Total		-	-	-	-	-	0.0	1	0.95	0.05	0.60	0.55	6.20	2.7	4.3	4.3	0.00	0.00	0.00	0%	NO	

We have created some tools to facilitate consistency and efficiency. I have added a snap shot of what our spreadsheet looks like here. We input the water quality standards, the concentration of effluent quality, number of data points, and it estimates the 95th percentile concentration on the LN curve, then calculates the projected in-stream concentration (by applying dilution). We then compare this value to the WQS. If the projected in-stream concentration is found to be 100% or greater of the WQS, then a WQBEL is required because the discharge has a reasonable potential to meet or exceed the WQS.

This particular example is for an industrial discharger, with several pollutants present. We can see that for Fluoride, a projected in-stream concentration of 3500 ug/L exists, which is 145% of the standard. Please note, that for our purposes, we by default first assess datasets using the 0.6 CV and the multiplier of 6.2, since this is the most conservative scenario. If it passes, then no further efforts should be used. If it fails, it can then be revised, to reflect the process. While this instance fails, even a calibrated CV and multiplier of 1.0 would still result in the need for a WQBEL.

Factsheet Representation of RPD Results

Outfall #	001	Description of Wastewater: Sanitary Sewage													
		Type of Treatment: Screening, primary settling, rotating biological contactors (RBCs), coagulation and settling, sand filtration, UV disinfection, microfiltration, and re-aeration													
Effluent Parameter	Units	Averaging Period	Existing Discharge Data			TBELs		Water Quality Data & WQBELs						ML	Basis for Permit Requirement
			Permit Limit	Existing Effluent Quality	# of Data Points (non-detects)	Limit	Basis	Ambient Bkgd. Conc.	WQ Std. or GV	WQ Type	Projected Instream Conc.	Calc. WQBEL	Basis for WQBEL		
5-day Carbonaceous	mg/L	Monthly Avg	5.0 – DM	5.6 (max)	61	30	TOGS 1.3.3	3.0 (assumed)	7.0 – DO (minimum)	Narrative	7.0 - DO	5.0 - DM	RSAT	-	WQBEL
		7 Day Avg				45	TOGS 1.3.3							-	
Biochemical Oxygen	lbs/d	Monthly Avg	*No Reporting Previously Required*			200	TOGS 1.3.3	4.0 (assumed)	9.3 - DO (minimum)	Narrative	56 – DO	33 - DM	RSAT	-	WQBEL
		7 Day Avg				300	TOGS 1.3.3							-	
Demand	% Rem	Monthly Avg	85	> 90	61	85	TOGS 1.3.3	*No WQS*						-	TBEL
($CBOD_5$)	Only 1 detection of $CBOD_5$ reported on DMR since 2013 (5.6 mg/L, Aug. 2016) The existing permit required ISEL $CBOD_5$ = 5.0 mg/L, which supersedes the secondary treatment TBEL. The downstream DO concentration was modeled using the Streeter-Phelps equations. The following assumptions were used in the model: Effluent DO = 7.0 mg/L, Effluent $CBOD_5$ = 5.0 mg/L, Effluent NOD = 6.6 mg/L = 1.1 mg/L (Ammonia, as NH_3). Downstream DO is satisfied under these typical conditions (Effluent flow < 0.8 MGD), thus $CBOD_5$ must continue to be limited as ISEL = 5.0 mg/L. No further stringency can be placed on $CBOD_5$ limit.														
Total Suspended	mg/L	Monthly Avg	10 – DM	<2.3	61	30	TOGS 1.3.3	UNK	Narrative: *None from sewage, industrial wastes or other wastes that will cause deposition or impair the waters for their best usages.*			10 - DM	703.2	-	WQBEL
		7 Day Avg				45	TOGS 1.3.3							-	WQBEL
Solids (TSS)	lbs/d	Monthly Avg	*No Reporting Previously Required*			200	TOGS 1.3.3	UNK				67 - DM	TOGS 1.3.3	-	WQBEL
		7 Day Avg				300	TOGS 1.3.3							-	WQBEL
	% Rem	Monthly Avg	85	> 97	61	85	TOGS 1.3.3	*No WQS*						-	TBEL
	All months since 2013 have DMR reported values as "less than" indicating at most 1 detection per month (only 2 samples collected per month). Smallest reported % removal is 97%. Given that adequate dilution is not available an effluent limitation equal to 10 mg/l daily max is appropriate and consistent with TOGS 1.3.3 for discharges to intermittent streams.														
Dissolved Oxygen	mg/L	Daily Min	7.0		61	7.0	Antibacksliding	7.7	7.0	Narrative	7.0	7.0	703.3	-	WQBEL
(DO)	The downstream DO concentration was modeled using the Streeter-Phelps equations. The downstream DO concentration was modeled using the Streeter-Phelps equations. The following assumptions were used in the model: Effluent DO = 7.0 mg/L, Effluent $CBOD_5$ = 5.0 mg/L, Effluent NOD = 6.6 mg/L = 1.1 mg/L (Ammonia, as NH_3). Downstream DO is satisfied under typical conditions (Effluent flow < 0.8 MGD). The RSAT model showed that a WQBEL for DO of 7.0 mg/L is necessary to maintain adequate downstream water quality.														
Nitrogen,	mg/l	Monthly Avg	*No Reporting Previously Required*			Monitor	BPJ	0	0.90	A (C)	0.32	No RP	40CFR 144 (RSAT)	-	Monitor
Ammonia		Daily Max	1.1 (as NH_3)	0.43 (as NH_3)	2 (23)	1.1 (as NH_3)	Antibacksliding	0	6.9	A (A)	3.4	No RP		-	TBEL
(as N)	lb/d	Monthly Avg	*No Reporting Previously Required*			Monitor	BPJ	0	1.2	A (C)	2.6	No RP		-	Monitor
Summer		Daily Max				Monitor	BPJ	0	9.2	A (A)	27	No RP		-	Monitor

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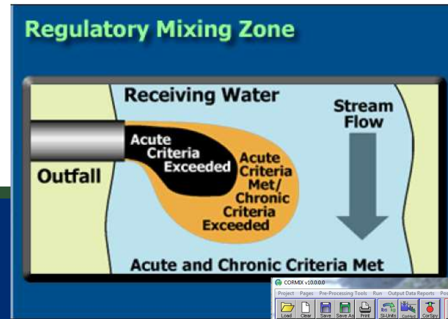
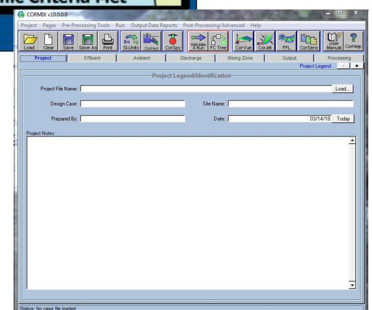
Now, looking back at the factsheet table, you will see all of this important data. You will have the ambient background concentration (when applicable), the WQS used, the projected instream concentration, and the calculated WQBEL if it is necessary. If no WQBEL is necessary (i.e. No Reasonable Potential) then it will say No RP. This really helps us inform not only permittees but also the public, that we did assess the discharge, here's the worst case scenario under our design conditions, and it is either protective or not of water quality.

Advanced WQ Modeling

CORMIX, Visual Plumes





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Discharge dilution modeling is a key factor in SPDES permit evaluations of water quality. Some simple discharges exhibit a completely-mixed scenario, in which the discharge utilizes the full receiving waterbody to mix. Completely mixed discharges can be defined as a mixing condition where there is no measurable difference in the concentration of the pollutant across any transect of the waterbody. More commonly, discharges exhibit complex, incompletely-mixed scenarios, where the discharge only mixes well with a portion of the receiving water. In these scenarios, only a portion of the streams cross-section and flow is allowed for dilution, which typically drives lower dilution ratios. This is where the concept of mixing zones comes into play, where there are acute and chronic mixing zones and the sizes of each of these are crucial for the protection of water quality.

NYSDEC has been utilizing more advanced modeling software, like CORMIX, to assist in permit development. With these advancements in technology and modeling software, coupled with the existing discharge review processes, more accurate predictions of mixing scenarios and environmentally protective effluent limits are being incorporated into SPDES permits. Historically, CORMIX models were developed for marine dischargers to determine their dilution rations and in some freshwaters, dilution studies coupled with CORMIX models have been developed and accepted by the Department.

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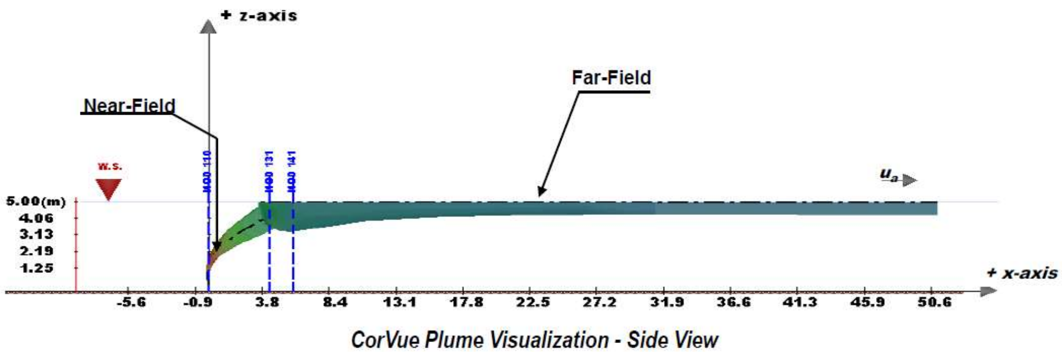
CORMIX Modeling of Incomplete Mixing



Source: CORMIX User Manual

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Now, people study these mixing interactions for a living and it can get very intricate, so we will just, “touch the surface” here.

There are two regions of modeling we need to delineate. These are the near-field and the far-field. Typically, a regulatory mixing zone will extend into a portion of the far-field region. The best way to discern between these two regions, is by their type of mixing. The near-field is dominated as discharge-induced mixing, where the momentum and buoyancy of the discharge influence the amount of mixing. In the far-field, the ambient conditions will dominate the mixing characteristics, typically density and receiving water momentum are the biggest factors.

Now, when we choose to apply a mixing zone for a discharger, we tend to follow USEPA guidance from the TSD and their chronic toxicity zone of initial dilution guidance document, which gives us a few options for different conditions. We can use 5 times the local water depth, 20 times the stream width, or 50 times the discharge length scale. The DLS is = square root of the cross-sectional area of the port. For lake discharges, the zone of initial dilution, or the near field, should utilize the local water depth at no greater than the 90% exceedance level (10 year low water level).

Examples

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In short, these are the types of events we are attempting to prevent from occurring.

Note: These are just dye studies, but we don't want these visual effects to occur from a typical discharge plume.

Thank You

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