Reviewing total maximum daily load reports

This guidebook is from a workshop given in 2020 to project managers and other interested staff in the Minnesota Pollution Control Agency (MPCA's) Watershed Division.

The goal of this workshop is to provide knowledge and tools to review and understand total maximum daily load (TMDL) reports. While you are not expected to understand all of the details of the data analysis and modeling, you should have enough understanding of the material to ensure that the report is complete and that the results are in-line with your understanding of the watershed. My role is to support the project managers' TMDL work. Because my role is not to review all TMDL reports in the state, I put together this training to help you in your work with consultants, local partners, or even internal staff who are developing TMDLs for you. I am available if you have specific questions about your TMDL work, so please feel free to contact me as you are working through a project.

In Part 1 of this workshop, we'll go through the different sections of the TMDL report, and I'll point out specific things to look for in your TMDL report. In Part 2, we'll go beyond reviewing TMDL reports—we'll look at the technical approaches and models that are often used to develop TMDLs in Minnesota to provide you with background knowledge, to better understand how the conclusions were drawn, and how to apply them to your watershed. In Part 3 we'll get into the math of TMDL tables, and then we'll have a look at a TMDL report and see how all of the pieces fit together.

Some of the information in this workshop will be very focused on what to look for in a TMDL report. Other information will stray into aspects of TMDL development that aren't strictly about reviewing TMDLs, but that could be useful for your general understanding of TMDLs. Keep in mind that I can't cover everything here. Feel free to ask questions, but know that we don't have time to get into all of the details.

For those of you who will be managing TMDL projects in your watershed but don't want to get into the nitty gritty of TMDL development, this workshop will provide you with the basics, and might get into a little more detail than you would like, especially in Part 2. For those of you who want to get deeper into TMDL development, this workshop is just the beginning, and future opportunities for mentoring and training in TMDL development will be made available to you. Because there is a large range in experience and background among the project managers, some parts of the training might be too basic for some of you, and some parts might be too advanced for others. Hopefully, you will all find something helpful that you can use as you move forward with your work on TMDLs.

After the workshop is over, I will distribute the PowerPoint file to all of you who attend. The file has detailed notes and serves as a manual to accompany the workshop. If you are viewing this PowerPoint after the workshop, please view it as a slide show so that the animations function.

Part 1: TMDL report components

In this part, we'll focus on the components of TMDL reports. More technical information is coming in Part 2. So even though I mention things like load duration curves in Part 1, don't worry if you don't understand all of the details; just look at the bigger picture here and we'll get to more detail in the next session.

The TMDL report template is being revised, mostly with additions of text that can be used in a TMDL report. Because some of the information does not change across TMDL reports, we are providing standard language that can be adapted for use in your watershed instead of having the TMDL writer needing to reinvent the wheel every time a new TMDL report is started.

After each section in this presentation, you will see a "section summary" that looks like this. This information from all three parts of this workshop is compiled in "Summary Guidelines for Reviewing TMDLs" in the appendix.

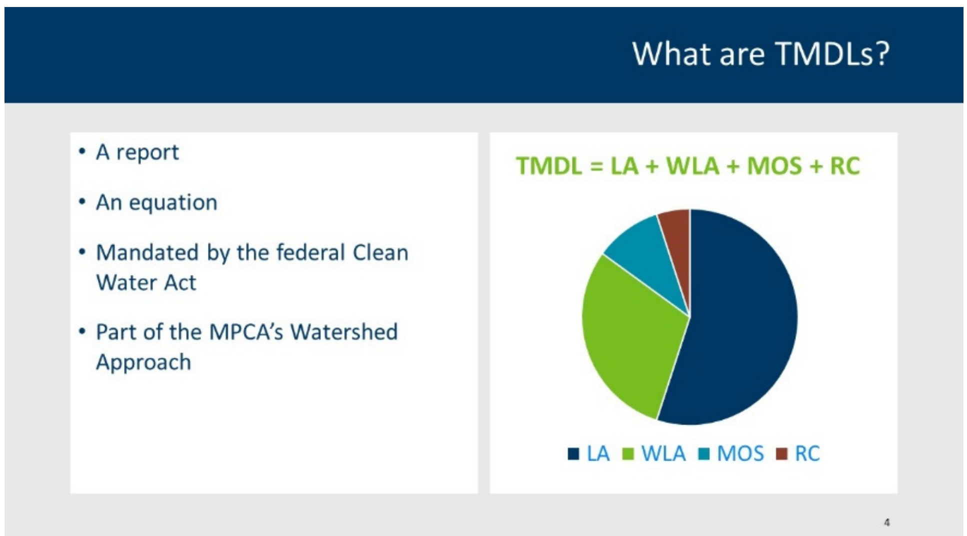
Section Summary

Compiled in appendix:

"Summary Guidelines for Reviewing TMDLs"

What are TMDLs?

This workshop is not a broad "TMDLs 101" course, so I won't be starting from the beginning on all of the parts of a TMDL. Suffice it to say that a "TMDL" is both a report and an equation. It's a study that is mandated by the federal Clean Water Act, and it is just one part of the MPCA's bigger picture water shed approach.



Resources for TMDL report review

- Required
  - EPA's [Guidelines for Reviewing TMDLs](#) (2002)
  - MPCA's TMDL report template [legal precedent, communication with the U.S. Environmental Protection agency (EPA)]
- Preferred
  - MPCA's TMDL report template (clarity, consistency)
- This workshop series

The information in this workshop is a combination of required and preferred elements. The EPA's "Guidelines for Reviewing TMDLs" presents report components that are required because they are required by the Clean Water Act and by regulation. The document also presents report elements that are "generally necessary for EPA to determine if a submitted TMDL is approvable." While EPA refers to these items as "shoulds," I am calling them required here, because they are generally needed for approval.

TMDL report outline

A TMDL report is a stand-alone document. All sections need to be described, even if it seems obvious to an insider.

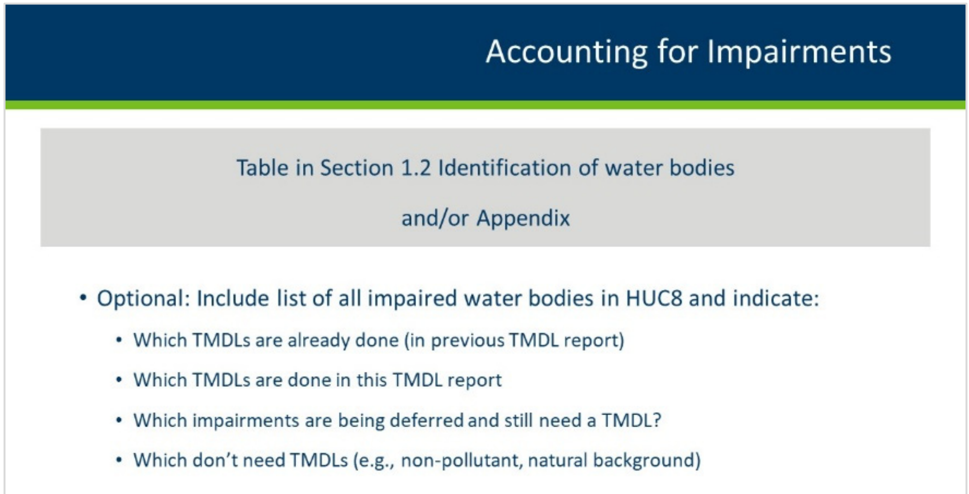
1. Project overview
    - 1.1 Purpose
    - 1.2 Identification of water bodies
    - 1.3 Priority ranking
2. Applicable water quality standards and numeric water quality targets
3. Watershed and water body characterization
    - 3.1 Lakes
    - 3.2 Streams
    - 3.3 Subwatersheds
    - 3.4 Land use
    - 3.5 Water quality
    - 3.6 Pollutant source summary
        - 3.6.1 [Parameter #1, e.g., *E. coli*]
        - 3.6.1.1 Permitted sources
        - 3.6.1.2 Non-permitted sources
        - 3.6.2 [Parameter #2, e.g., TSS]
        - 3.6.2.1 Permitted sources
        - 3.6.2.2 Non-permitted sources
4. TMDL Development
    - 4.1 [Parameter #1]
        - 4.1.1 Loading capacity methodology
        - 4.1.2 Load allocation (LA) methodology
        - 4.1.3 Wasteload allocation (WLA) methodology
        - 4.1.4 Margin of safety
        - 4.1.5 Seasonal variation and critical conditions
        - 4.1.6 Reserve capacity
        - 4.1.7 Baseline year
        - 4.1.8 Percent reduction
        - 4.1.9 TMDL summary
    - 4.2 [Parameter #2]
5. Future growth considerations
    - 5.1 New or expanding permitted MS4 WLA transfer process
    - 5.2 New or expanding wastewater (TSS and *E. coli* TMDLs only)
6. Reasonable assurance
7. Monitoring plan
8. Implementation strategy summary
    - 8.1 Permitted sources
    - 8.2 Non-permitted sources
    - 8.3 Cost
    - 8.4 Adaptive management
9. Public participation
    - 9.1 Public notice
10. Literature cited

    Appendices

Identification of water bodies: accounting for impairments

The project overview has a section called "Identification of water bodies" where we list the impairments that are addressed in the report. When we started doing TMDLs on a Hydrologic Unit Code (HUC)-8 watershed basis, this got more complicated, because we also wanted to acknowledge impairments for which TMDLs are **not** being developed. And as we move into the next round of HUC-8 TMDLs, it's nice to also list TMDLs that have already been completed.

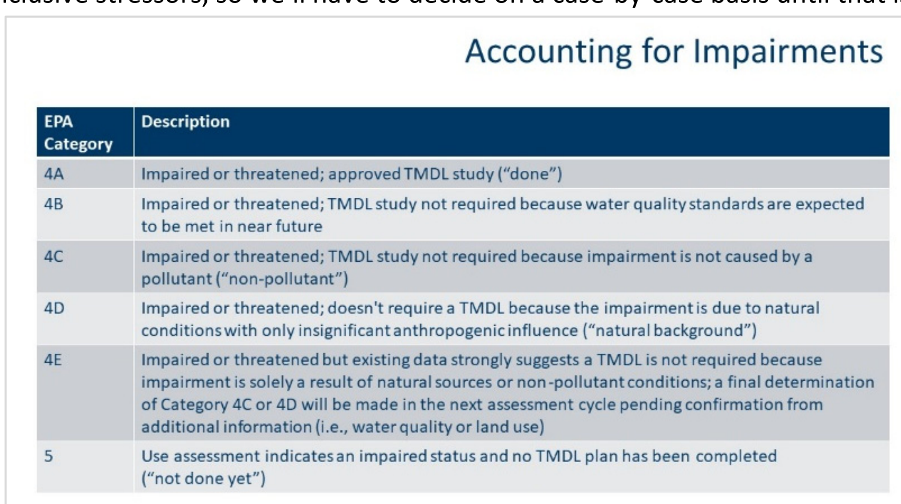
In essence, we want to provide an overall status update on the impairments in the watershed, or "accounting for impairments." In addition to being a helpful resource for someone who wants to know what's going on in the watershed, we also need to keep track of impairments to appropriately categorize them in the list of impaired water bodies.



We want to answer these questions: Which TMDLs have already been completed? Which TMDLs are developed in this report? Which impairments still need TMDLs? Which impairments don't need TMDLs at all? This information either could be in a table at the beginning of a TMDL report (Section 1.2), or it can be put in an appendix if there are a lot of impairments in the watershed. It's sometimes clearer to just include the impairments for which TMDLs are being developed in the report in the main body of the report (i.e., Section 1.2). The revised TMDL template provides a sample table in the appendix for tracking the status of all impairments in a watershed. The table can be adapted based on personal preference and the specifics of your watershed. While including all HUC-8 impairments isn't required for a TMDL report, it does provide a helpful overview of watershed impairments.

If you are doing a HUC-8 TMDL, consider including a list of all of the impairments in the HUC-8 watershed and indicating the status, including what we call the "EPA category."

For many impairments, these questions here are pretty straightforward to answer. It gets more complicated with the biota impairments, especially when there are multiple stressors involved. We still have not developed guidance on what to do with inconclusive stressors, so we'll have to decide on a case-by-case basis until that is resolved.



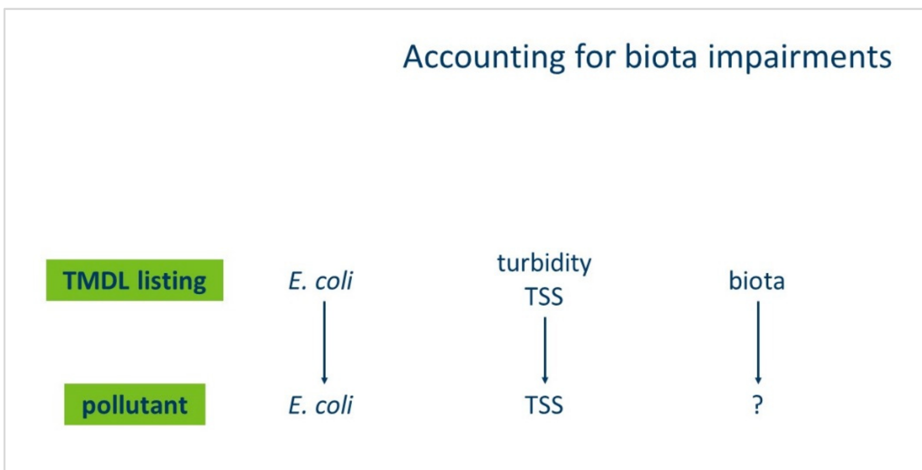
EPA Category	Description
4A	Impaired or threatened; approved TMDL study ("done")
4B	Impaired or threatened; TMDL study not required because water quality standards are expected to be met in near future
4C	Impaired or threatened; TMDL study not required because impairment is not caused by a pollutant ("non-pollutant")
4D	Impaired or threatened; doesn't require a TMDL because the impairment is due to natural conditions with only insignificant anthropogenic influence ("natural background")
4E	Impaired or threatened but existing data strongly suggests a TMDL is not required because impairment is solely a result of natural sources or non-pollutant conditions; a final determination of Category 4C or 4D will be made in the next assessment cycle pending confirmation from additional information (i.e., water quality or land use)
5	Use assessment indicates an impaired status and no TMDL plan has been completed ("not done yet")

Here are the categories that are used to account for TMDLs. In Minnesota's list of impaired water bodies, they are referred to as the "EPA category," and they are included as part of each listing. Each **impairment** is assigned a category. So if a water body has multiple impairments, it will have multiple categories—one per impairment. All of the categories listed here are for impaired waters; there are other categories that are used for unimpaired water bodies.

The main categories that we're concerned with in TMDL reports are 4A ("done"), 4C ("non-pollutant"), 4D ("natural background"), and 5 ("not done yet"):

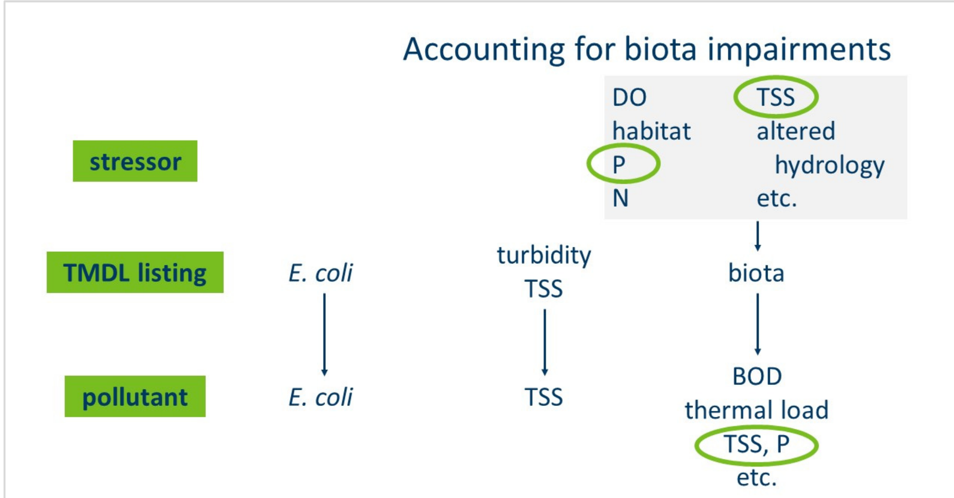
- Category 4A is used if the water body is impaired but there is an approved TMDL study for that impairment. In other words, these TMDLs are "done."
- Category 4B is used when a TMDL study is not required because water quality standards (WQS) are expected to be met in the near future. In some states, one way that this has been used is when a new point source permit limit is expected to bring the water body back into compliance with WQS. There are no water bodies categorized as 4B in Minnesota (as of approved 2018 list). It's a lot of work to justify, so sometimes it's easier just to write a TMDL for the water body.
- Category 4C is when the impairment is not caused by a pollutant. This is common with biota impairments where the impairment is due to a non-pollutant stressor such as habitat or hydrologic connectivity. Because these stressors are not pollutants, we cannot write TMDLs for them.
- Category 4D impairments also don't require a TMDL, but in this case it is because the impairment is due to natural conditions with only insignificant anthropogenic influence. We commonly refer to this concept as "natural background." For these 4D impairments, a site-specific standard has not yet been developed.
- Category 4E is not common; it's only been used once in the state. It was used when there wasn't enough information to determine if the impairment should be in 4C (non-pollutant) or 4D (natural background). It might be easier to wait and leave the impairment in Category 5 until you figure out if it should be in 4C or 4D.
- Category 5 are the impairments for which TMDLs have not been developed, or "not done yet."

Accounting for biota impairments

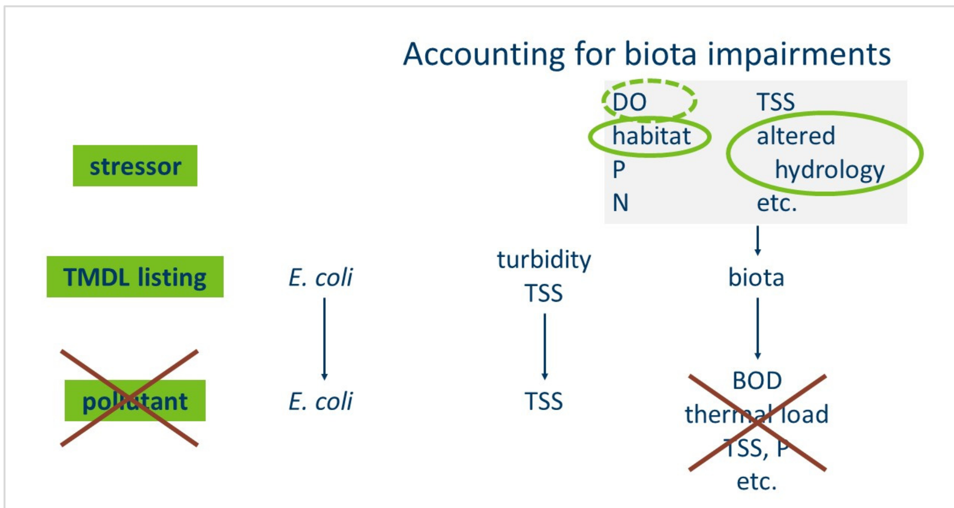


Some of the accounting for impairments can get complicated with biota impairments, and this is because of the extra step of stressor identification that is needed. With many of the conventional listings, like *E. coli* and total suspended solids (TSS), it is straightforward to determine which pollutant the TMDL should be written on. For an *E. coli* listing, an *E. coli* TMDL is developed, because the **pollutant** *E. coli* is what causes the **listing** of *E. coli*. The same is true for TSS impairments. With turbidity impairments, which were listed before the TSS standard replaced the older turbidity standard, the "pollutant" TSS is what typically caused the turbidity impairments, and therefore a TSS TMDL is developed for turbidity impairments. But with biota impairments, we need to do some work to identify what is causing the impairment. This is what the stressor identification does.

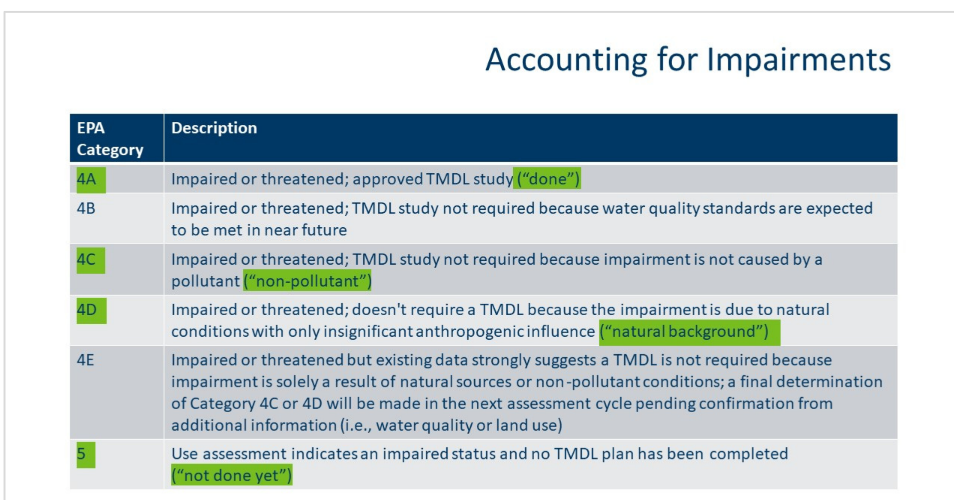
The stressor identification looks at all of the possible stressors that could be causing the biota impairment. If a pollutant is identified that causes the impairment, then a TMDL can be developed for that pollutant. For example, a TSS or a phosphorus TMDL would be developed if TSS or phosphorus were identified as the stressor.



However, in many cases the stressors that cause impairment are not pollutant-based. Habitat and altered hydrology are two straightforward examples. Because we need a pollutant if we want to develop a TMDL, we can not develop a TMDL if the stressor is not a pollutant. Dissolved oxygen (DO) can go both ways: if it is linked to a pollutant (e.g., high phosphorus leading to eutrophication leading to low DO), then a TMDL can be written on the pollutant. It could also be non-pollutant, for example if the low DO is due to flat topography and a natural lack of reaeration.



When you have multiple stressors with a biota impairment, it can get a little more complicated to determine which category the impairment falls under.

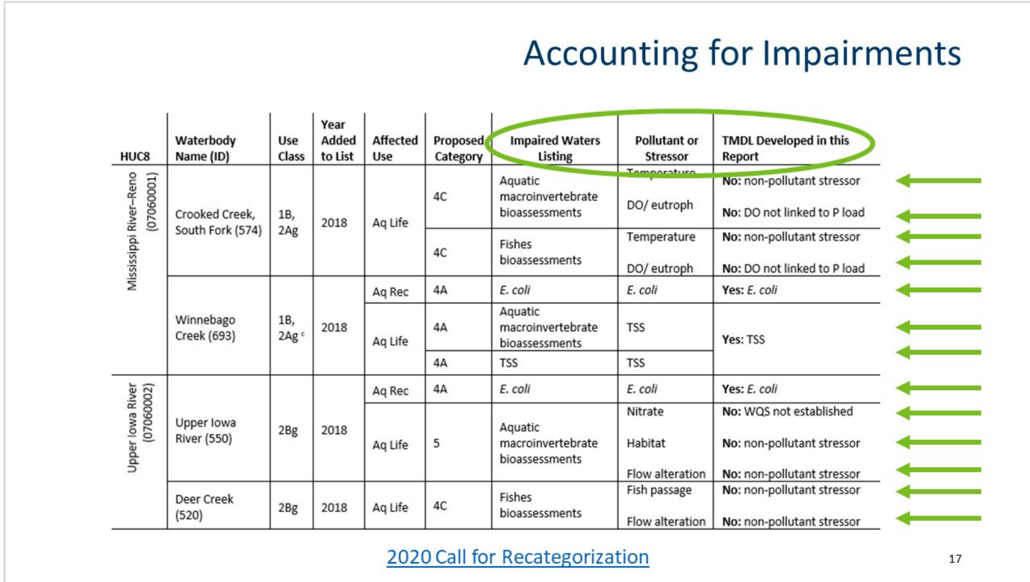


Accounting for Impairments

EPA Category	Description
4A	Impaired or threatened; approved TMDL study ("done")
4B	Impaired or threatened; TMDL study not required because water quality standards are expected to be met in near future
4C	Impaired or threatened; TMDL study not required because impairment is not caused by a pollutant ("non-pollutant")
4D	Impaired or threatened; doesn't require a TMDL because the impairment is due to natural conditions with only insignificant anthropogenic influence ("natural background")
4E	Impaired or threatened but existing data strongly suggests a TMDL is not required because impairment is solely a result of natural sources or non-pollutant conditions; a final determination of Category 4C or 4D will be made in the next assessment cycle pending confirmation from additional information (i.e., water quality or land use)
5	Use assessment indicates an impaired status and no TMDL plan has been completed ("not done yet")

Category 4A is used only if there are no other TMDLs needed. If there is a stressor left unresolved, the impairment stays in Category 5 (e.g., if there is one TMDL approved for one stressor to an impairment, but one TMDL is still needed for another stressor of the same impairment, it is Category 5). If there is one pollutant stressor for which a TMDL has been approved, and one non-pollutant stressor, the impairment goes to Category 4A. Even though there is that one non-pollutant stressor, Category 4A overrides Category 4C to account for the completed TMDL.

Here's an example of a table that could be included in the report to account for impairments. Notice the right side of the table—it includes the listing, the pollutant or stressor, and whether or not a TMDL is developed in the report. Again, this is straightforward for the *E. coli* and TSS impairments. See also that there is one biota impairment for which TSS was identified as the stressor; this biota impairment is being addressed by a TSS TMDL. For these *E. coli* and TSS TMDLs, the proposed Category is 4A, because all of the needed TMDLs will have been developed upon approval of this report.



Accounting for Impairments

HUC8	Waterbody Name (ID)	Use Class	Year Added to List	Affected Use	Proposed Category	Impaired Waters Listing	Pollutant or Stressor	TMDL Developed in this Report
Mississippi River–Reno (07060001)	Crooked Creek, South Fork (574)	1B, 2Ag	2018	Aq Life	4C	Aquatic macroinvertebrate bioassessments	Temperature	**No:** non-pollutant stressor
							DO/ eutroph	**No:** DO not linked to P load
					4C	Fishes bioassessments	Temperature	**No:** non-pollutant stressor
							DO/ eutroph	**No:** DO not linked to P load
	Winnebago Creek (693)	1B, 2Ag [c]	2018	Aq Rec	4A	*E. coli*	*E. coli*	**Yes:** *E. coli*
				Aq Life	4A	Aquatic macroinvertebrate bioassessments	TSS	**Yes:** TSS
					4A	TSS	TSS	
Upper Iowa River (07060002)	Upper Iowa River (550)	2Bg	2018	Aq Rec	4A	*E. coli*	*E. coli*	**Yes:** *E. coli*
				Aq Life	5	Aquatic macroinvertebrate bioassessments	Nitrate	**No:** WQS not established
							Habitat	**No:** non-pollutant stressor
							Flow alteration	**No:** non-pollutant stressor
	Deer Creek (520)	2Bg	2018	Aq Life	4C	Fishes bioassessments	Fish passage	**No:** non-pollutant stressor
							Flow alteration	**No:** non-pollutant stressor

2020 Call for Recategorization

17

For some of the biota impairments, the stressors are non-pollutant, and TMDLs are not developed. The proposed Category is 4C, which is for non-pollutant impairments.

And, lastly, for one of the biota impairments, nitrate was identified as a stressor. Even though this is a pollutant, the state has decided to defer these TMDLs until an aquatic life numeric standard for nitrate is developed. Therefore, this TMDL is not developed in this report, but for a different reason than the others. This is categorized as 5, because there is still a TMDL that is needed that has not yet been developed. In this case, Category 5 overrides Category 4C, because a TMDL is still needed for this impairment.

By putting the EPA categories in the report, it does not automatically change the classification! The change in classification is done through the impaired waters list, and any change in classification that is not a simple "TMDL completed" needs to be submitted to Miranda Nichols. You will need to submit documentation to reclassify impairments.

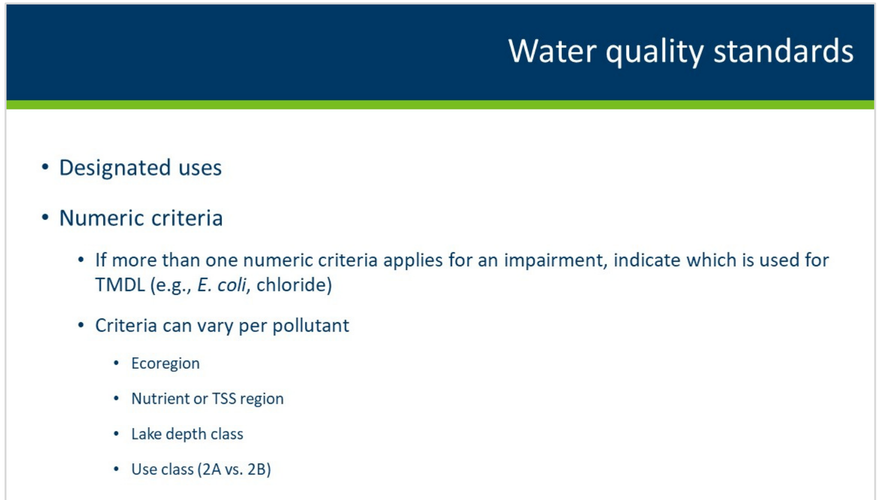
Section Summary

What will be the proposed status of the impairment upon approval of TMDL report?

- **One proposed category per impairment**
- **With multiple stressors:**
  - **4A overrides 4C**
  - **5 overrides all others**

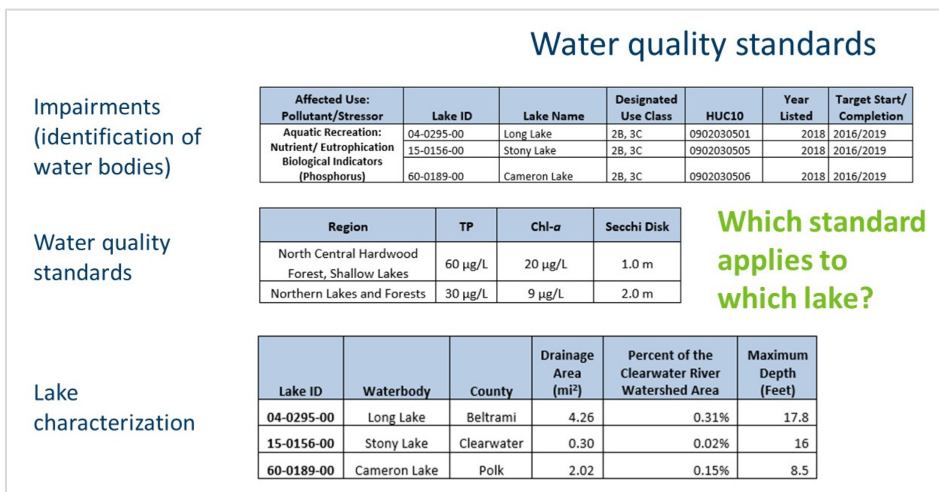
Water quality standards

Water quality standards (WQS) should be included only for parameters for which TMDLs are developed in the report. Include all relevant standards for each pollutant. For example, some parameters have more than one numeric standard per impairment. This is the case with *E. coli*, where there is a monthly geometric mean standard and a maximum standard for individual samples. In that case, indicate which numeric standard is used for the TMDL and explain why. For some pollutants, standards vary by ecoregion, lake depth, or use class. In that case, include all of the standards that are relevant to the TMDLs developed in the report.



One thing frequently missing in TMDL reports is clarity on which standards apply to which impaired water body when there is more than one standard per parameter. This is becoming more important as we write TMDL reports that address many impairments where it's not so easy to keep track of the relevant standards without explicitly and clearly including the information, preferably in a table in the WQS section (although it could be elsewhere in the report, as long as it's included).

This is an example from a draft TMDL. The report included a table with the list of impairments (first table), and a table with the water quality standards by ecoregion (second table). There was also a table in the water body characterization section with useful information about drainage area and depth (third table). But none of these tables show which WQS apply to which lake.



Affected Use: Pollutant/Stressor	Lake ID	Lake Name	Designated Use Class	HUC10	Year Listed	Target Start/ Completion
Aquatic Recreation: Nutrient/ Eutrophication Biological Indicators (Phosphorus)	04-0295-00	Long Lake	2B, 3C	0902030501	2018	2016/2019
	15-0156-00	Stony Lake	2B, 3C	0902030505	2018	2016/2019
	60-0189-00	Cameron Lake	2B, 3C	0902030506	2018	2016/2019

Region	TP	Chl-*a*	Secchi Disk
North Central Hardwood Forest, Shallow Lakes	60 µg/L	20 µg/L	1.0 m
Northern Lakes and Forests	30 µg/L	9 µg/L	2.0 m

Lake ID	Waterbody	County	Drainage Area (mi^2)	Percent of the Clearwater River Watershed Area	Maximum Depth (Feet)
04-0295-00	Long Lake	Beltrami	4.26	0.31%	17.8
15-0156-00	Stony Lake	Clearwater	0.30	0.02%	16
60-0189-00	Cameron Lake	Polk	2.02	0.15%	8.5

To make it clear which WQS, or TMDL endpoints, were used in the TMDLs, make the link between each water body and the relevant standard. There are many ways that you can do this; choose the option that works best for you. The best options are to include the endpoints in the WQS table or in the lake or stream characterization table. In this example, either option works fine. If there are many impairments in the report, it might be easiest to add a column to the lake or stream characterization table.

Water quality standards

Make the link between water body and standard. Options:

Water quality standards

Region	TP	Chl-*a*	Secchi Disk	Lake
North Central Hardwood Forest, Shallow Lakes	60 µg/L	20 µg/L	1.0 m	Stony, Cameron
Northern Lakes and Forests	30 µg/L	9 µg/L	2.0 m	Long

Lake or stream characterization

Lake ID	Waterbody	County	Drainage Area (mi²)	Percent of the Clearwater River Watershed Area	Maximum Depth (Feet)	Ecoregion	Lake Depth Class
04-0295-00	Long Lake	Beltrami	4.26	0.31%	17.[illegible]	NLF	Lake
15-0156-00	Stony Lake	Clearwater	0.30	0.02%	16	NCHF	Shallow lake
60-0189-00	Cameron Lake	Polk	2.02	0.15%	8.5	NCHF	Shallow lake

Section Summary

- **Are WQS presented for all impairments for which TMDLs are developed?**
- **Is it clear which standard applies to which water body?**

Watershed and water body characterization

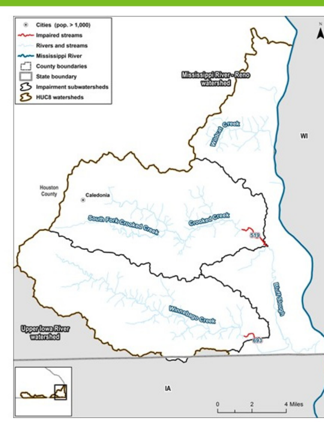
The water body characterization section contains general information on the impaired lakes and streams—including lake surface area and depth, watershed area, and drainage direction.

Lakes, streams, subwatersheds

The template includes three sections—lakes, streams, and subwatersheds—that are primarily tables and maps to show water body sizes, depths, areas, etc. A map of subwatershed boundaries should be included; several maps may need to be shown depending on the size of the watershed and the numbers of impairments. The example here is a simple one, with only two impaired reaches in this part of the watershed.

Lakes, streams, subwatersheds

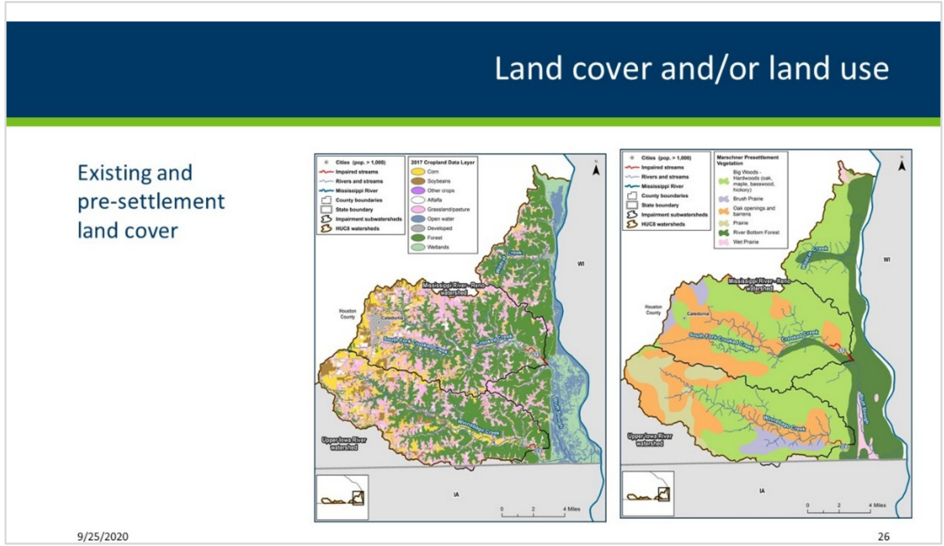
- Water body size, depth, area
- Watershed size, boundaries, and drainage



25

Land cover and/or land use

Maps and tables are used to describe both the existing land cover or land use and the pre-settlement land cover.



Water quality

In the water quality (WQ) section, figures and tables are used to describe the most recent 10 years of data. This section can vary greatly so I'll just show you some examples of data summaries. When reviewing a TMDL report, what you should look for is a description of the data sources, the monitoring sites, and the years and months of the data. It's especially important to know if only certain months of data were used in cases where a WQ criterion only applies during certain months of the year. This table states that the summaries include data from the months during which the standard applies. This seems like it should be obvious, but if it's not stated, then we wouldn't necessarily have the confidence that it was actually done.

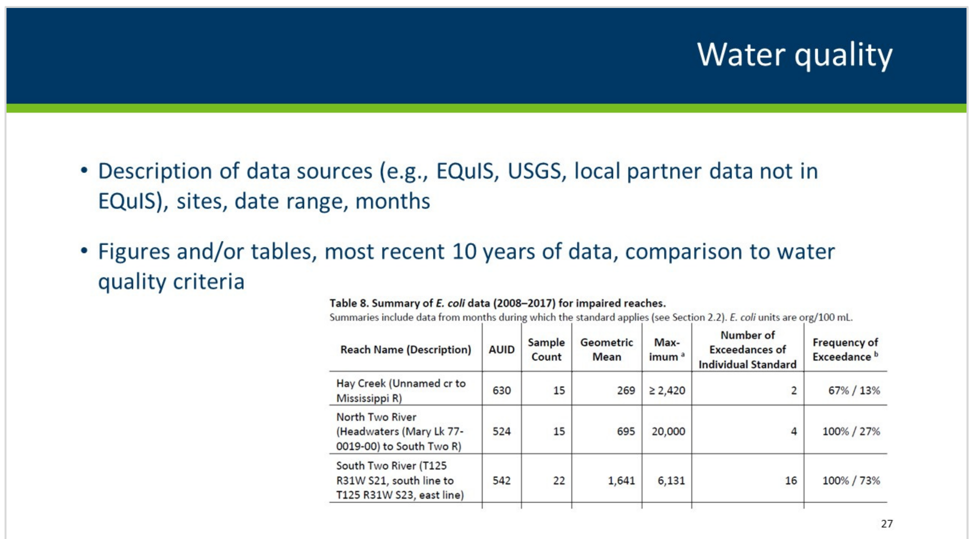


Table 8. Summary of *E. coli* data (2008–2017) for impaired reaches.
Summaries include data from months during which the standard applies (see Section 2.2). *E. coli* units are org/100 mL.

Reach Name (Description)	AUID	Sample Count	Geometric Mean	Max-imum [a]	Number of Exceedances of Individual Standard	Frequency of Exceedance [b]
Hay Creek (Unnamed cr to Mississippi R)	630	15	269	≥ 2,420	2	67% / 13%
North Two River (Headwaters (Mary Lk 77-0019-00) to South Two R)	524	15	695	20,000	4	100% / 27%
South Two River (T125 R31W S21, south line to T125 R31W S23, east line)	542	22	1,641	6,131	16	100% / 73%

For lake WQ data, the phosphorus, chlorophyll-*a*, and Secchi data can be shown in a graph and/or a table. See that in this example, the date range, the months, the monitoring sites, and the WQS are all presented.

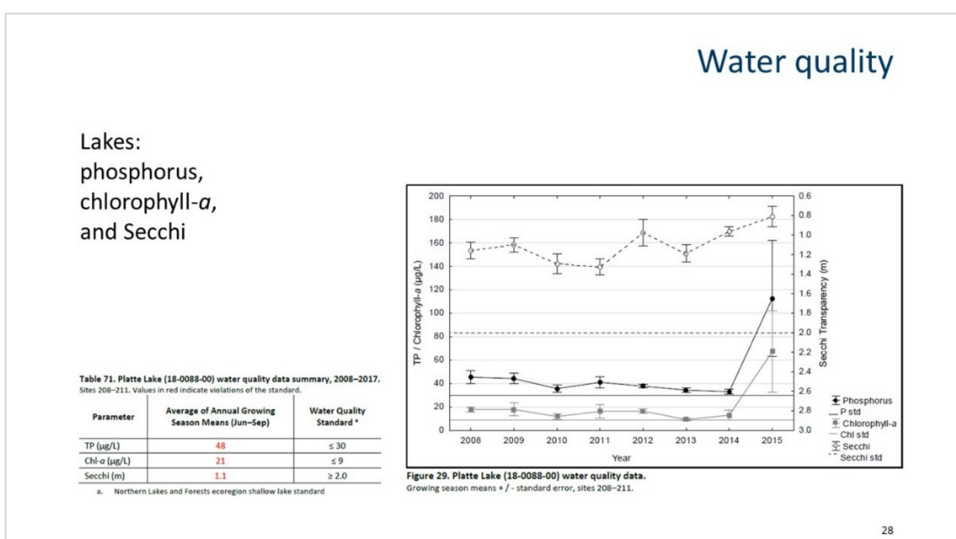
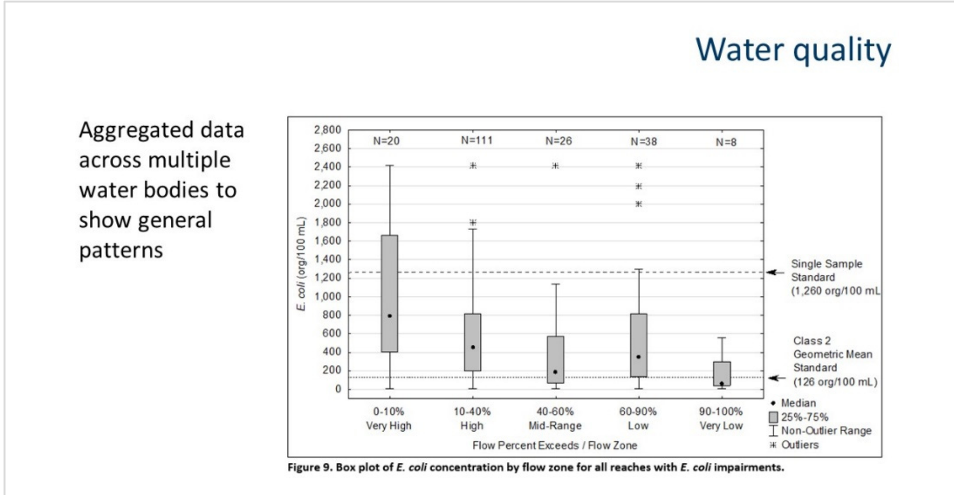


Table 71. Platte Lake (18-0088-00) water quality data summary, 2008–2017.
Sites 208–211. Values in red indicate violations of the standard.

Parameter	Average of Annual Growing Season Means (Jun–Sep)	Water Quality Standard [a]
TP (µg/L)	48	≤ 30
Chl-*a* (µg/L)	21	≤ 9
Secchi (m)	1.1	≥ 2.0

a. Northern Lakes and Forests ecoregion shallow lake standard

In addition to summaries for each water body, data can be combined across multiple water bodies to show general WQ trends in the watershed. For example, this box plot shows the *E. coli* concentrations by flow zone for all of the *E. coli* impairments in the watershed. The data suggest that, across the board, higher *E. coli* is observed during high flows.

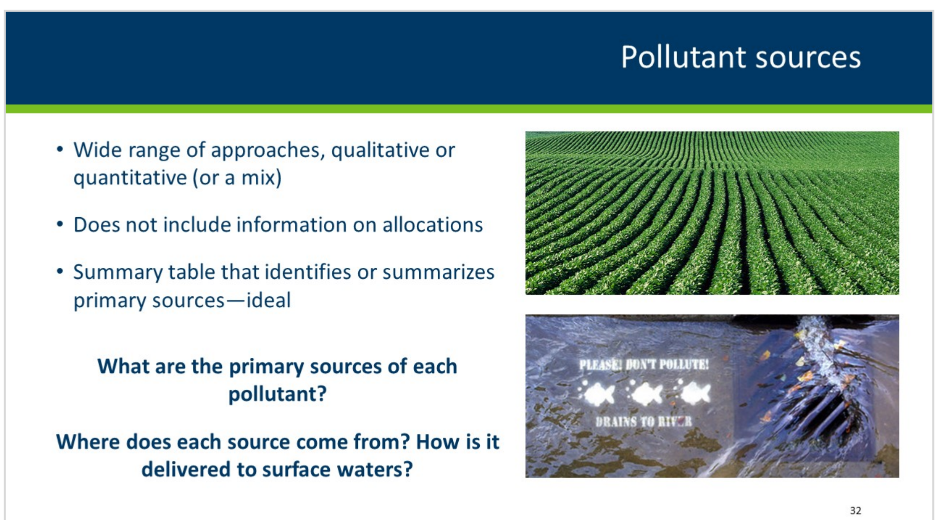


<u>**Section Summary**</u>

- **Lakes, streams, subwatersheds: is all of the required information included? (see template)**
- **Land cover and/or land use maps and tables**
- **Water quality: description of data sources, sites, date range, months**

Pollutant sources

There is a wide range of approaches for the source assessment. The level of information included depends on the scope of the project, the information available, and other particulars about the watershed and the project. The organization of this section can really vary, depending on how many pollutants and how many sources per pollutant and how much overlap. So there's a lot of flexibility regarding what this section looks like.



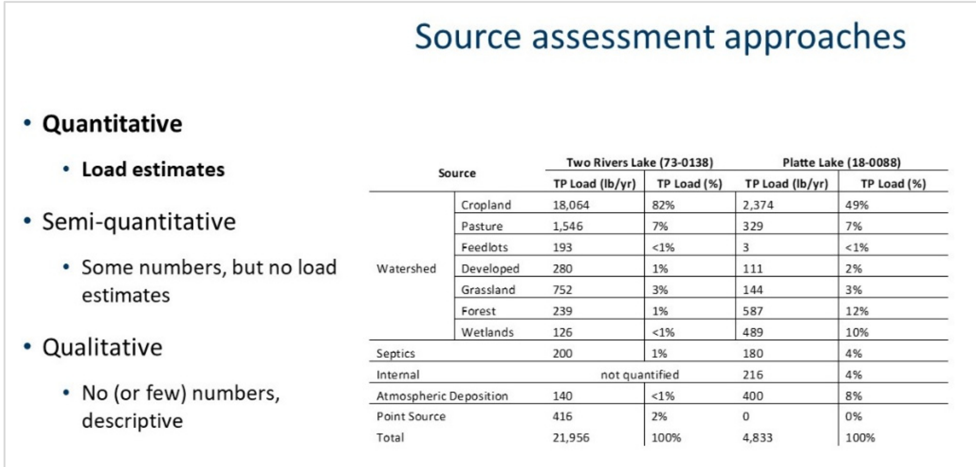
It's best to not introduce anything related to TMDL allocations here. Keep this section to the estimates of the existing sources, and not what needs to be done for the TMDL scenario.

In the end, the question that you should be able to easily answer from this section is, *What are the primary sources of each pollutant?* Plus a little more detail on each source—*Where does each source come from? How is it delivered to surface waters?*

Source assessment approaches

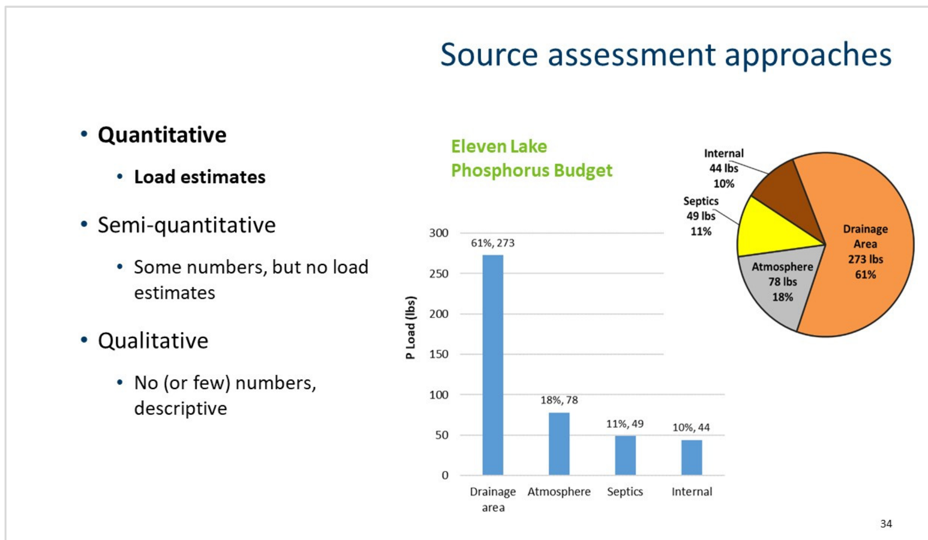
I'll discuss three general levels of source assessment: quantitative, semi-quantitative, and qualitative.

By "quantitative," I mean that there are numeric load estimates for the various sources for each impaired water body. Here is an example of a quantitative source assessment for two lake TMDLs in the Mississippi River–Sartell Watershed TMDL report. In this example, both the actual loads are provided in addition to the percent load.



Source		Two Rivers Lake (73-0138) TP Load (lb/yr)	Two Rivers Lake (73-0138) TP Load (%)	Platte Lake (18-0088) TP Load (lb/yr)	Platte Lake (18-0088) TP Load (%)
Watershed	Cropland	18,064	82%	2,374	49%
	Pasture	1,546	7%	329	7%
	Feedlots	193	<1%	3	<1%
	Developed	280	1%	111	2%
	Grassland	752	3%	144	3%
	Forest	239	1%	587	12%
	Wetlands	126	<1%	489	10%
Septics		200	1%	180	4%
Internal		not quantified		216	4%
Atmospheric Deposition		140	<1%	400	8%
Point Source		416	2%	0	0%
Total		21,956	100%	4,833	100%

Quantitative source assessments can also be summarized using pie charts or bar graphs. The pie graph is from the draft Kettle River Watershed TMDL, and the bar graph on the left is another way of showing the same data. It can be helpful to show the actual numeric values, either in a table or as labels in a figure, because these often come in handy to use in other related reports, studies, or grant applications.



Semi-quantitative source assessments are common in *E. coli* TMDLs, because numeric loading estimates are not traditionally provided.

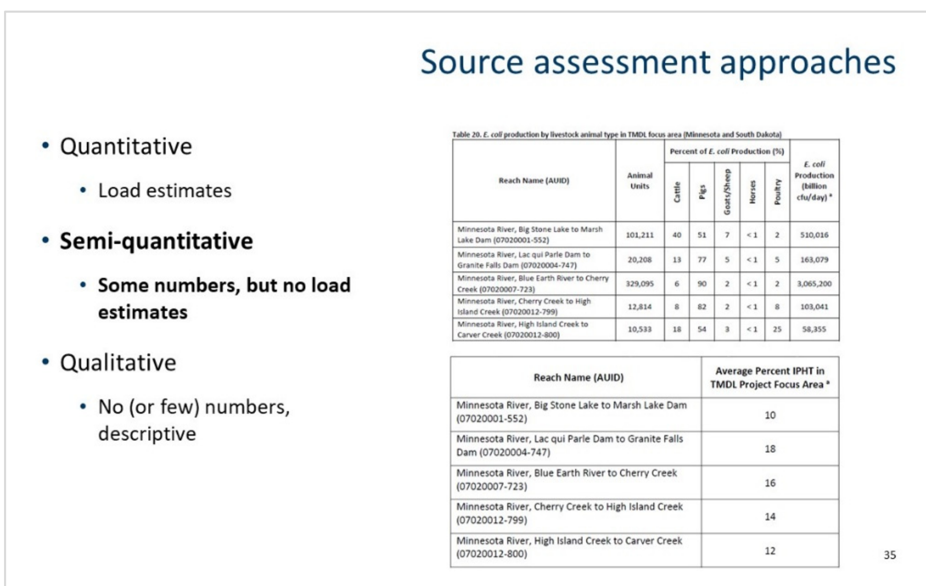
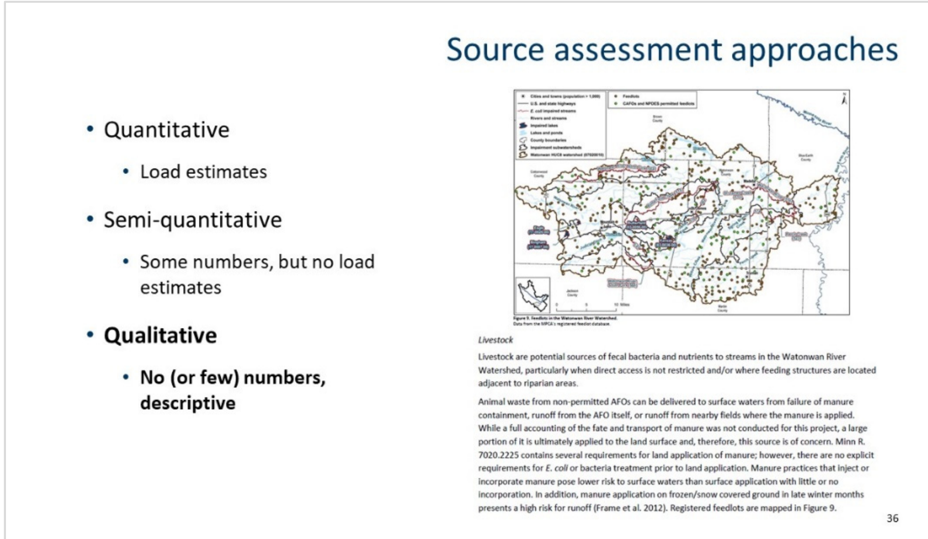


Table 20. *E. coli* production by livestock animal type in TMDL focus area (Minnesota and South Dakota)

Reach Name (AUID)	Animal Units	Percent of *E. coli* Production (%) Cattle	Pigs	Goats/Sheep	Horses	Poultry	*E. coli* Production (billion cfu/day) [a]
Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552)	101,211	40	51	7	< 1	2	510,016
Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747)	20,208	13	77	5	< 1	5	163,079
Minnesota River, Blue Earth River to Cherry Creek (07020007-723)	329,095	6	90	2	< 1	2	3,065,200
Minnesota River, Cherry Creek to High Island Creek (07020012-799)	12,814	8	82	2	< 1	8	103,041
Minnesota River, High Island Creek to Carver Creek (07020012-800)	10,533	18	54	3	< 1	25	58,355

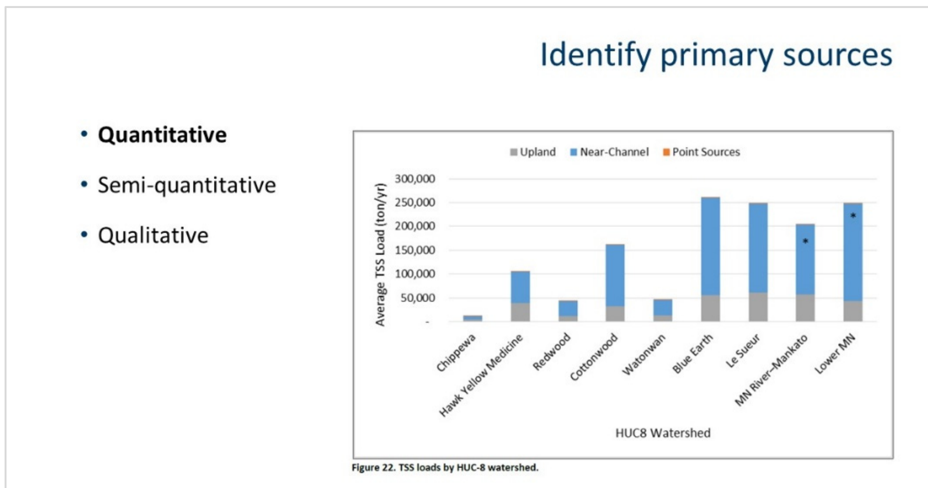
Reach Name (AUID)	Average Percent IPHT in TMDL Project Focus Area [a]
Minnesota River, Big Stone Lake to Marsh Lake Dam (07020001-552)	10
Minnesota River, Lac qui Parle Dam to Granite Falls Dam (07020004-747)	18
Minnesota River, Blue Earth River to Cherry Creek (07020007-723)	16
Minnesota River, Cherry Creek to High Island Creek (07020012-799)	14
Minnesota River, High Island Creek to Carver Creek (07020012-800)	12

You might decide to do a more descriptive, or qualitative, source assessment if you don't have the data to support something more quantitative, or if you have a tight project budget and/or time line.



Identify primary sources

Of the sources discussed in the source assessment, the report should also identify the primary sources. Knowing what the primary sources are is important to guide implementation. In this example, you can quickly scan this figure and see that near-channel sources are the primary TSS source in this project area, upland loads are lower but still substantial, and point sources are not a primary source.



In the semi-quantitative example, information about the sources was used to determine if each source was a likely *E. coli* source, a potential source, or an unlikely source. Even though there are not numeric estimates, the reader can still look at this table and pull out the primary sources for each impairment.

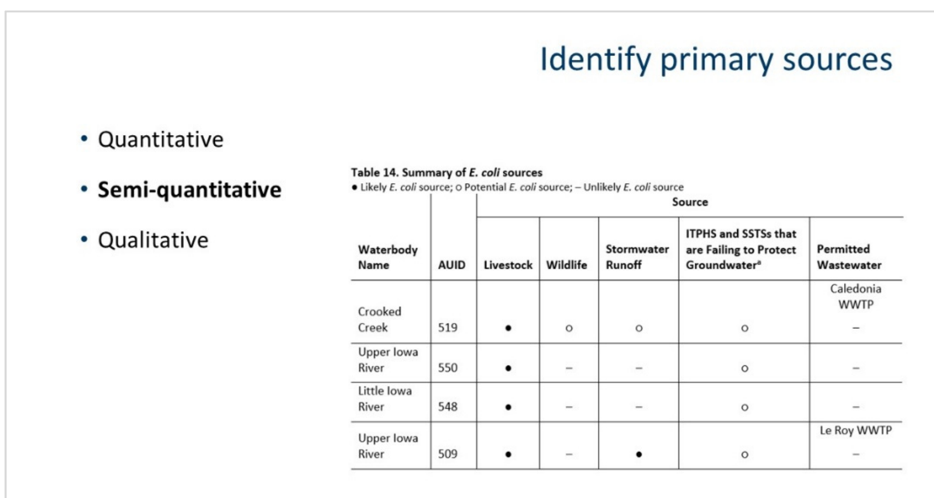
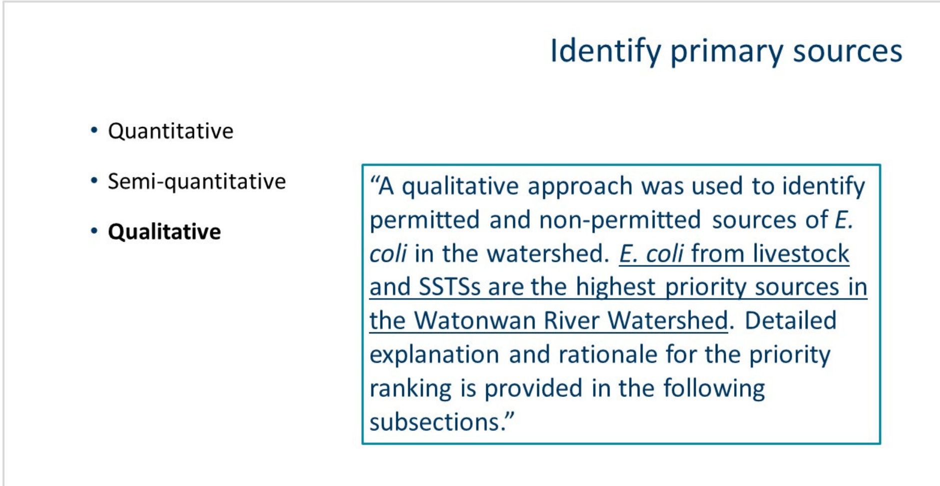


Table 14. Summary of *E. coli* sources
● Likely *E. coli* source; ○ Potential *E. coli* source; – Unlikely *E. coli* source

Waterbody Name	AUID	Source: Livestock	Wildlife	Stormwater Runoff	ITPHS and SSTSs that are Failing to Protect Groundwater[a]	Permitted Wastewater
Crooked Creek	519	●	○	○	○	Caledonia WWTP –
Upper Iowa River	550	●	–	–	○	–
Little Iowa River	548	●	–	–	○	–
Upper Iowa River	509	●	–	●	○	Le Roy WWTP –

It's helpful to clearly identify the primary sources, even if the source assessment isn't quantitative.

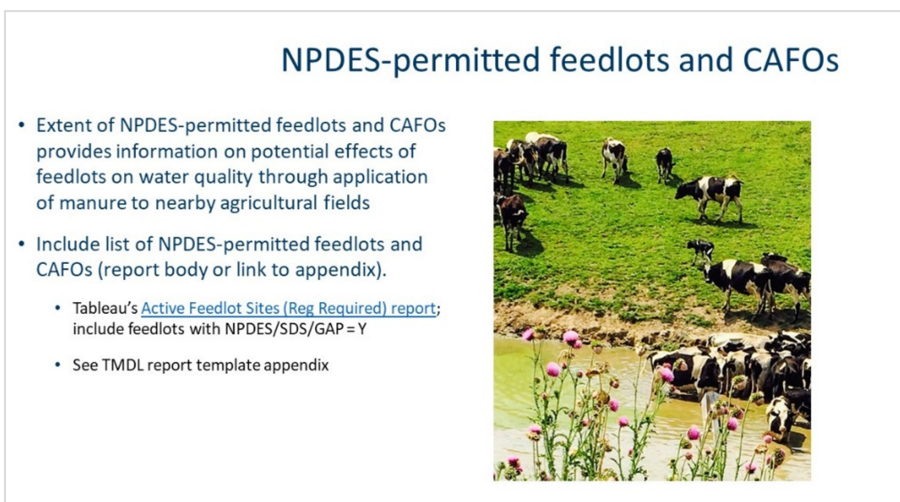


Natural background sources

Regardless of the approach used to assess sources, we have to address natural background sources in all TMDL reports. This is one of the outcomes of legal challenges to TMDLs in Minnesota. Because of the legal implications, the template contains language that should be used and adapted in every TMDL report.

NPDES-permitted feedlots and CAFOs

As somewhat of a side note, based on recent discussions with the EPA, we should list all National Pollutant Discharge Elimination System (NPDES)- or State Disposal System (SDS)-permitted feedlots and concentrated animal feeding operations (CAFOs) in the report. The intent is to provide a sense of how many CAFOs are in the area, because the manure from those CAFOs is likely ending up on fields in the vicinity. Therefore, we do not need to list the feedlots by impaired watershed, but rather can list them by HUC-12 for the entire HUC-8 watershed. These data can be generated in the Tableau report listed here.

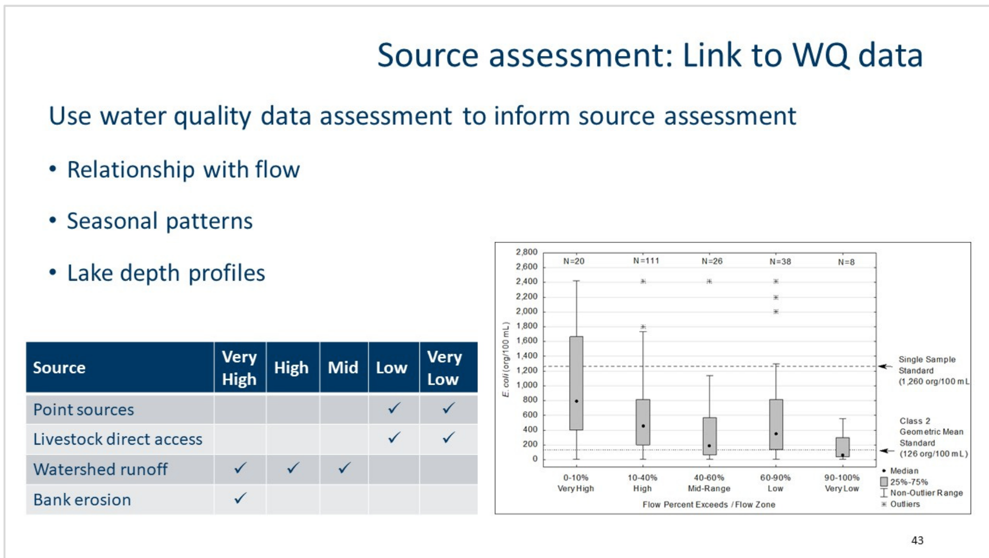


<u>**Section Summary**</u>

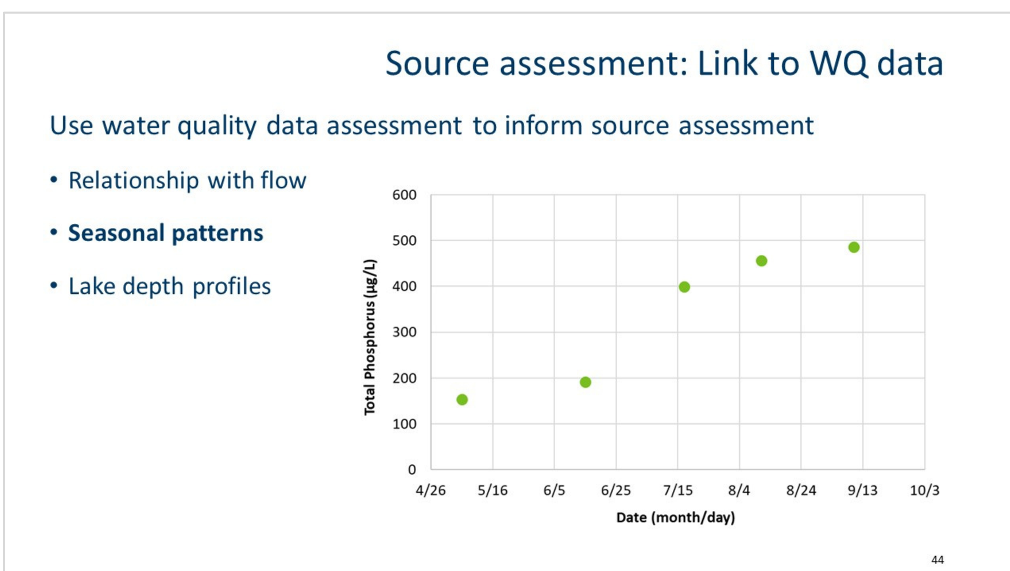
- **Are the primary sources of each pollutant identified?**
- **Does the report describe where each source comes from and how it is delivered to surface waters?**

Source assessment: link to WQ data

It is often helpful to reference the WQ data assessment in the source assessment, because we can learn a lot about the primary sources based on patterns in WQ data. One example is how pollutant concentrations change by flow. We looked at this figure earlier as an example that could be included in the water quality section. This figure then could be referenced in the source assessment, to show how the water quality data support the source assessment. This is because different pollutant sources are more likely to occur under certain flow regimes. For example, impacts from point sources and direct access of livestock to streams are more pronounced during low flows, because the loads aren't diluted by high flows. In contrast, impacts from watershed runoff and bank erosion are more pronounced during high flows, because this is when large amounts of watershed runoff occur and when high stream velocities lead to erosion of the banks.

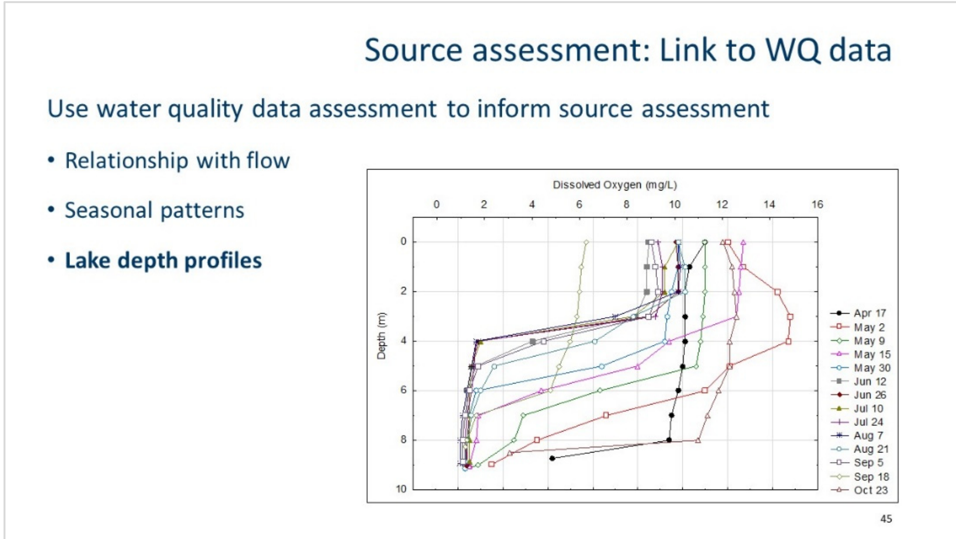


Back to the figure on the right (of the above slide): if the highest concentrations and the majority of the exceedances are observed under high flows, it suggests that runoff driven sources such as stormwater runoff and bank erosion are more likely sources, and the sources that would be more prominent under low flows are less likely.



Seasonal patterns in data also can provide useful information. For example, if higher lake phosphorus concentrations are observed in the late summer and fall, it often indicates that internal loading could be an important source of phosphorus.

Similarly, lake depth profiles that show stratification and low DO concentrations in the bottom waters also suggest that internal loading could be an important source.

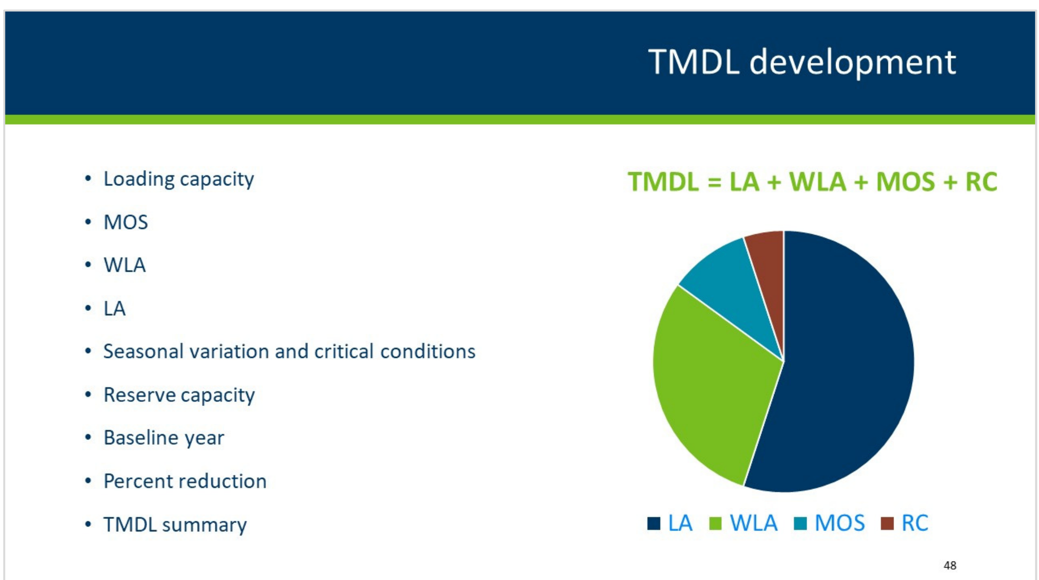


Section Summary

Look at the WQ data summary and compare it to the source assessment and see if they are consistent with one another.

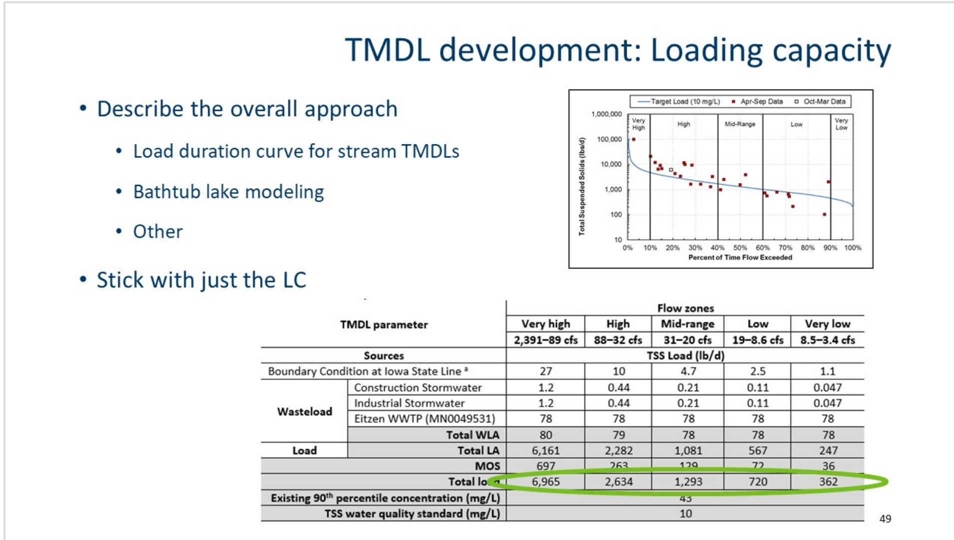
TMDL development

You will need to review the TMDL development section in the report to make sure that there is enough detail on how the loading capacity and each of the allocations was developed. I will briefly review each of the components and give you important pieces of information to look for.



Loading capacity

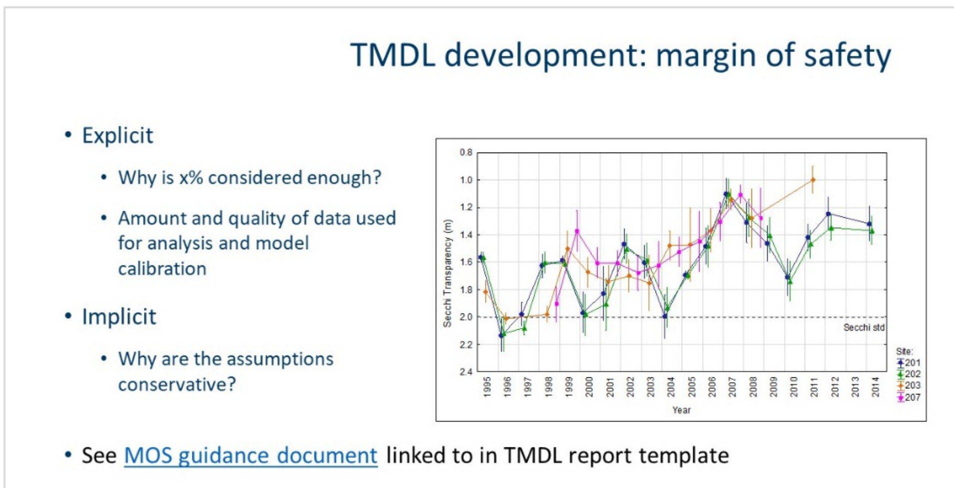
The loading capacity section should explain the overall approach that was used to develop the TMDLs. This will be the load duration curve approach for many stream TMDLs, and lake modeling using the Bathtub model for many lake TMDLs. The goal of this section is to describe how the overall loading capacity (LC), or total load that the water body can assimilate, was derived, without going into details about how it was allocated to the different sources.

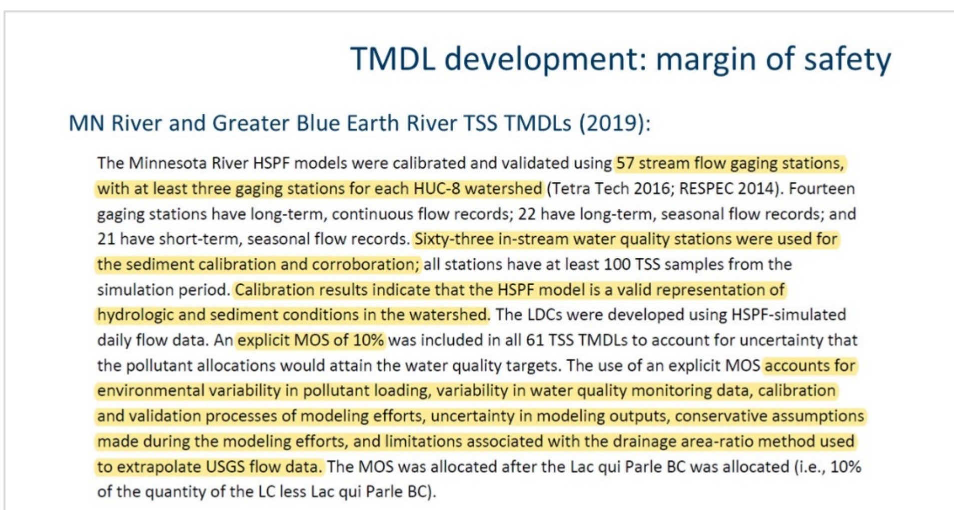


TMDL parameter		Flow zones				
		Very high	High	Mid-range	Low	Very low
		2,391–89 cfs	88–32 cfs	31–20 cfs	19–8.6 cfs	8.5–3.4 cfs
Sources		TSS Load (lb/d)				
Boundary Condition at Iowa State Line [a]		27	10	4.7	2.5	1.1
Wasteload	Construction Stormwater	1.2	0.44	0.21	0.11	0.047
	Industrial Stormwater	1.2	0.44	0.21	0.11	0.047
	Eitzen WWTP (MN0049531)	78	78	78	78	78
	Total WLA	80	79	78	78	78
Load	Total LA	6,161	2,282	1,081	567	247
MOS		697	263	129	72	36
Total load		6,965	2,634	1,293	720	362
Existing 90th percentile concentration (mg/L)		43				
TSS water quality standard (mg/L)		10				

Margin of safety

The margin of safety (MOS) is used to account for uncertainty about pollutant loads and the water body's response. The MOS can be explicit, where we set aside load that is then not available to be allocated among the sources, or it can be implicit, where we've made conservative assumptions in the modeling to cover for the uncertainties. If an explicit MOS was used, the report needs to state why the MOS is considered enough. Often the amount and the quality of data that were used in the analysis and/or the model calibration is discussed. For example, a model with lots of calibration sites that have long-term calibration data would support a smaller MOS. If the model has few calibration sites and/or a poor data record, that could warrant a larger MOS. If an implicit MOS was used, the report needs to describe what the assumptions are and why they are conservative.

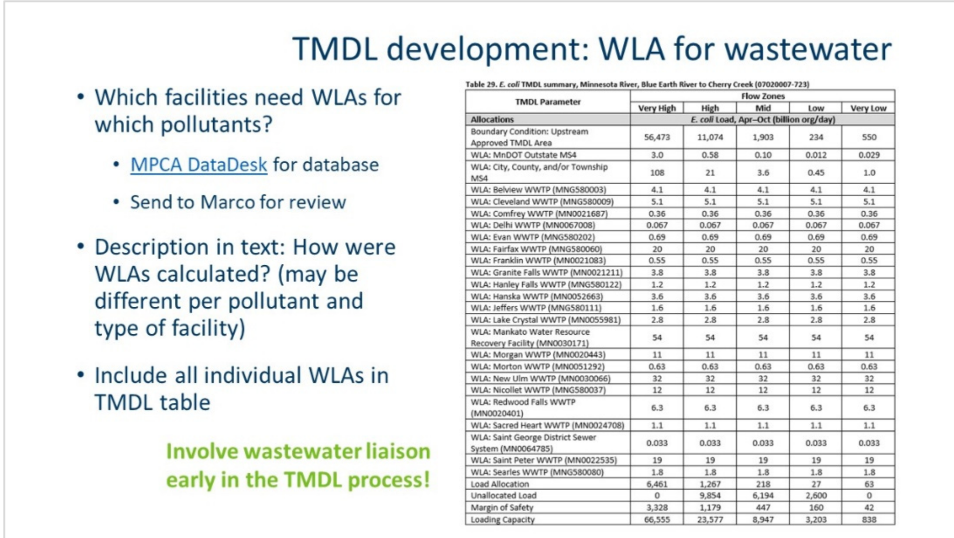




This is an example of the justification for an explicit MOS, where the number and quality of calibration sites is described.

WLA for wastewater

Wasteload allocations (WLAs) are developed for NPDES permitted sources of pollutants—typically wastewater and/or permitted stormwater. For wastewater, you need to make sure that you know which facilities need WLAs for which pollutants. The TMDL writer should first email the MPCA DataDesk and request a database of all permitted facilities in the watershed of interest. After the TMDL writer has reviewed the data, they should send the list to the MPCA's wastewater liaison for review and discussion regarding how to approach the WLAs. Please do this early on in the project to make sure that the TMDL writer is moving in the right direction. This can save a lot of time and budget in a project.

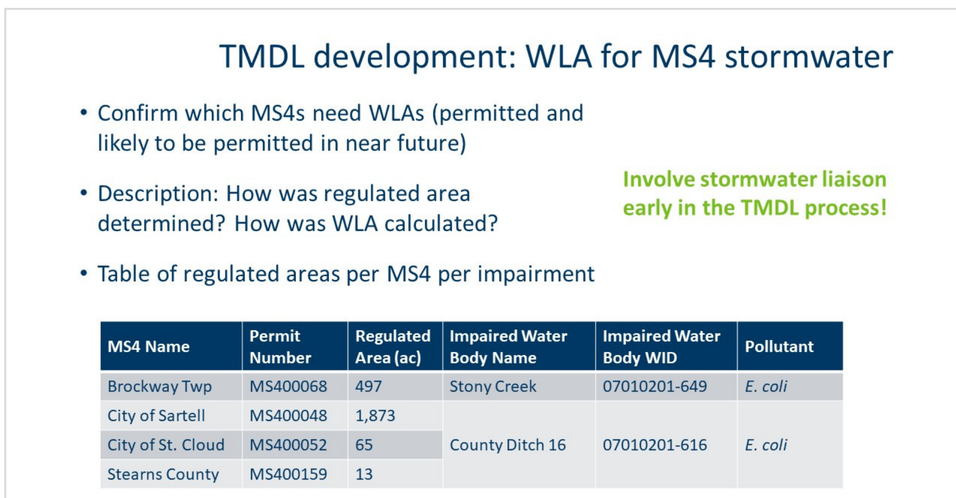


TMDL Parameter	Flow Zones				
	Very High	High	Mid	Low	Very Low
Allocations	*E. coli* Load, Apr–Oct (billion org/day)				
Boundary Condition: Upstream Approved TMDL Area	56,473	11,074	1,903	234	550
WLA: MnDOT Outstate MS4	3.0	0.58	0.10	0.012	0.029
WLA: City, County, and/or Township MS4	108	21	3.6	0.45	1.0
WLA: Belview WWTP (MNG580003)	4.1	4.1	4.1	4.1	4.1
WLA: Cleveland WWTP (MNG580009)	5.1	5.1	5.1	5.1	5.1
WLA: Comfrey WWTP (MN0021687)	0.36	0.36	0.36	0.36	0.36
WLA: Delhi WWTP (MN0067008)	0.067	0.067	0.067	0.067	0.067
WLA: Evan WWTP (MNG580202)	0.69	0.69	0.69	0.69	0.69
WLA: Fairfax WWTP (MNG580060)	20	20	20	20	20
WLA: Franklin WWTP (MN0021083)	0.55	0.55	0.55	0.55	0.55
WLA: Granite Falls WWTP (MN0021211)	3.8	3.8	3.8	3.8	3.8
WLA: Hanley Falls WWTP (MNG580122)	1.2	1.2	1.2	1.2	1.2
WLA: Hanska WWTP (MN0052663)	3.6	3.6	3.6	3.6	3.6
WLA: Jeffers WWTP (MNG580111)	1.6	1.6	1.6	1.6	1.6
WLA: Lake Crystal WWTP (MN0055981)	2.8	2.8	2.8	2.8	2.8
WLA: Mankato Water Resource Recovery Facility (MN0030171)	54	54	54	54	54
WLA: Morgan WWTP (MN0020443)	11	11	11	11	11
WLA: Morton WWTP (MN0051292)	0.63	0.63	0.63	0.63	0.63
WLA: New Ulm WWTP (MN0030066)	32	32	32	32	32
WLA: Nicollet WWTP (MNG580037)	12	12	12	12	12
WLA: Redwood Falls WWTP (MN0020401)	6.3	6.3	6.3	6.3	6.3
WLA: Sacred Heart WWTP (MN0024708)	1.1	1.1	1.1	1.1	1.1
WLA: Saint George District Sewer System (MN0064785)	0.033	0.033	0.033	0.033	0.033
WLA: Saint Peter WWTP (MN0022535)	19	19	19	19	19
WLA: Searles WWTP (MNG580080)	1.8	1.8	1.8	1.8	1.8
Load Allocation	6,461	1,267	218	27	63
Unallocated Load	0	9,854	6,194	2,600	0
Margin of Safety	3,328	1,179	447	160	42
Loading Capacity	66,555	23,577	8,947	3,203	838

The TMDL report should explain how the WLAs were calculated, and all individual WLAs should be included in the TMDL table. This might seem excessive for a TMDL such as the one shown here, but it makes it easier for you, the project manager, to enter the data into Tempo. If you want to instead list all of the individual WLAs in a separate table, that's okay, as long as the separate table is located directly below the TMDL table, again, to facilitate entry of all of the WLAs into Tempo and to be clear which WLAs apply to which TMDL.

WLA for MS4 stormwater

For Municipal Separate Storm Sewer Systems (MS4) stormwater, you need to confirm which MS4s need WLAs—this will include permitted MS4s and MS4s that are likely to be permitted in the near future. The report should include a description of how the regulated area was estimated and how the WLA was calculated. These are two different questions! The template contains a table that lists each MS4 that receives a WLA, along with the estimated regulated area and associated impairment. Please make sure that this information is in the report. The stormwater liaison should be involved early on in the process. It will save the TMDL writer time if they confirm which MS4s need WLAs early on in the project.



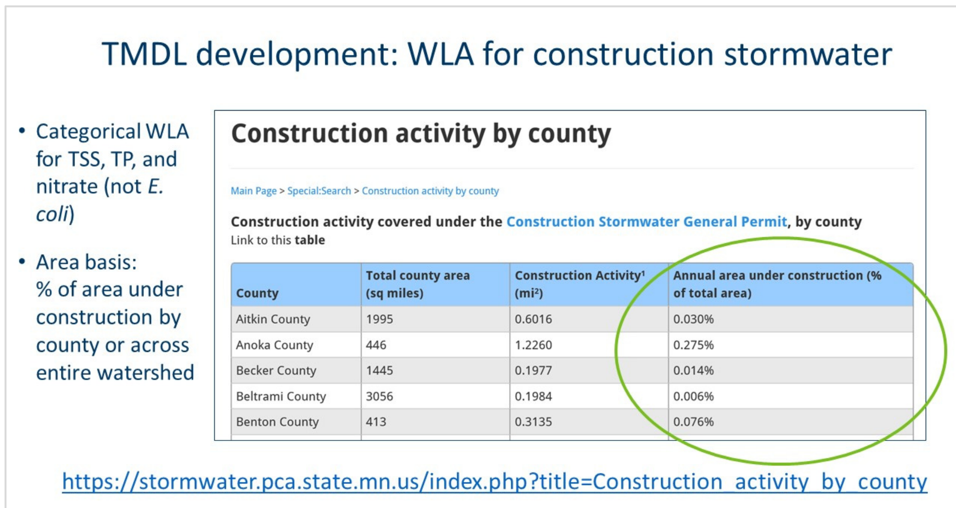
MS4 Name	Permit Number	Regulated Area (ac)	Impaired Water Body Name	Impaired Water Body WID	Pollutant
Brockway Twp	MS400068	497	Stony Creek	07010201-649	*E. coli*
City of Sartell	MS400048	1,873	County Ditch 16	07010201-616	*E. coli*
City of St. Cloud	MS400052	65			
Stearns County	MS400159	13			

WLA for permitted feedlots and CAFOs

Because permitted feedlots and CAFOs are not allowed to discharge to surface waters except for under extreme events, they get a WLA of zero. This should be stated in the report, but the feedlots should not be listed in the TMDL table.

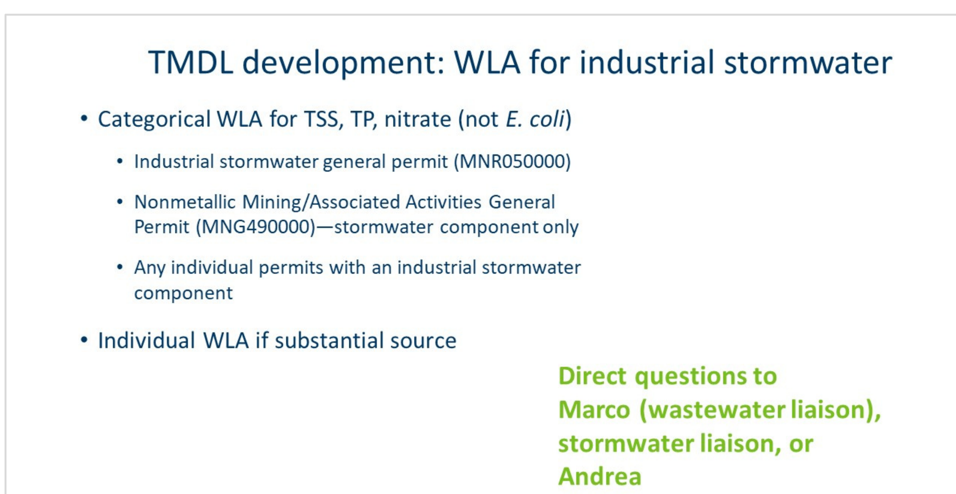
WLA for construction stormwater

The WLA for construction stormwater (CSW) is typically calculated as a percent of the total load allocated to watershed runoff. The Minnesota Stormwater Manual provides a table of the annual area under construction by county, as a percent of the total area in the county. There is also a new Tableau report, CSW Sites, that provides similar information. You don't need to necessarily check all of the math on these calculations, but you can make sure that the correct value was used. Another approach that is sometimes used is to select a percentage that is used across the whole project area. This is done when the project area covers many counties with similarly low construction area percentages, and greatly simplifies the calculations. This was done with the Minnesota River and Greater Blue Earth TSS TMDLs. Just know that, even though an approach might seem standard or common, it doesn't mean that there isn't room for using a different approach when there is reason to.



WLA for industrial stormwater

A categorical WLA typically is also assigned to industrial stormwater (ISW). Because it would be difficult to estimate the volumes associated with these stormwater discharges, and because these discharges are expected to be small relative to the rest of the stormwater volume in the watershed, we typically set this WLA as a small number and can have it be equal to the CSW WLA.



The categorical WLA applies to any permitted ISW in the watershed. In addition to the ISW general permit, ISW can be permitted under the non-metallic mining/associated activates general permit (this is typically for sand and gravel mining). These permits can have both a stormwater component and a dewatering component.

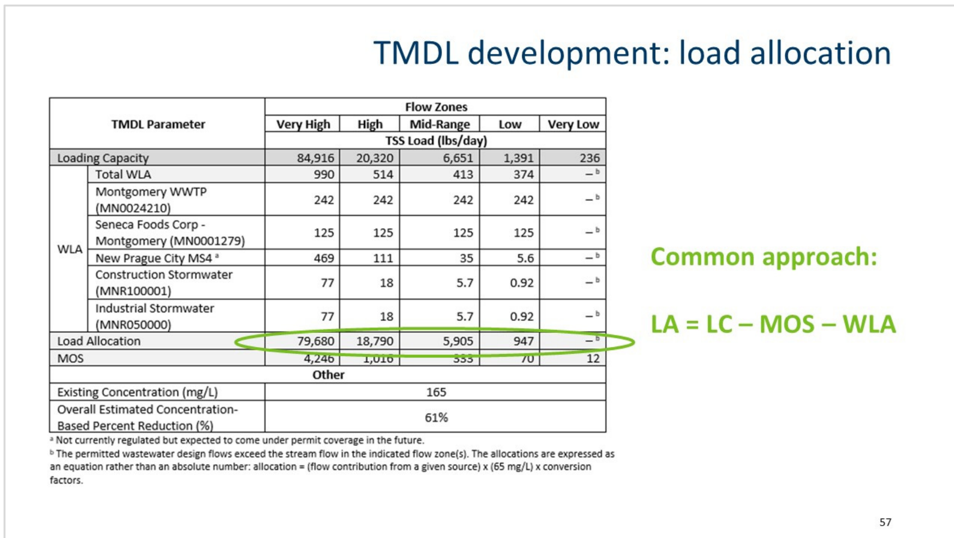
The categorical ISW WLA only covers the stormwater component of the non-metallic mining general permit; if there are dewatering discharges associated with the permit, that would need an individual WLA if it was expected to have the pollutant of concern.

An individual WLA can be given for an ISW permit if it is a substantial pollutant source in the watershed. For example, if an airport is close to an impaired lake, and if there are few other watershed runoff sources, the airport might contribute to impairment and could be called out in the TMDL.

Load allocation

The LA is often calculated as what is remaining out of the loading capacity after the MOS and WLAs are subtracted from it. While this isn't necessarily ideal, it's a practical and acceptable way of calculating the LA. Make sure it is clear how the LA was calculated.

You can assign one LA per impairment, which covers allocations for all nonpermitted sources. This is typically done in stream TMDLs, as in the example here.



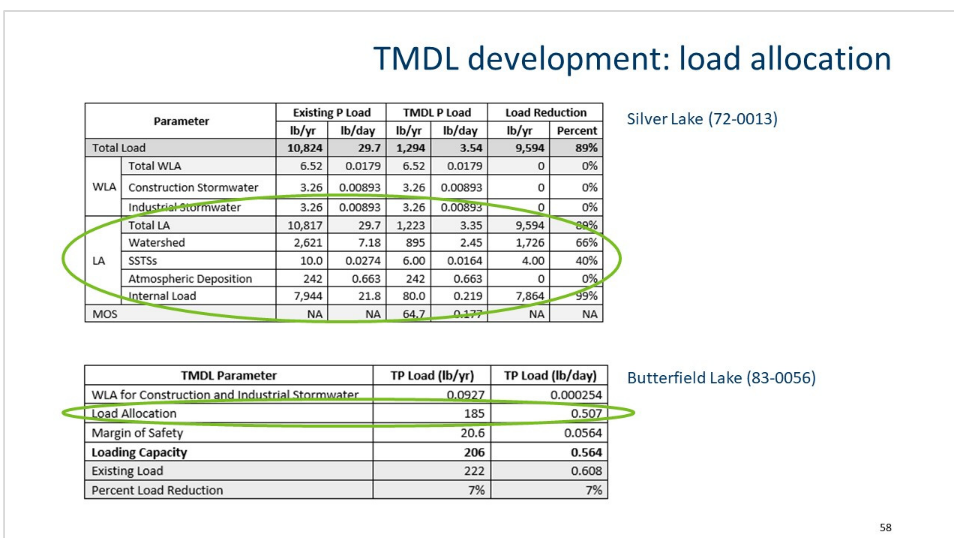
TMDL development: load allocation

TMDL Parameter		Flow Zones				
		Very High	High	Mid-Range	Low	Very Low
		TSS Load (lbs/day)				
Loading Capacity		84,916	20,320	6,651	1,391	236
WLA	Total WLA	990	514	413	374	–[b]
	Montgomery WWTP (MN0024210)	242	242	242	242	–[b]
	Seneca Foods Corp - Montgomery (MN0001279)	125	125	125	125	–[b]
	New Prague City MS4[a]	469	111	35	5.6	–[b]
	Construction Stormwater (MNR100001)	77	18	5.7	0.92	–[b]
	Industrial Stormwater (MNR050000)	77	18	5.7	0.92	–[b]
Load Allocation		79,680	18,790	5,905	947	–[b]
MOS		4,246	1,016	333	70	12
Other						
Existing Concentration (mg/L)		165				
Overall Estimated Concentration-Based Percent Reduction (%)		61%				

[a] Not currently regulated but expected to come under permit coverage in the future.
[b] The permitted wastewater design flows exceed the stream flow in the indicated flow zone(s). The allocations are expressed as an equation rather than an absolute number: allocation = (flow contribution from a given source) x (65 mg/L) x conversion factors.

A side note—see the MS4 that is included here. For the city of New Prague, the footnote explains that the city is not currently regulated but is expected to come under permit coverage in the near future. This is an example of why it's best to contact the stormwater liaison early in your project, so that you know from the start which MS4s should be included.

If you have the data to do so, you can split up the load allocation into different allocations for different types of nonpermitted sources. This is often done in lake TMDLs, where it's more straightforward to calculate LAs for different sources because the allocations are based on average annual loads, as opposed to in streams where the allocations are assigned for multiple flow zones.



TMDL development: load allocation

Silver Lake (72-0013)

Parameter		Existing P Load		TMDL P Load		Load Reduction	
		lb/yr	lb/day	lb/yr	lb/day	lb/yr	Percent
Total Load		**10,824**	**29.7**	**1,294**	**3.54**	**9,594**	**89%**
WLA	Total WLA	6.52	0.0179	6.52	0.0179	0	0%
	Construction Stormwater	3.26	0.00893	3.26	0.00893	0	0%
	Industrial Stormwater	3.26	0.00893	3.26	0.00893	0	0%
LA	Total LA	10,817	29.7	1,223	3.35	9,594	89%
	Watershed	2,621	7.18	895	2.45	1,726	66%
	SSTSs	10.0	0.0274	6.00	0.0164	4.00	40%
	Atmospheric Deposition	242	0.663	242	0.663	0	0%
	Internal Load	7,944	21.8	80.0	0.219	7,864	99%
MOS		NA	NA	64.7	0.177	NA	NA

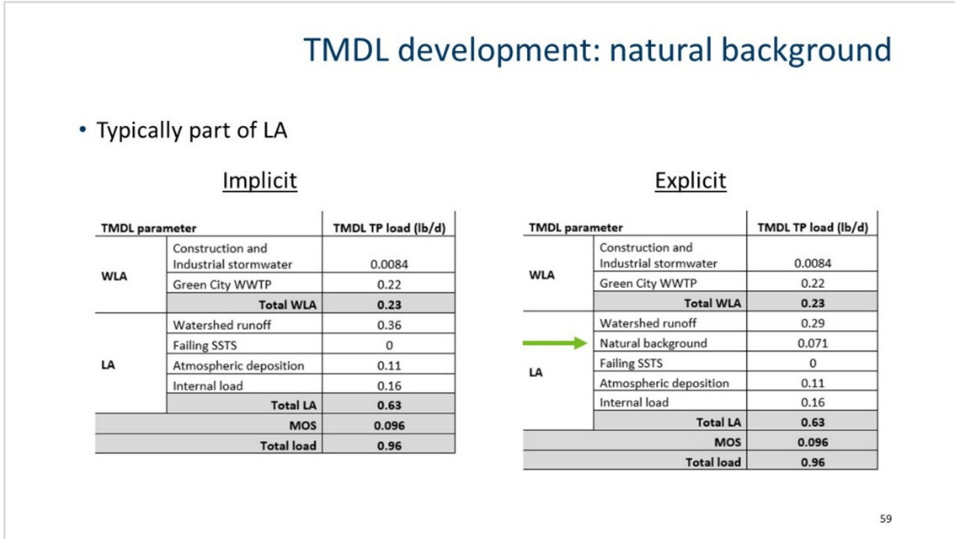
Butterfield Lake (83-0056)

TMDL Parameter	TP Load (lb/yr)	TP Load (lb/day)
WLA for Construction and Industrial Stormwater	0.0927	0.000254
Load Allocation	185	0.507
Margin of Safety	20.6	0.0564
Loading Capacity	**206**	**0.564**
Existing Load	222	0.608
Percent Load Reduction	7%	7%

You can also assign just one lumped LA for lake TMDLs as well. Use this option if assigning individual LAs for different sources doesn't have added value, or if you don't have the data to support it. You can also assign the one lumped LA in the TMDL table, but assign loading goals for the different sources in the implementation section of the TMDL report.

Natural background

You have already made sure that natural background was addressed as a potential source in the source assessment. Here we need to state where natural background is accounted for in the allocations. Typically we say that it is implicitly included in the LA, as in the example table on the left; the report template has text for this. In some cases, it could be an explicit LA line item in a TMDL table, as in the example on the right. Either approach is fine, just make sure that it is addressed and that it is clear how it was addressed.



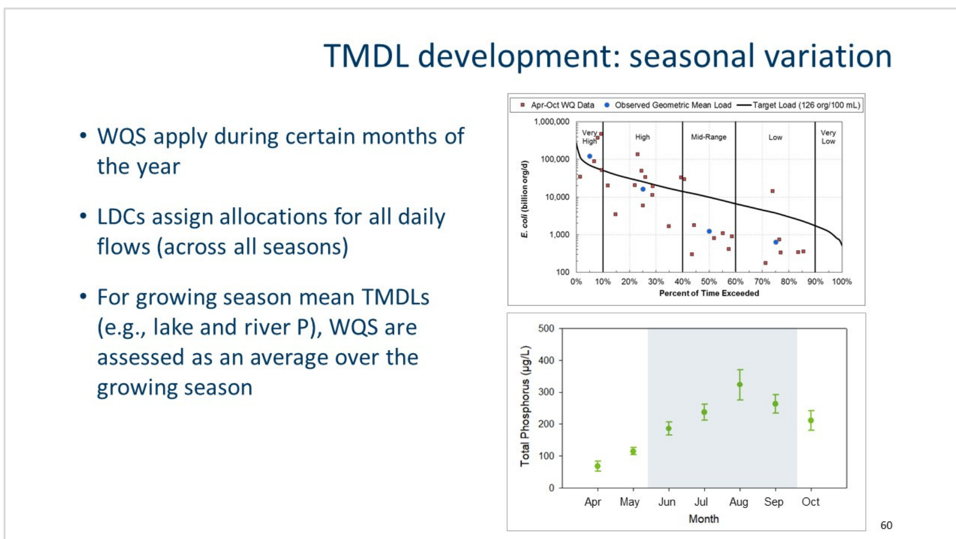
TMDL parameter		TMDL TP load (lb/d)
WLA	Construction and Industrial stormwater	0.0084
	Green City WWTP	0.22
	Total WLA	0.23
LA	Watershed runoff	0.36
	Failing SSTS	0
	Atmospheric deposition	0.11
	Internal load	0.16
	Total LA	0.63
MOS		0.096
Total load		0.96

TMDL parameter		TMDL TP load (lb/d)
WLA	Construction and Industrial stormwater	0.0084
	Green City WWTP	0.22
	Total WLA	0.23
LA	Watershed runoff	0.29
	Natural background	0.071
	Failing SSTS	0
	Atmospheric deposition	0.11
	Internal load	0.16
	Total LA	0.63
MOS		0.096
Total load		0.96

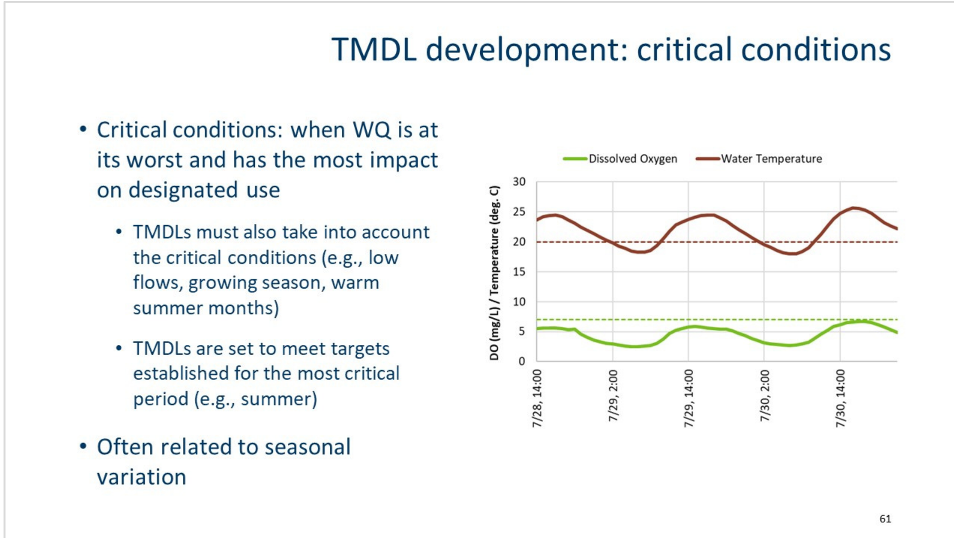
Seasonal variation

This section includes statements about how seasonal variation is taken into account in any part of the TMDL. Often the WQS is mentioned, because the WQS often apply only during certain months of the year, so seasonal variation is inherently taken into account in the WQS.

The TMDL approach is relevant with seasonal variation. For TMDLs that use load duration curves (LDCs), they inherently take into account the flow variability that comes along with seasonal variation, because the LDC assigns a loading capacity for all daily flows, across all seasons. For TMDLs that are based on seasonal means, such as lake and river phosphorus (P) TMDLs, seasonal variation is taken into account because the TMDL is based on the season (e.g., the summer months of the growing season), when the WQS apply and when eutrophication is most likely to occur.



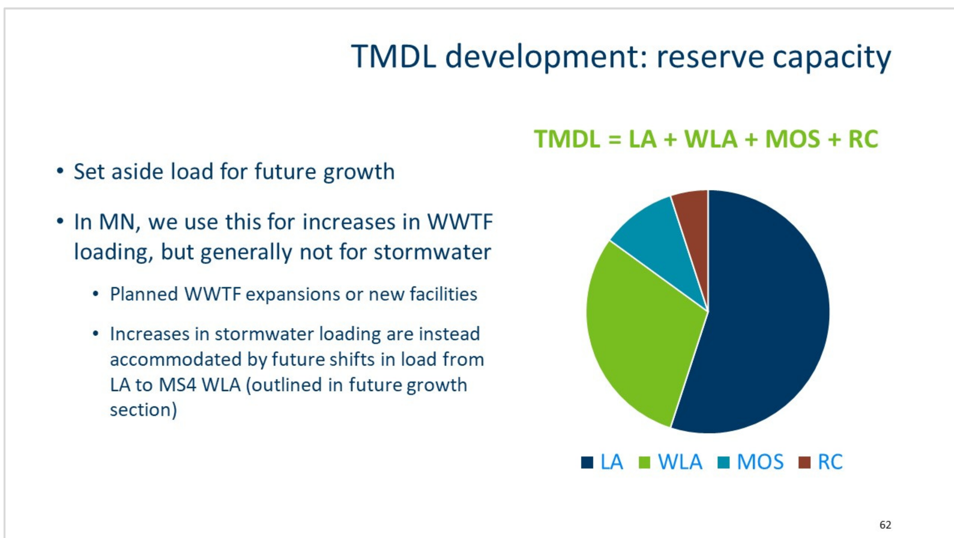
Critical conditions



TMDLs must also "take into account critical conditions for stream flow, loading, and WQ parameters." Critical conditions are conditions, such as low flow or warm temperatures, when water quality is expected to be at its worst and to have the most impact on the designated use. For example, the critical condition for a DO TMDL may be in the warm summer months under low flows, when DO is most likely to be low and affect aquatic life. For a TSS TMDL it may being during spring run-off events.

Critical conditions are often covered by the seasonality discussion, and they're combined in the report template. For example, critical conditions for lake eutrophication are during the growing season, which is also the months when the WQS applies.

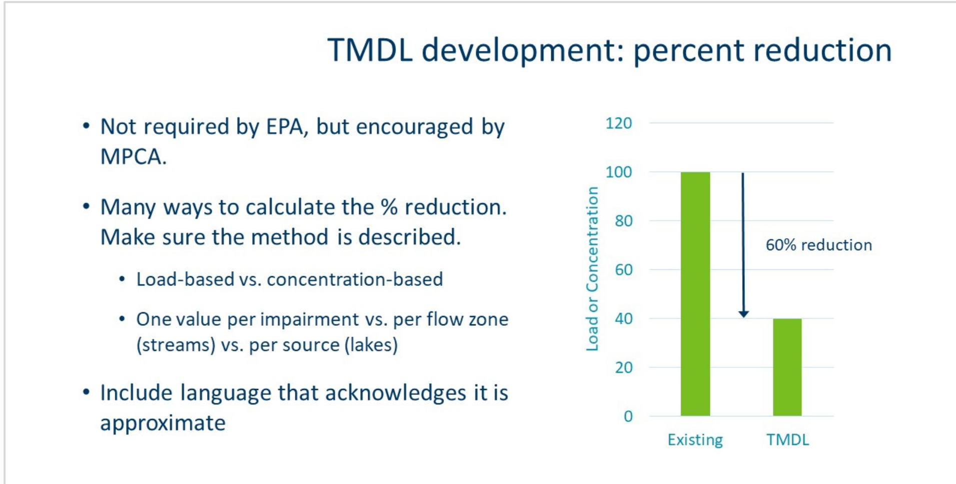
Reserve capacity



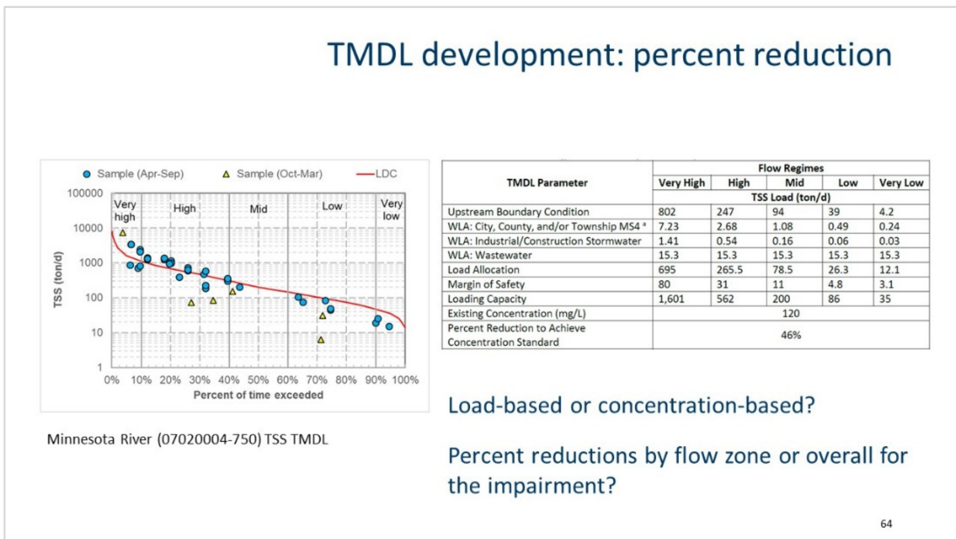
Reserve capacity (RC) is part of the TMDL equation; it sets aside load to account for future growth. Including RC in TMDLs is optional. In Minnesota, RC has been used only in phosphorus lake TMDLs for existing, unsewered populations, but may be applicable to other circumstances in the future. In Minnesota, RC has not been used to provide WLAs for new and/or expanding industrial or municipal discharges. We also haven't used RC for increases in stormwater loading expected from future growth. Instead, we accommodate increases in stormwater loading by shifting load from the LA to the MS4 WLA. Section 5.1 in the TMDL template provides language to address this.

Percent reduction

Percent reductions are not required by the EPA, but they are useful for interpreting TMDLs, and the MPCA generally encourages TMDLs to include percent reductions. Because there are many unknowns and a lot of variability in the data sets, it is important to acknowledge that the percent reduction is a rough estimate, meant to describe the level of effort needed to reduce loads or concentrations. If percent reductions are included, make sure that you explain how it was calculated.



This example highlights the difference between load-based and concentration-based percent reductions. In the LDC, you can see that the standard is exceeded in the very high and high flow zones. If we were to calculate a load-based percent reduction for each flow zone, we would first need to calculate an existing load for each flow zone, using the monitoring data that you see here. Notice that there is a pretty good representation of TSS concentrations in the very high and high flow zones, but less so for the other flow zones. So any estimate of existing load in these lower flow zones would have a lot of error associated with it. Also, if you calculate percent reductions by flow zone, you would have approximately 50–60% reduction needed in the higher flow zones, and no reductions needed in the other flow zones.

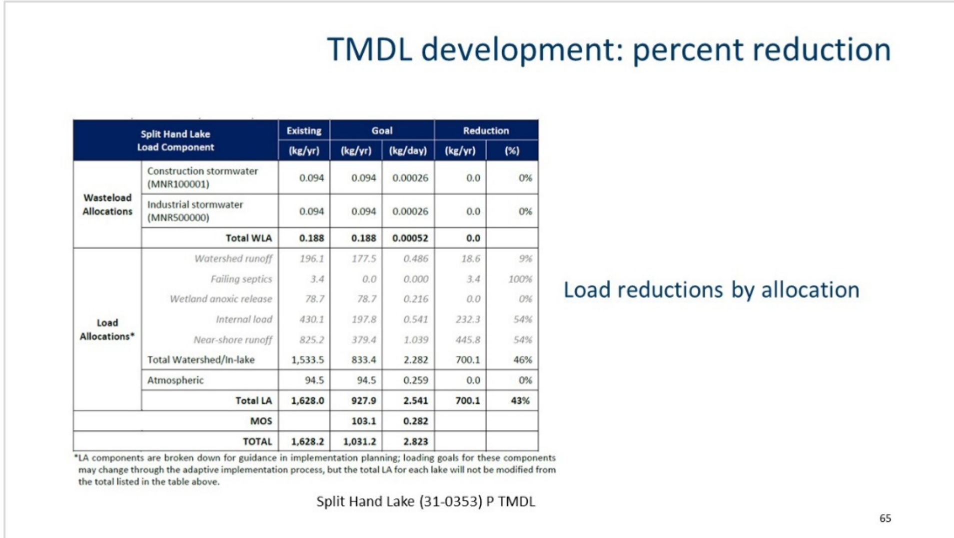


TMDL Parameter	Flow Regimes				
	Very High	High	Mid	Low	Very Low
	TSS Load (ton/d)				
Upstream Boundary Condition	802	247	94	39	4.2
WLA: City, County, and/or Township MS4 [a]	7.23	2.68	1.08	0.49	0.24
WLA: Industrial/Construction Stormwater	1.41	0.54	0.16	0.06	0.03
WLA: Wastewater	15.3	15.3	15.3	15.3	15.3
Load Allocation	695	265.5	78.5	26.3	12.1
Margin of Safety	80	31	11	4.8	3.1
Loading Capacity	1,601	562	200	86	35
Existing Concentration (mg/L)	120				
Percent Reduction to Achieve Concentration Standard	46%				

This example is from the Minnesota River and Greater Blue Earth River Watershed TSS TMDL, which had over 60 impairments, with a wide range of existing data sets. To maintain consistency throughout the report in how the percent reductions were calculated, it was decided to just show one percent reduction in the TMDL table, and to base it on concentration. An estimate of existing concentration is provided, along with the estimated percent reduction.

The approach that is taken can vary by project based on the robustness of the datasets and the particulars of the watershed and the local concerns.

Here's an example of load reductions by source type in a lake TMDL.



Split Hand Lake Load Component		Existing (kg/yr)	Goal (kg/yr)	Goal (kg/day)	Reduction (kg/yr)	Reduction (%)
Wasteload Allocations	Construction stormwater (MNR100001)	0.094	0.094	0.00026	0.0	0%
	Industrial stormwater (MNR500000)	0.094	0.094	0.00026	0.0	0%
	Total WLA	**0.188**	**0.188**	**0.00052**	**0.0**	
Load Allocations*	*Watershed runoff*	*196.1*	*177.5*	*0.486*	*18.6*	*9%*
	Failing septics	*3.4*	*0.0*	*0.000*	*3.4*	*100%*
	Wetland anoxic release	*78.7*	*78.7*	*0.216*	*0.0*	*0%*
	Internal load	*430.1*	*197.8*	*0.541*	*232.3*	*54%*
	Near-shore runoff	*825.2*	*379.4*	*1.039*	*445.8*	*54%*
	Total Watershed/In-lake	1,533.5	833.4	2.282	700.1	46%
	Atmospheric	94.5	94.5	0.259	0.0	0%
	Total LA	**1,628.0**	**927.9**	**2.541**	**700.1**	**43%**
	MOS		**103.1**	**0.282**		
	TOTAL	**1,628.2**	**1,031.2**	**2.823**		

*LA components are broken down for guidance in implementation planning; loading goals for these components may change through the adaptive implementation process, but the total LA for each lake will not be modified from the total listed in the table above.

TMDL summary

Finally, we get to the TMDL tables themselves. The report template includes examples of TMDL tables for typical stream TMDLs and for typical lake TMDLs. I'll point out a few specifics here, but when you're reviewing a TMDL, please review the template and make sure that the specifics that are requested are included in your tables. In Part 3 of this TMDL training workshop we will address how to check the math of the TMDL tables.

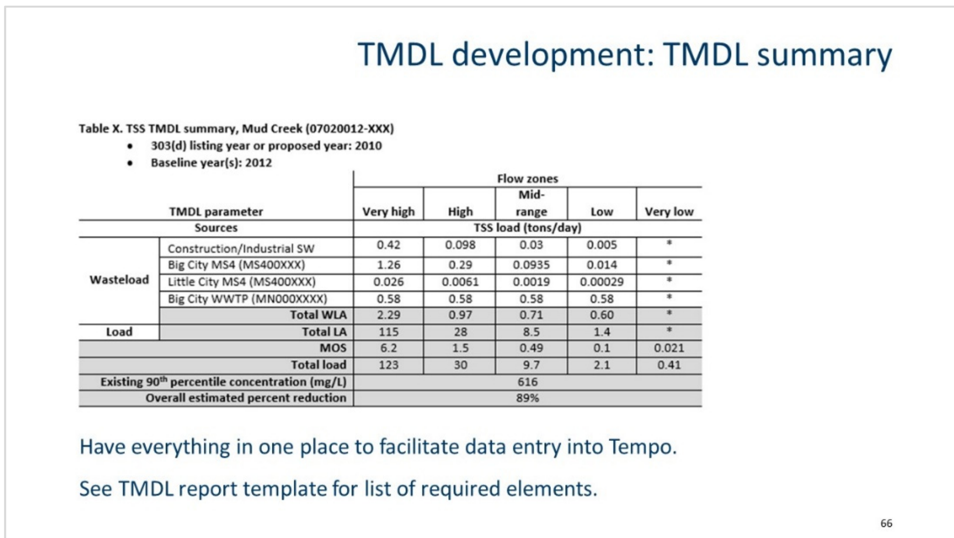


Table X. TSS TMDL summary, Mud Creek (07020012-XXX)

- **303(d) listing year or proposed year: 2010**
- **Baseline year(s): 2012**

TMDL parameter		Flow zones: Very high	High	Mid-range	Low	Very low
Sources		**TSS load (tons/day)**				
Wasteload	Construction/Industrial SW	0.42	0.098	0.03	0.005	*
	Big City MS4 (MS400XXX)	1.26	0.29	0.0935	0.014	*
	Little City MS4 (MS400XXX)	0.026	0.0061	0.0019	0.00029	*
	Big City WWTP (MN000XXXX)	0.58	0.58	0.58	0.58	*
	Total WLA	2.29	0.97	0.71	0.60	*
Load	**Total LA**	115	28	8.5	1.4	*
	MOS	6.2	1.5	0.49	0.1	0.021
	Total load	123	30	9.7	2.1	0.41
Existing 90th percentile concentration (mg/L)		616				
Overall estimated percent reduction		89%				

Because of the information that you need to enter into Tempo for each impairment, the template requests certain information to be built into the TMDL table so that it is all in one place when you enter the data. For example, the AUID, the listing year, and the baseline year should all be included. All of the individual WLAs should be included in the TMDL table along with their permit numbers. If the list of individual WLAs is extensive, it can be included in a separate table, but should be located immediately below the TMDL table to facilitate data entry.

Section Summary

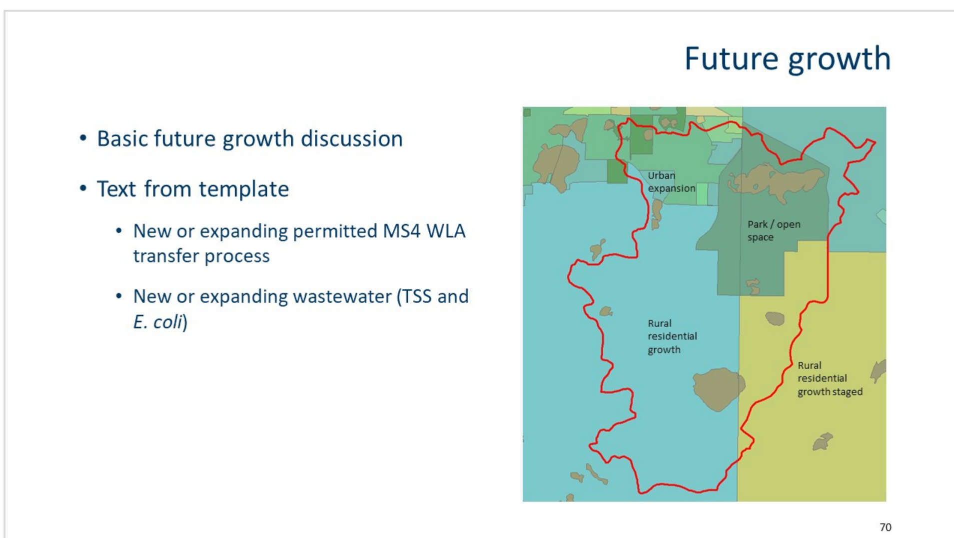
- **Is it clear which methods were used to calculate TMDL components?**
  - **Loading capacity**
  - **MOS**
  - **Wastewater WLA: Involve wastewater liaison early in the project; include all individual WLAs in TMDL table**
  - **MS4 WLA: How was regulated area determined? How was WLA calculated? Table of regulated area per MS4 per impairment**
  - **Permitted feedlots and CAFOs: WLA of zero (stated in text, not in table)**
  - **LA**
  - **Percent reductions**
- **Discussion of seasonal variation and critical conditions**
- **Complete TMDL tables**

Future growth, reasonable assurance, monitoring, implementation strategy, public participation

The remaining sections are less technical in nature but still important.

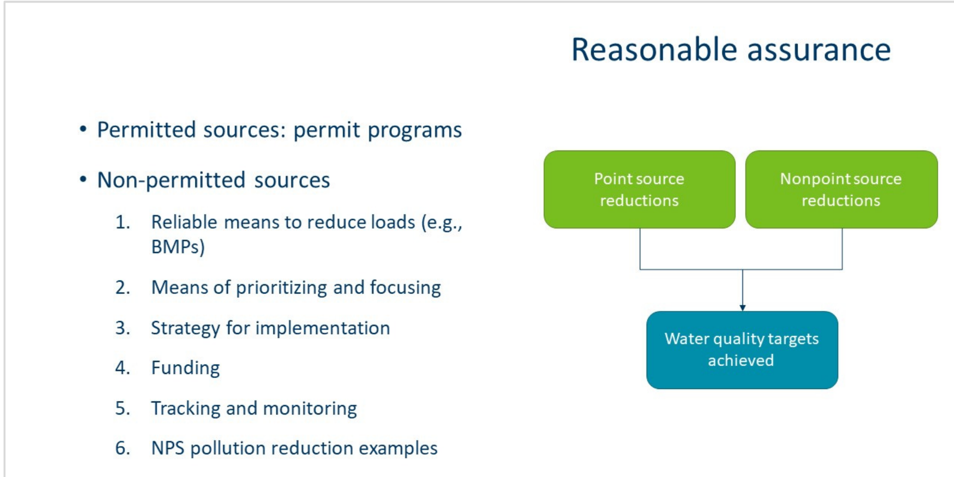
Future growth

The section on future growth is related to reserve capacity but is more broad. Whereas RC sets aside a specific allocation for a future permitted source, the future growth section provides a discussion about growth expectations in the watershed, in addition to two mechanisms to account for future growth without needing a RC. See the TMDL report template for language for these two mechanisms. Make sure to review this language in the context of your report. For example, if you don't have any TSS or *E. coli* TMDLs in the report, you don't need to include the part about new or expanding wastewater.



Reasonable assurance

The reasonable assurance section needs to show that elements are in place for both permitted and non-permitted source load reductions, so that ultimately the WQ targets are achieved. For permitted sources, you need to cite and briefly describe permit programs. For nonpoint source reductions, the template lists these six elements that need to be addressed. Make sure that the elements are all covered in the RA section.



Sample text was added to the report template; the new text describes programs that can be used in the RA for many TMDLs.

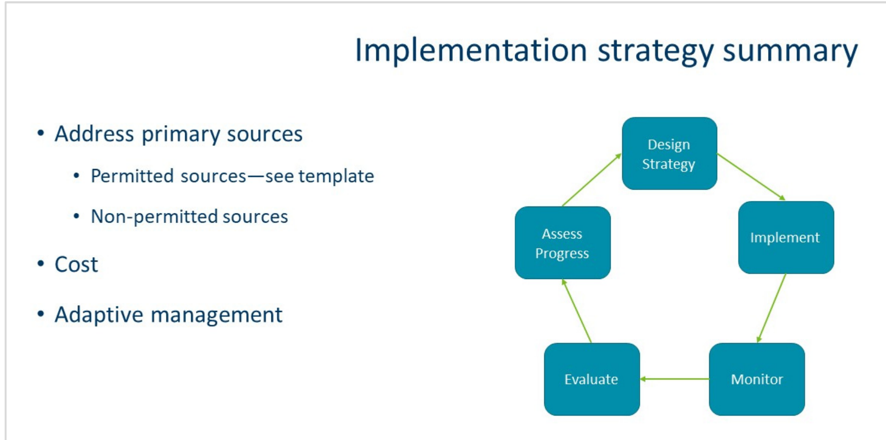
Monitoring plan

In the monitoring plan, typically a description of existing monitoring programs is included, such as the MPCA's Intensive Watershed Monitoring, the Watershed Pollutant Load Monitoring Network, local partner monitoring, and citizen monitoring. Best management practices (BMPs) monitoring can also be mentioned if there are plans for that.

Lately there has been a direction towards not including a complete monitoring wish list, being careful about not committing state or local partners to monitoring if there isn't current funding or plans for it. If you do want to include a more complete monitoring wish list, consider including it in a different section and state that these are just ideas for future consideration.

Implementation strategy summary

There's a range of detail that this section could have, and recently we have opted for less detail and instead referencing the Watershed Restoration and Protection Strategy (WRAPS) report, which will contain a more fleshed out implementation strategy. It can be helpful to write the WRAPS first, and then summarize it in this section. Even if you don't do that, at least make sure that this section in the TMDL report doesn't contradict with anything in the WRAPS report.



Review this section with the primary pollutant sources in mind from the "pollutant source summary" and make sure that the selected implementation strategies address all of the primary pollutant sources that had been identified earlier in the report.

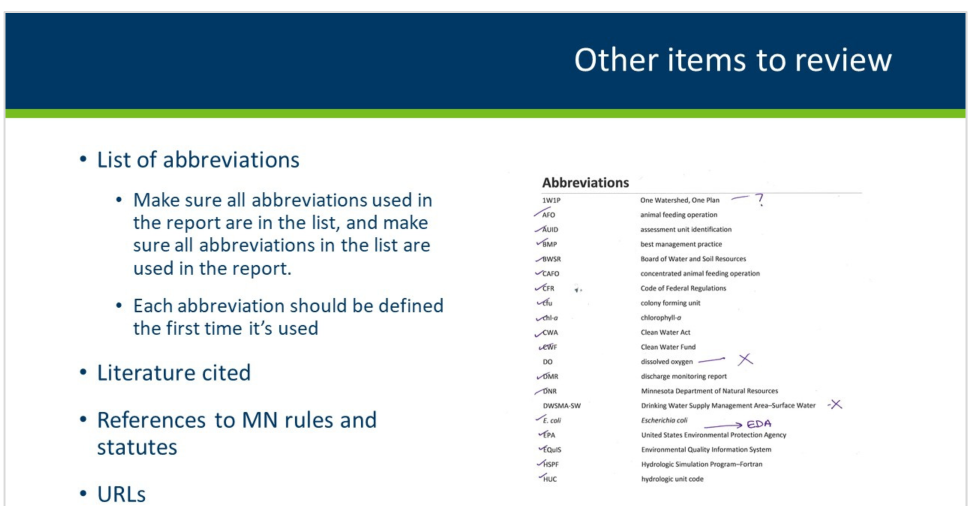
A cost estimate is required as part of this section. Again, a wide range of approaches is acceptable. For a small watershed where you generally know what needs to be done to achieve WQS, you can include a cost estimate based on specific BMPs. For many TMDL reports that cover a wide range of impairments and a large watershed area, the cost estimates will likely be based on typical costs for certain BMPs or even more generalized average costs per pound of pollutant that needs to be reduced.

Public participation

This section is also flexible, and at a minimum must contain information about the public notice and comment letters received during the public comment period. Additional information can be provided about core team or local partner team meetings held throughout the process, in addition to civic engagement activities.

Other items to review

Lastly, once the report is more or less complete, review the list of abbreviations and make sure that all abbreviations in your list are actually in your report. Also review the report and make sure that all of the abbreviations that are used in the report are in the list, and that each abbreviation is defined the first time that it is used in the report.



Do the same two-way review for the literature cited—make sure that everything referenced in the report is in the literature cited, and make sure that everything in the literature cited is referenced in the report. A good way to do these checks is to print out the list of abbreviations and the literature cited. Go through the report and check off each abbreviation or citation as you find it in the report, noting any missing ones. When you're done, it will also be clear which abbreviations or citations have not been used or referenced in the report.
We also frequently reference Minnesota rules and statutes in TMDL reports. When reviewing a report, we often gloss over these references, but they should be checked, because mistakes are easily made with these numbers. It's also good to familiarize yourself with the rules and statutes that they reference.

Also check all URLs in the report and make sure the links work. In general, please insert only the most important links and select links that should have the most longevity. Consider referencing documents in the TMDL report and adding links to the references in the "Literature cited" section instead of adding the links in the report body.

Section Summary

Review remaining sections, continuing to keep in mind the existing water quality, pollutant sources, and load reductions needed for each impairment.

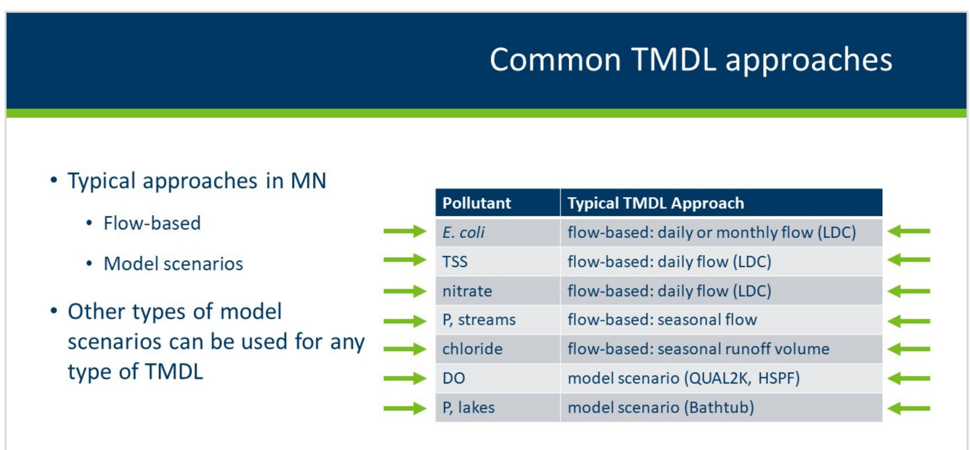
Part 2: Technical approaches and models

For this session, we'll get into more details of technical approaches for TMDL development. Even if you will not be developing TMDLs, knowing a little more about the approaches will help you understand what was done, how to interpret and review the work, and ultimately how to help implement it. If you are interested in developing TMDLs, this session will serve as an introduction to the technical approaches.

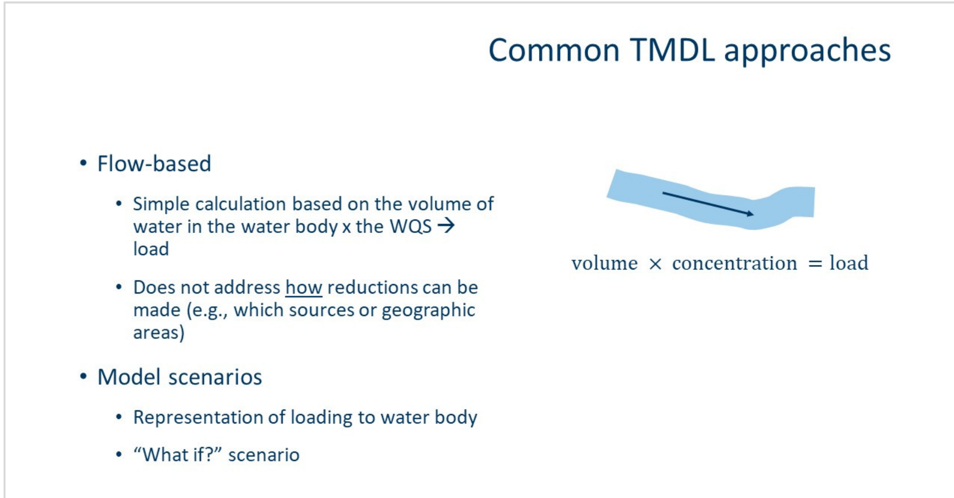
TMDL approaches

Common TMDL approaches

The most common TMDL approaches in Minnesota are flow-based calculations and model scenarios. Although there are many variations on these two approaches, the approaches can be distilled down to these two types. Many of you are familiar with LDCs—these are flow-based TMDLs and are commonly used to develop *E. coli*, TSS, and nitrate (for drinking water) TMDLs. Flow-based TMDLs can also use calculations similar to those used in the LDC approach, but with seasonal flows or runoff volumes, as in stream phosphorus and chloride TMDLs. Model scenarios are commonly used to develop dissolved oxygen and lake phosphorus (P) TMDLs. Although not shown here, model scenarios theoretically can be used to develop just about any type of TMDL.



First I'll briefly explain flow-based and model scenario approaches, and then we'll go into more detail about each. Flow-based TMDLs are a simple calculation based on the amount of water in the water body multiplied by the WQS, which is a concentration, to yield a pollutant load. This load is the loading capacity, or TMDL, because it represents the load of pollutant in the water body if all of the water were at the water quality standard concentration. We're not really showing **how** the reductions can be made, we're just making a simple calculation.

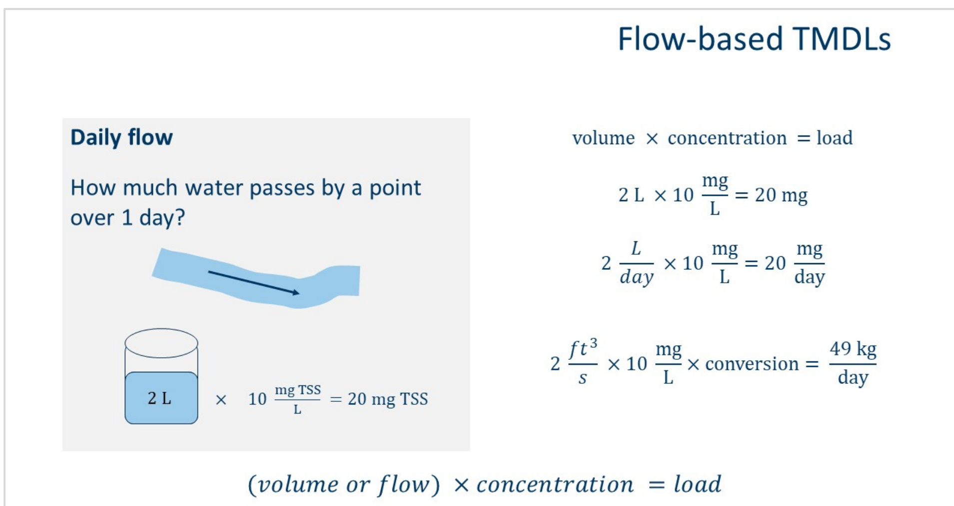


With a model scenario, we develop a representation (or a model) of loading to the water body and then develop a "what if?" scenario.

Flow-based TMDLs

With flow-based TMDLs, we commonly look at the daily average flow in a stream. To help conceptualize this, let's talk about volumes—for a stream, think about how much water passes by a single point on the stream over one day. Think of that volume in one giant beaker. To get the loading capacity for TSS, for example, we multiply that volume by the TSS water quality standard to get a daily load.

Here's a simple equation to get you thinking about how the math works. If your beaker had 2 liters (L) of water, you would multiply that by the TSS WQS of 10 mg/L to get 20 mg of TSS. In other words, if the entire 2 L of water in the beaker were at a concentration of 10 mg/L, the amount of TSS in the beaker would be 20 mg.

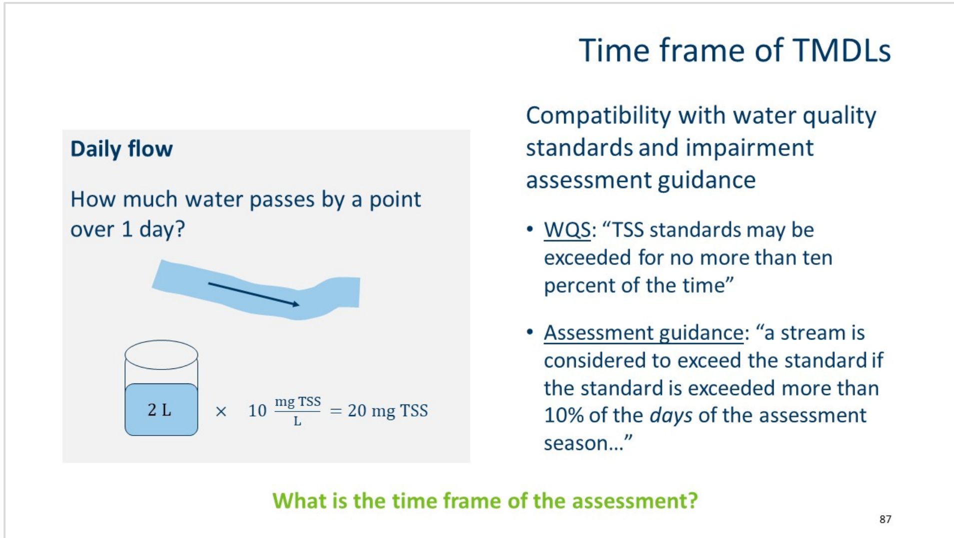


Now let's bring in a time component. Our beaker might be thought of as a lake—it holds a relatively stable amount of water. But in our stream example we asked, how much water passes by a point in one day? Let's say that the 2 L of water was the entire amount of flow that passed by a point over the course of the day (a trickle, I know, but bear with me). The flow would be 2 L per day, multiplied by 10 mg/L to get 20 mg of TSS per day. Now it's feeling more like a TMDL, with a load per unit time period.

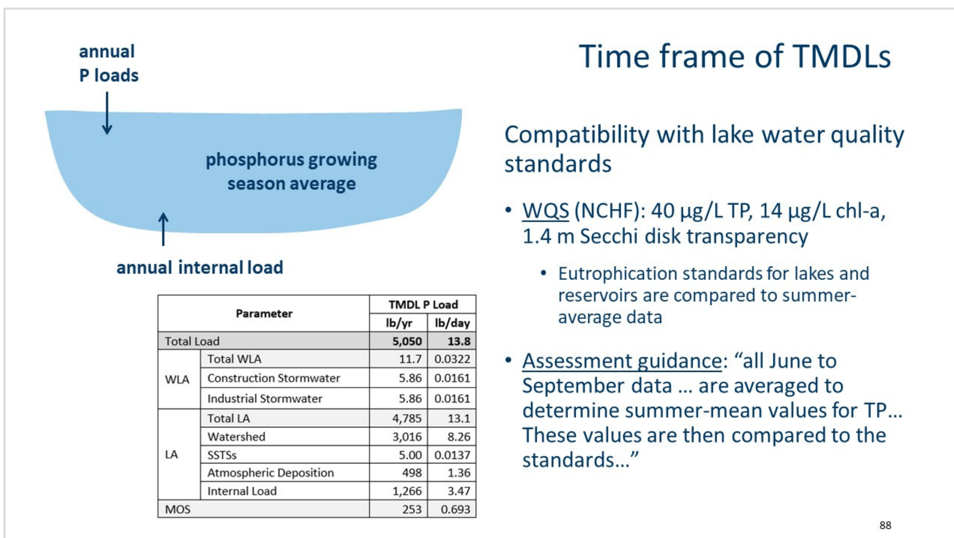
One more equation for now—let's look at an example that has units that we're more familiar with in stream TMDLs. Let's say that our average flow over one day is 2 cubic feet per second. We can multiply this by the TSS WQS of 10 mg/L, then a conversion factor to make the units match up, and it will give us 49 kg per day of TSS. [1 ft3 = 28.3 L; 86,400 s = 1 day; 10^6 mg = 1 kg]

Time frame of TMDLs

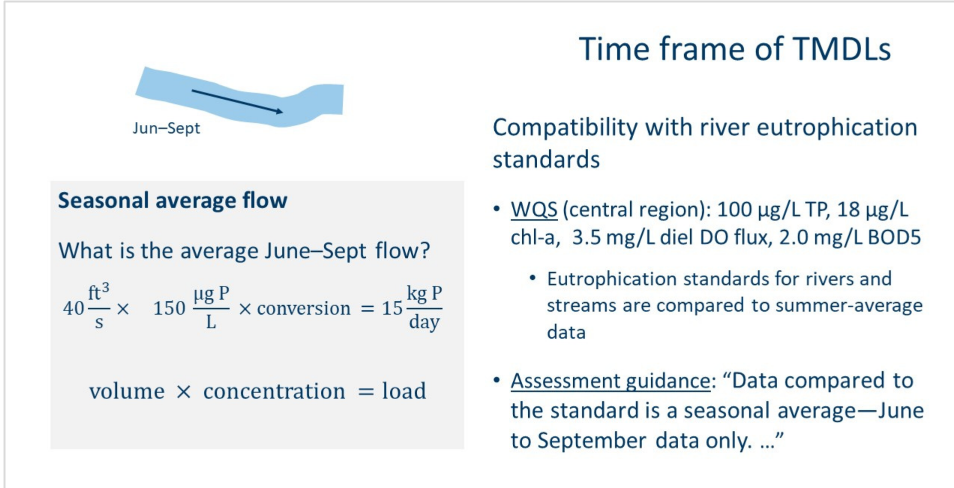
Why did we look at the flow over one day? Why not the flow over a week, or month, or year? We need to make sure that this TMDL approach is compatible with the specific WQS and how water bodies are assessed for that parameter, because the TMDL needs to show that the standard would be met. What is the time frame of the assessment? Let's continue with the TSS example. The WQS states that "TSS standards may be exceeded for no more than ten percent of the time." The guidance manual for assessment states that "a stream is considered to exceed the standard if the standard is exceeded more than 10% of the days of the assessment season…" Notice the word "days." We're evaluating the stream on a daily basis to see if it meets the standard. This is why we calculate the TMDL on a daily basis.



Think of how this differs from a lake TMDL. With lakes, we typically look at annual or seasonal loads to the lake to evaluate the lake WQ. What do the standards and assessment guidance say? The rule provides the numeric values, and it also states that the standards are compared to summer average data. This statement isn't directly with the numeric standards in the rule, so it's a little harder to find, but it's in there. We can also look to the MPCA's assessment guidance, where it says that all June through September data are to be averaged to determine a summer average phosphorus concentration. This is the concentration that is compared to the standard in order to assess for impairment. This is why lake TMDL tables are based on annual loads; we identify the load that relates to the assessment time period, and base the TMDL on that. Because of how the CWA was written, we still need to provide daily loads in the TMDL table, but they are derived directly from the annual loads.



Parameter		TMDL P Load	
		lb/yr	lb/day
Total Load		**5,050**	**13.8**
WLA	Total WLA	11.7	0.0322
	Construction Stormwater	5.86	0.0161
	Industrial Stormwater	5.86	0.0161
LA	Total LA	4,785	13.1
	Watershed	3,016	8.26
	SSTSs	5.00	0.0137
	Atmospheric Deposition	498	1.36
	Internal Load	1,266	3.47
MOS		253	0.693

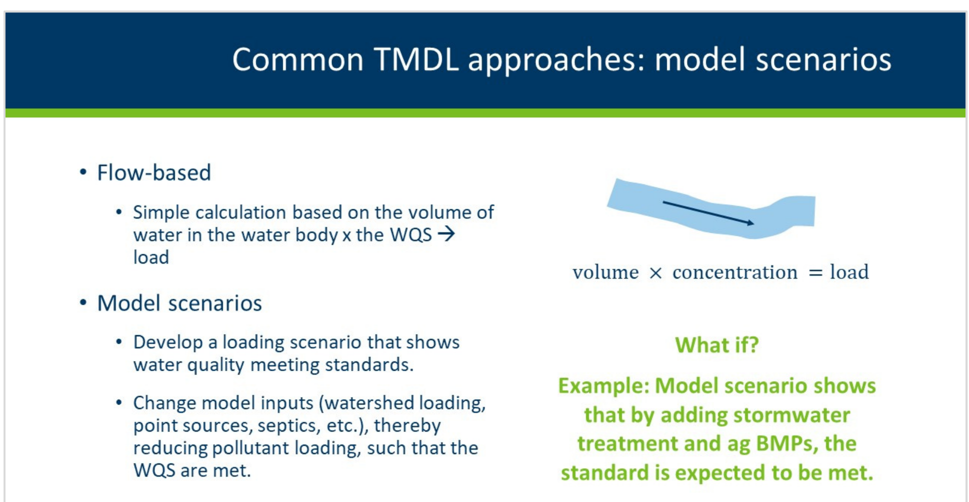


One more example that involves the time frame of TMDLs—let's go back to streams. We had looked at the TSS example and developing the TMDL on a daily basis. What about river eutrophication TMDLs? Similar to lake eutrophication standards, the rule provides the numeric criteria in addition to a statement about comparing the standards to summer average data. The assessment guidance says the same. This is why we do not use flow duration curves based on daily average flows for stream P TMDLs. Because it's a stream, we can still take a flow-based approach like we did with the TSS TMDLs, but we need to select a flow that represents summer average conditions. Our TMDL is still based on the calculation of "volume times concentration equals load," but it's based on just the seasonal average flow, providing one set of allocations in the TMDL table.

Section Summary

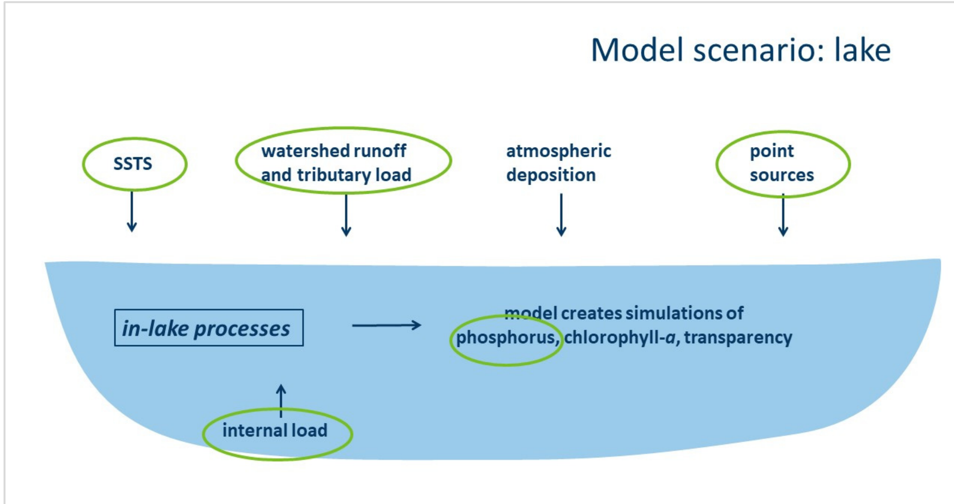
- **What approach was used to calculate the TMDL? Is it flow-based? Is it a model scenario?**
- **What is the appropriate averaging period for the pollutant? Is the appropriate averaging period used in the approach and the TMDL table?**

Model scenarios

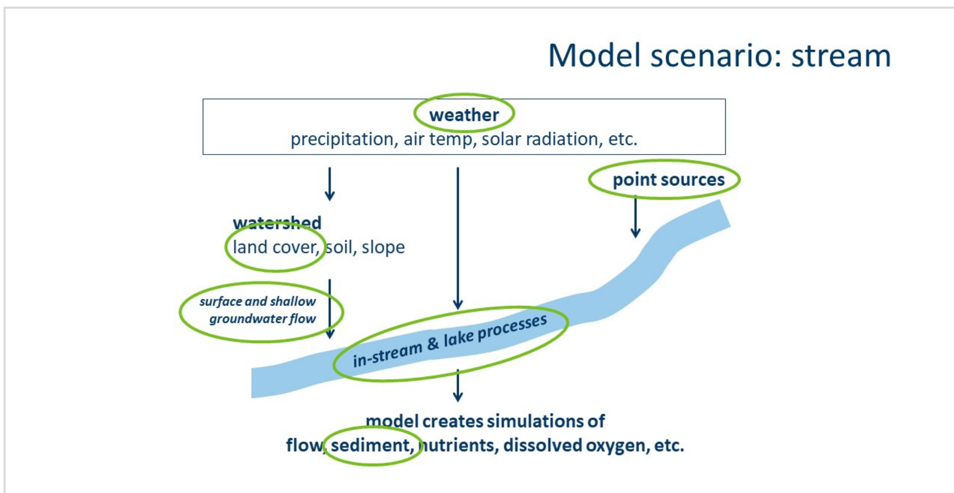


With a model scenario, we develop a representation (or a model) of loading to the water body and then develop a "what if?" scenario. In this scenario, we change the model inputs to simulate load reductions—we change these loading inputs enough until the model predicts that the water body will meet WQS. For example, a model scenario might show that by adding a certain amount of stormwater treatment and agricultural BMPs, the WQS can be met.

This diagram represents the inputs and outputs of a lake water quality model for phosphorus. The model is developed based on what we know about the P sources to the lake, and we calibrate it to make sure that the model adequately predicts the observed P concentration based on the inputs that we've provided. With a model scenario, we can change any or all of the P inputs and see the effect on the predicted output, or phosphorus concentration in the case of a P TMDL. To develop the TMDL, we would decrease the P inputs until the model predicts that the lake P concentration meets the WQS. The TMDL would be the total load to the lake in that model scenario.

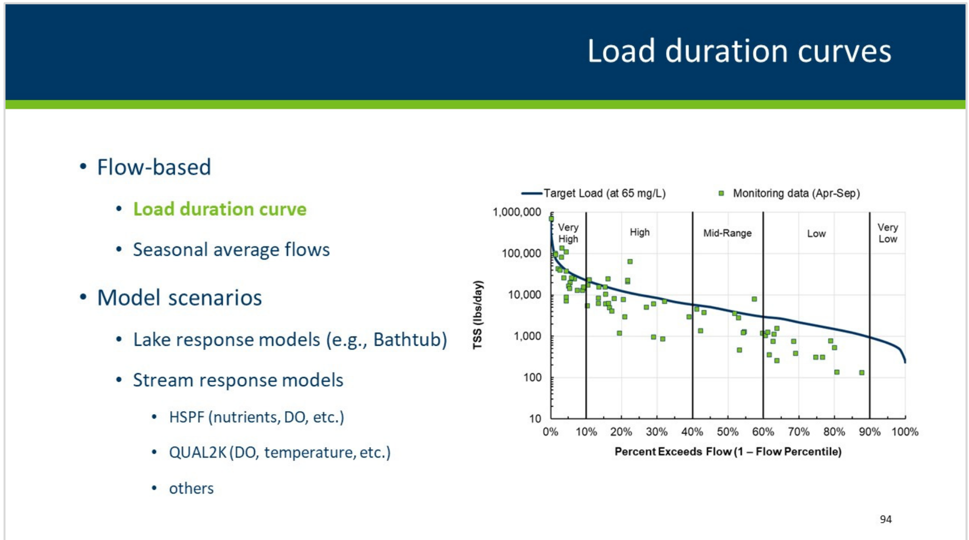


The concept is similar for other types of models. This diagram represents generally how Hydrologic Simulation Program–Fortran (HSPF) works, but it applies to other stream models as well. In this case, weather drives the model, with watershed characteristics influencing how water travels across the surface to the water bodies. The combination of all of the inputs creates the simulations of the flow and water quality model outputs. With a model scenario, you would modify any of the inputs—including the pollutant sources, the instream processes, or the weather or climate—and develop a scenario where the water body meets the standard, whether it's TSS or phosphorus or dissolved oxygen. Then, the TMDL would be based on the sum of all of the modeled pollutant loads in that model scenario.

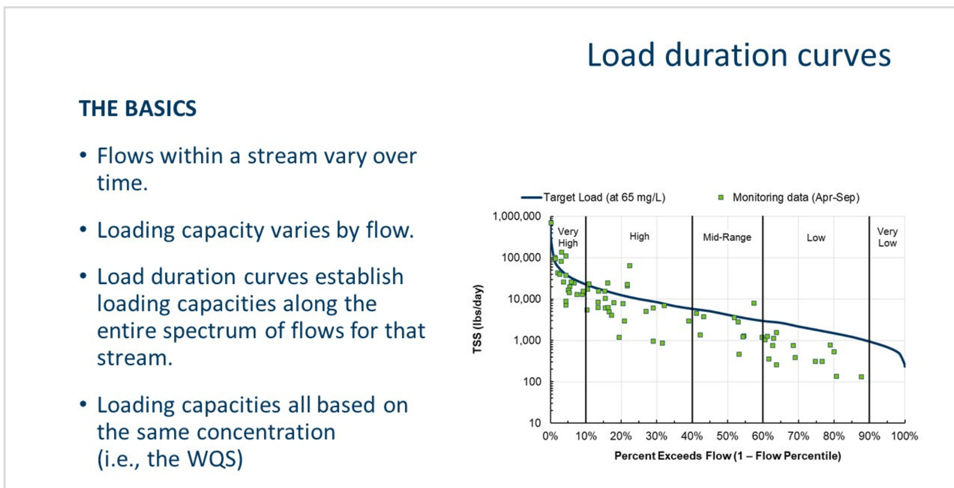


Load duration curves

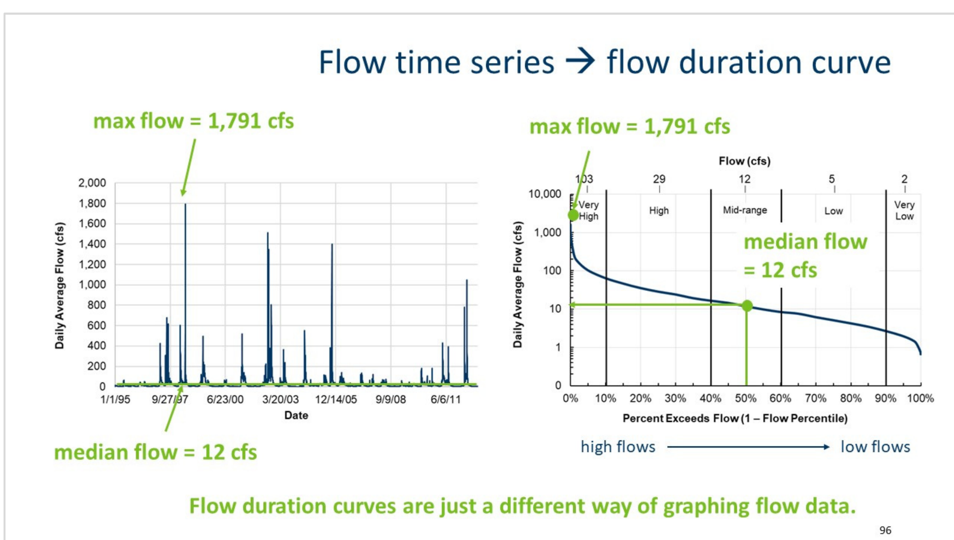
We talked about the two general types of TMDLs—flow-based and model scenario. I'm going to go back to each of these and provide a little more detail about each. This section will be heavy on numbers and tables and figures, so if you've had enough detail for the day, just sit back and listen and try to get the gist of it without worrying about the details. If you're really excited about these approaches, then this section might be for you.



First I'm going to break down load duration curves to show you how they are developed and how they are turned into TMDLs. Many of you have probably seen LDCs, so you know that there's a curve that represents loads from high to low flows in the stream, and that monitoring data are also plotted on the graph. The LDC approach was developed for TMDLs as a way to acknowledge that flows within a stream vary over time, and the loading capacity of a stream varies by flow. So it establishes the different loading capacities at any flow that you might observe in a stream, and lets you know the likelihood of observing that flow. The loading capacities are all based on the same concentration—the WQS.



The first step in developing a load duration curve is to develop a flow duration curve (FDC). We're used to seeing flow graphed as a time series, like the graph on the left, with time on the x-axis and flow on the y-axis. With a flow duration curve, instead of ordering flows by date, flows are ordered from high to low on the x-axis and adjusted to show how frequent each flow is observed in the stream. The x-axis is the percent of time

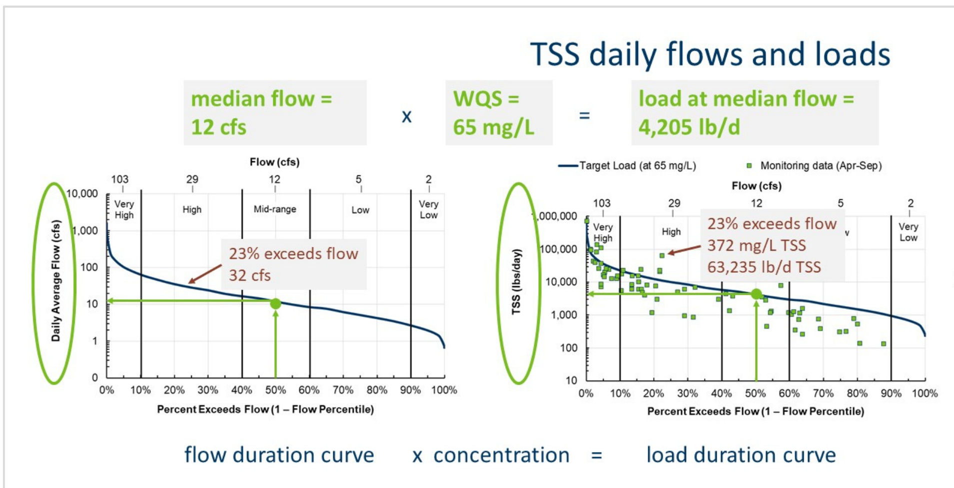


that the flow represented on the graph is exceeded, in short-hand the "percent exceeds flow." For example, the 50% exceeds flow is 12 cubic feet per second (cfs). This means that stream flow is higher than 12 cfs on half of the days on average, and stream flow is lower than 12 cfs on half of the days on average.

For this flow duration curve, flows were added to the top x-axis so that you can see how the flows relate to the percent exceeds flows.

We can see how these two graphs relate to one another, that they display the same data. The maximum observed flow of 1,791 cfs was in June of 1998, which you can see on the left graph. The maximum is also considered the 0% exceeds flow, because this flow is exceeded on 0% of the days. On the right graph, you can see the same value of 1,791 cfs at the very left at the top of the graph. Similarly, you can see the 50% exceeds flow on both graphs. Flow duration curves are just a different way of graphing flow data, ordering from high flow to low flow instead of by time.

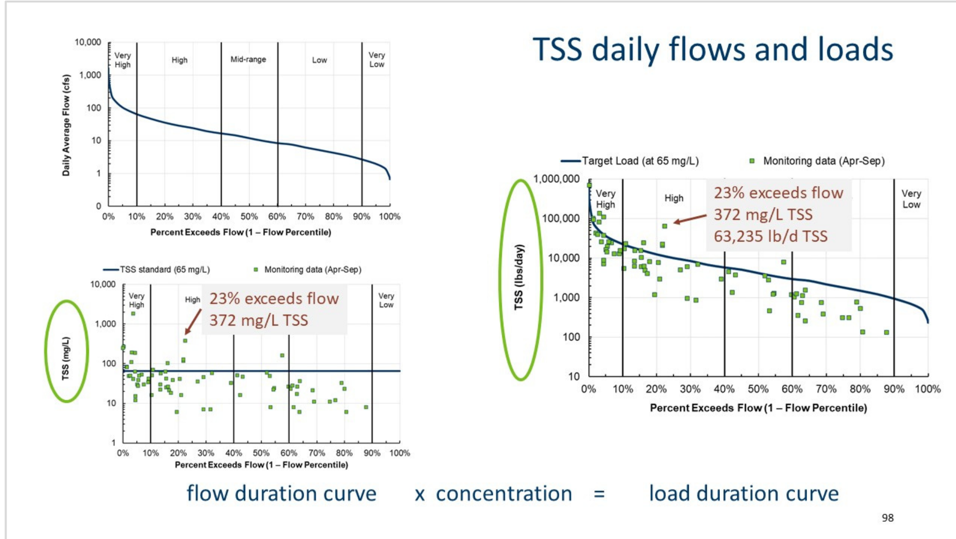
Recall that flow-based TMDLs are a simple calculation of flow x concentration = load. We apply this concept to the FDC. We take the FDC and multiply each value along the curve by the concentration-based WQS. Instead of having just one "flow times concentration" calculation, we have many equations. As one example, let's look at the median flow again. We take the median flow of 12 cfs and multiply it by the 65 mg/L TSS standard that applies to this water body, and that gives us 4,205 lb/d. This means that when the stream has 12 cfs of flow in it, it can assimilate up to 4,205 lb of TSS per day and still meet the WQS. This is the loading capacity of the stream at the median, or 50% exceeds, flow. Note that the x-axis is the same in both graphs—the percent of days that the daily average flow is exceeded. Even though the graph on the right has *load* on the y-axis, the x-axis still shows the percent exceeds *flow*. The point that we're looking at represents the load that the stream can assimilate on days when flow is about average.



We can do the same thing with every point along this curve on the left—multiply it by the WQS to calculate the loading capacity at that flow. That loading capacity gets plotted on the curve on the right.

The last points that are typically plotted on LDCs are the monitoring data themselves. Because monitoring data are concentrations, we also multiply each monitoring data point by the flow to calculate the load. For example, this point is from a day when the flow was at 32 cfs, which is the 23% exceeds flow. The concentration was 372 mg/L, well above the 65 mg/L WQS. We multiply 32 cfs by 372 mg/L to get a load of over 63,000 lbs TSS. Any point that is above the load duration curve exceeds the standard, and any point that is below the LDC is less than the standard. This demonstrates one of the most useful parts of LDCs—we can see patterns of WQ relative to flow. In this graph, most of the exceedances of the WQS are under high flows, suggesting that the sources are either runoff-driven or a result of near-channel processes.

Here is one more way to look at the data, which might help you better understand LDCs. On the top left is the flow duration curve, and on the right is the load duration curve that we were just looking at. On the bottom left we have somewhat of an intermediate step—a concentration duration curve. The x-axis is the same—the percent exceeds flow. But the y-axis is just concentration. We show the WQS at 65 mg/L and the monitoring data plotted as plain old concentrations. We can find that same point that we were just looking at, at the 23% exceeds flow.

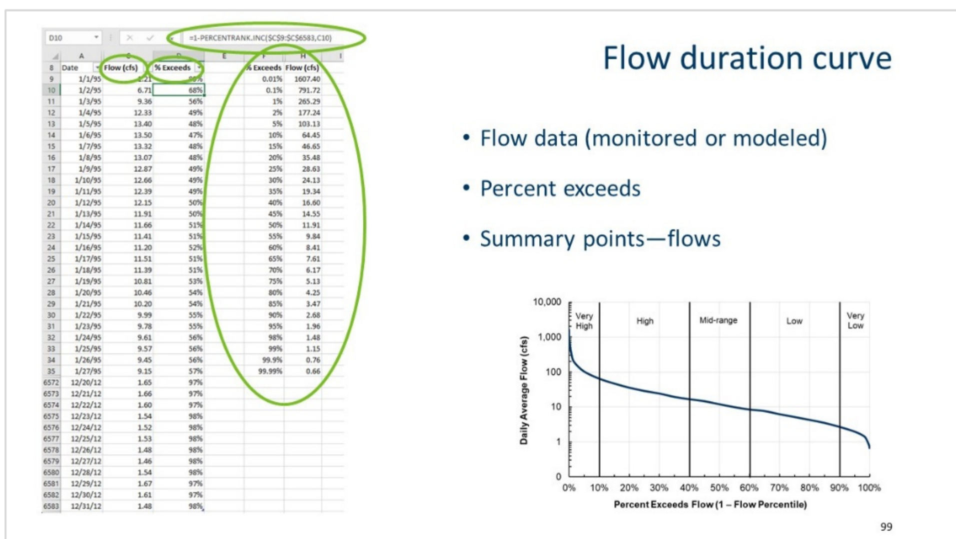


Concentration duration curves are sometimes helpful to look at when you want to more directly see how concentrations, instead of loads, vary with flow. We don't necessarily put them in all TMDL reports, but they can be a useful tool in certain situations or with certain audiences because concentration duration curves are easier to understand than LDCs for many people.

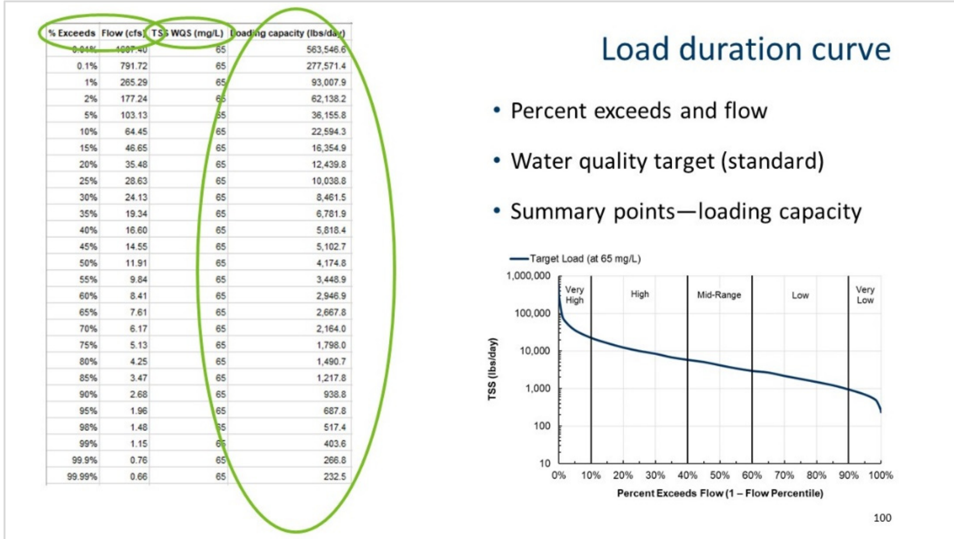
The previous slides explained the concept of a load duration curve in general; here I'll show you the specific steps that are taken to develop a load duration curve for a TMDL.

First, we gather flow data. Flow data can either be long-term monitoring data or can be modeled flows. Using modeled flows has become more common in Minnesota because we have HSPF models that can provide simulated, or modeled, flows at many locations throughout a watershed.

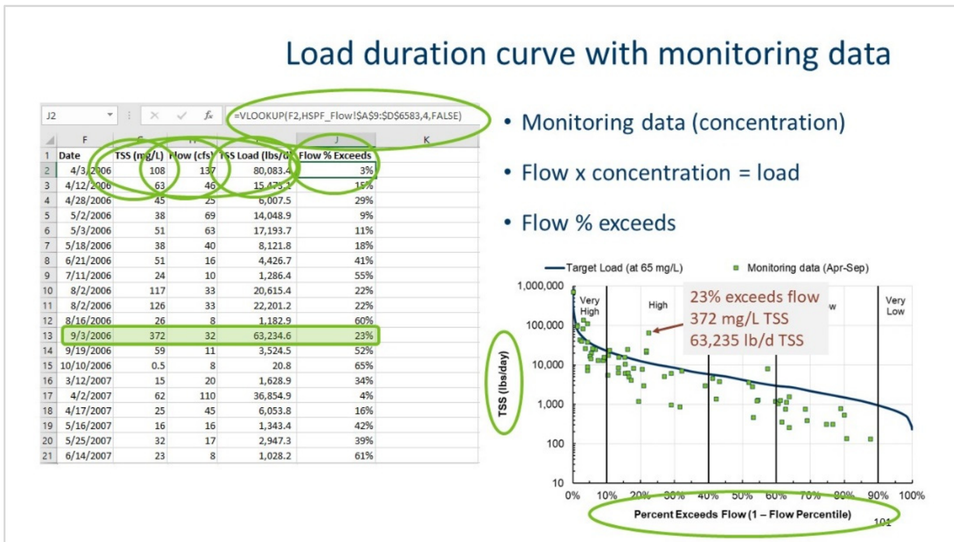
This table shows the daily average modeled flows from 1995 through 2012. We calculate the percent exceeds with a formula that I show here in the slide, but we won't get into those details today. We can then develop a shorter table with summary points that we use to develop the FDC. Columns F + H are the same as columns C + D, I just selected some points to use in the figure and ordered them from high to low flow. The flow duration curve plots these points. Again, flows go from high to low, with the percent exceeds flow on the x-axis, and the actual flows on the y-axis.



To then make the **flow** duration curve into a **load** duration curve, we take that same summary table, and we calculate the loading capacity at each of the summary points. We have the percent exceeds flows, which we multiply by the WQS to get the loading capacity. These summary points are used to plot the LDC. This curve represents the loading capacity across the range of flows observed in this stream.

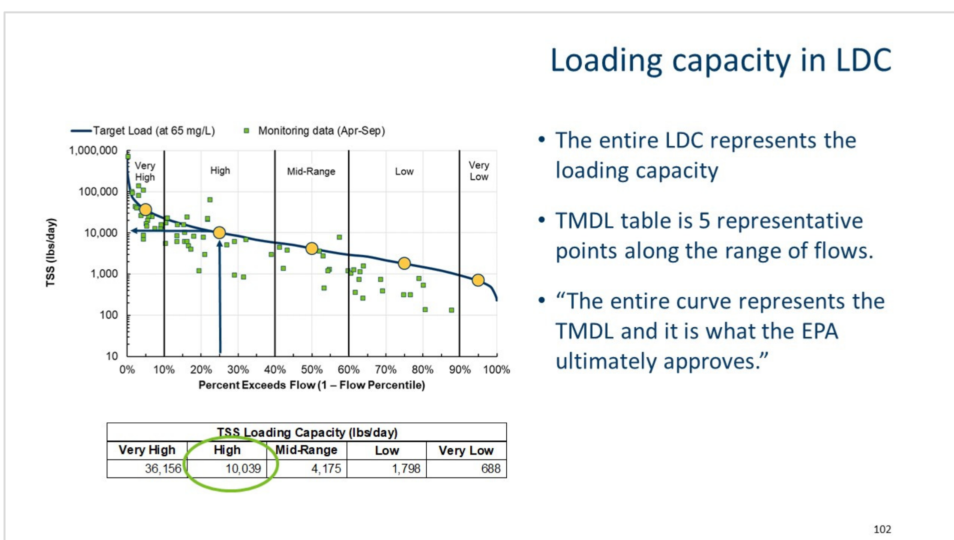


And the last step—plotting the monitoring data onto the LDC. We gather our TSS monitoring data, and then we need to determine what the stream flow was on that day. We use a formula to reference our flow data to pull that value in to the table. We then calculate the load with the same formula that we've been using: flow x concentration = load. Lastly, we need to also reference the percent exceeds flow on that day so that we can plot the point on the LDC.



Looking back at that same point that we looked at a few slides ago, we see the monitoring point and the calculations in the table on the left.

We then take the LDC and we typically select five representative points along the curve to present in the TMDL table. In this example, we selected the midpoints of these five flow zones—you can see that the loading capacity at the 25% exceeds flow is approximately 10,000 lb/day. We do have language in the TMDL report template that specifies that the "full spectrum of allowable loading capacities is represented by the resulting

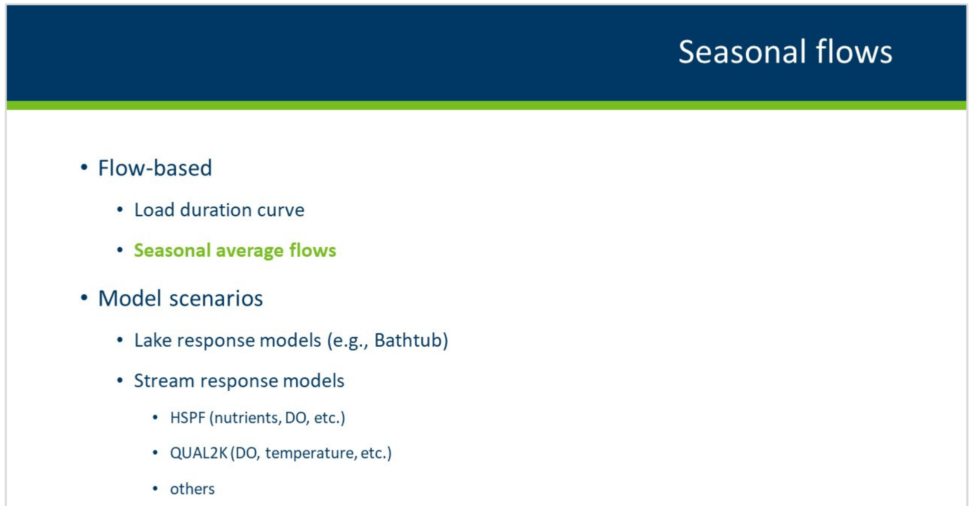


curve." Even though only five points of the entire LDC are presented in the TMDL table, "the entire curve represents the TMDL and it is what the EPA ultimately approves."

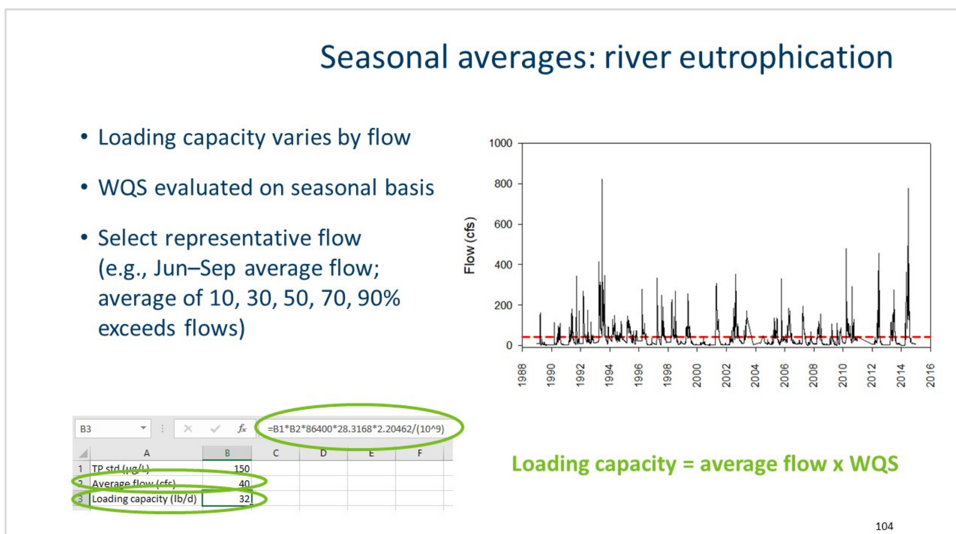
This workshop does not address how to allocate loads to the different sources. There are many ways to do this, and the approach that you select will depend on the particulars of your project.

Seasonal flows

Doing a TMDL based on seasonal average flows has fewer computations, because we don't have LDCs.

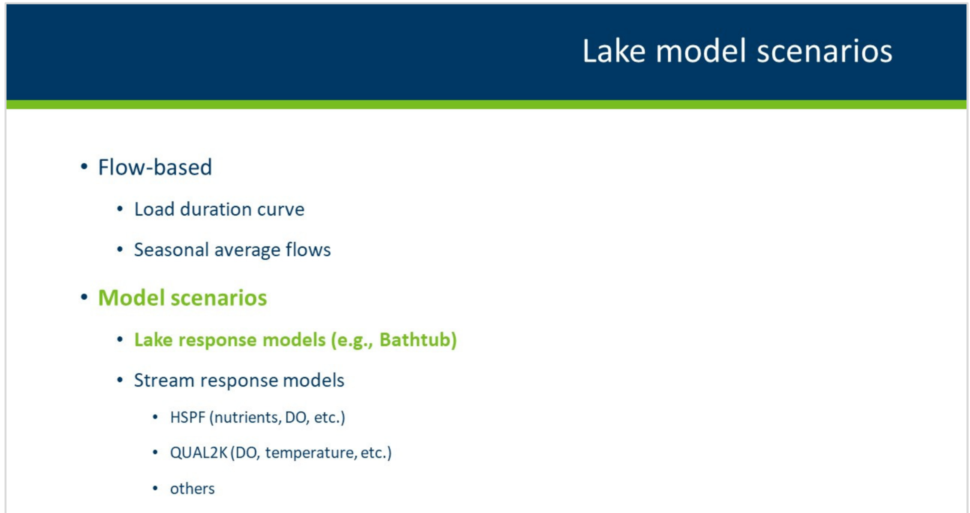


Recall that the same concept applies—that the loading capacity varies by flow. What's different is that the WQS are evaluated on a seasonal basis, and therefore we need to select a flow that is representative of the entire season. As with other TMDLs, the flow data that we're using can be either monitored or modeled flows. For the river eutrophication standards, we select a June through September representative flow—there are many ways to do this. Once we've determined our seasonal average flow, the calculation of the loading capacity is the same as in the other examples: flow x WQS = loading capacity.

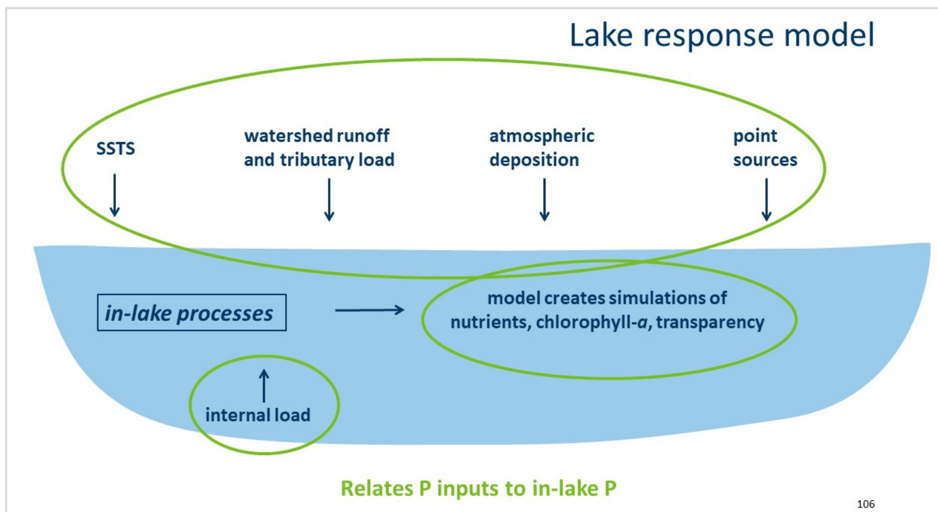


Model scenarios

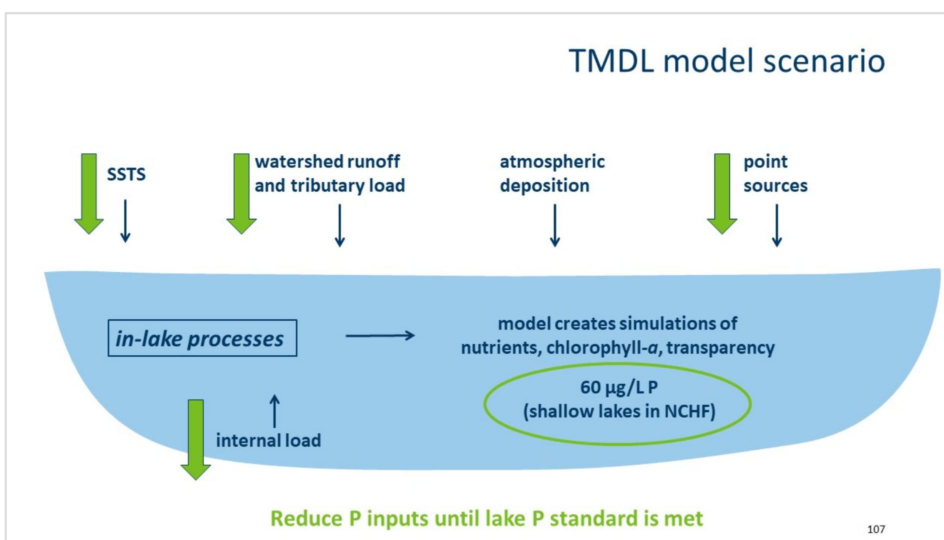
We went into a lot of detail on how to derive LDCs, but we won't go into detail about model development. There are so many types of models, with varying levels of complexity, that it's outside the scope of this workshop. I will, however, provide a few examples of using model scenarios to develop TMDLs. The first is for lake TMDLs.



In Minnesota, we frequently use Bathtub for lake TMDL development. The Bathtub model relates P inputs to the in-lake P concentration. In a model scenario, we alter the P inputs and look at the effect on the lake P concentration. Note that the inputs are often developed from other models. For example, HSPF can provide P watershed loads to a lake.

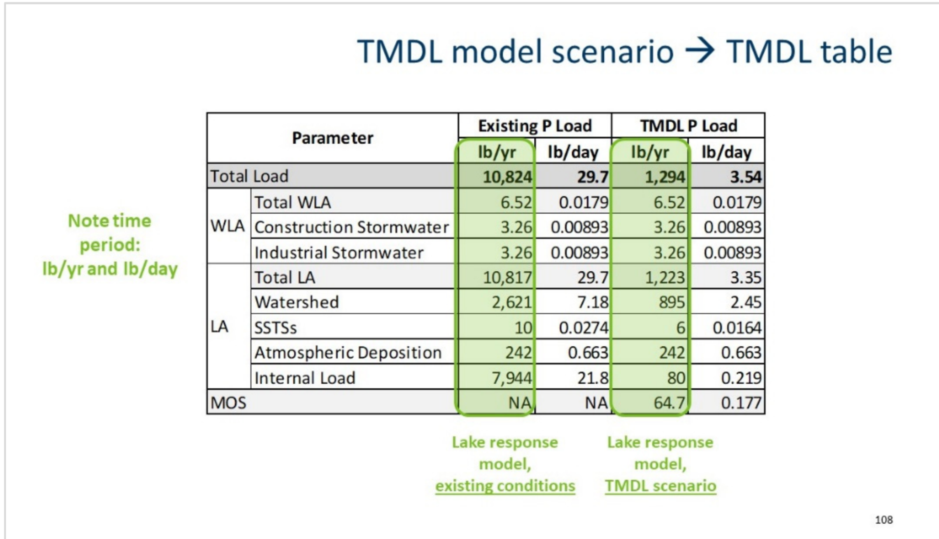


For a lake TMDL, we reduce the P inputs to the lake in the model scenario until the lake standard is met. Once we have a scenario where the lake standard is met, it is the sum of all of these loads to the lake in the TMDL scenario that is the P loading capacity of the lake.



The model scenario then gets translated into a TMDL table. We often include the existing P loads in the TMDL table, to show the level of load reductions that are needed to meet the TMDL. The existing loads in the TMDL table are from the existing conditions Bathtub model, and the TMDL loads in the table are from the TMDL model scenario.

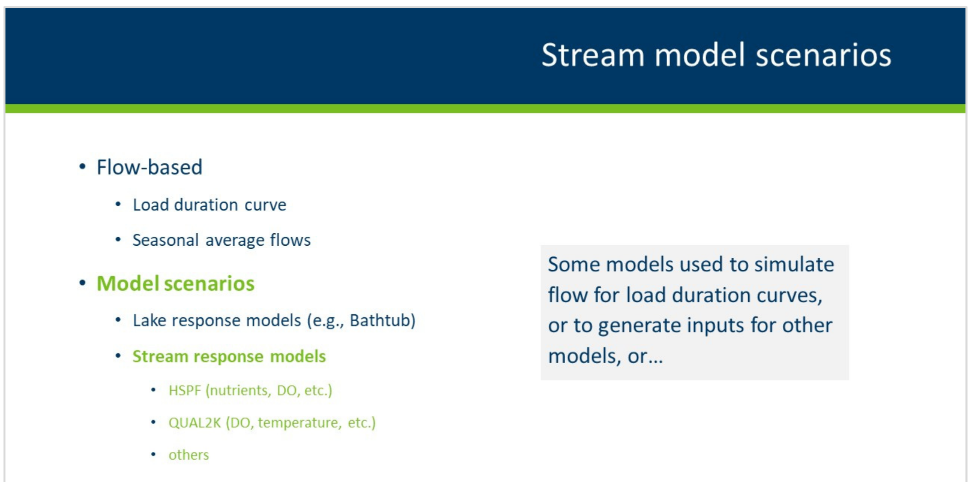
We also need to show the daily allocated loads, because that is what EPA approves. It's best to include all of this information in the same table—it streamlines the information and it makes it easier for you when you input it into Tempo.



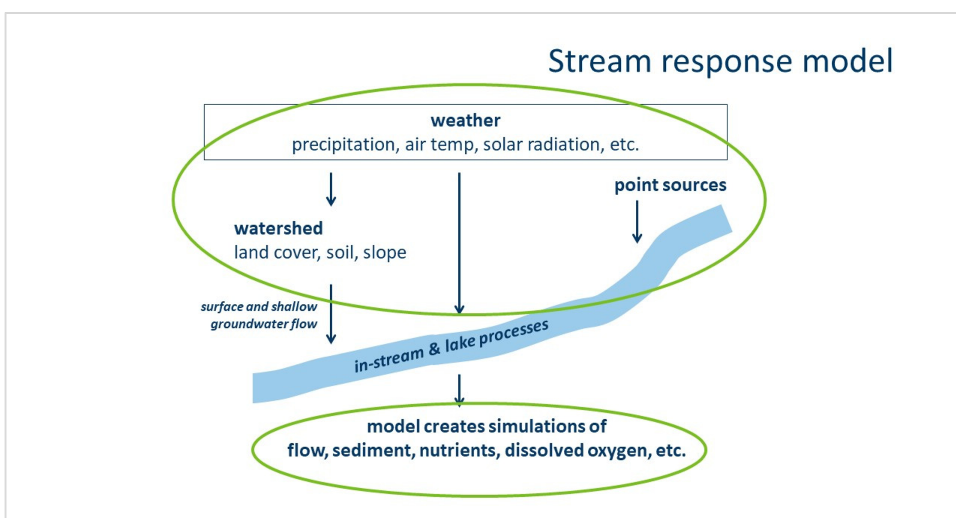
Parameter		Existing P Load lb/yr	Existing P Load lb/day	TMDL P Load lb/yr	TMDL P Load lb/day
Total Load		**10,824**	**29.7**	**1,294**	**3.54**
WLA	Total WLA	6.52	0.0179	6.52	0.0179
	Construction Stormwater	3.26	0.00893	3.26	0.00893
	Industrial Stormwater	3.26	0.00893	3.26	0.00893
LA	Total LA	10,817	29.7	1,223	3.35
	Watershed	2,621	7.18	895	2.45
	SSTSs	10	0.0274	6	0.0164
	Atmospheric Deposition	242	0.663	242	0.663
	Internal Load	7,944	21.8	80	0.219
MOS		NA	NA	64.7	0.177

There are many types of models that can be used to develop scenarios for stream TMDLs. Note that, although HSPF is in this list for model scenarios, it's more commonly used for LDCs and source assessment in Minnesota.

A model can be used with different types of approaches. Saying that you "used HSPF" to develop a TMDL doesn't say much about how you used it. Was it used to simulate flow for LDC development? Did you use the existing conditions model to quantify loads by subwatershed or by source? And did you take it a step further and use it to develop a TMDL scenario or an implementation scenario for the WRAPS?

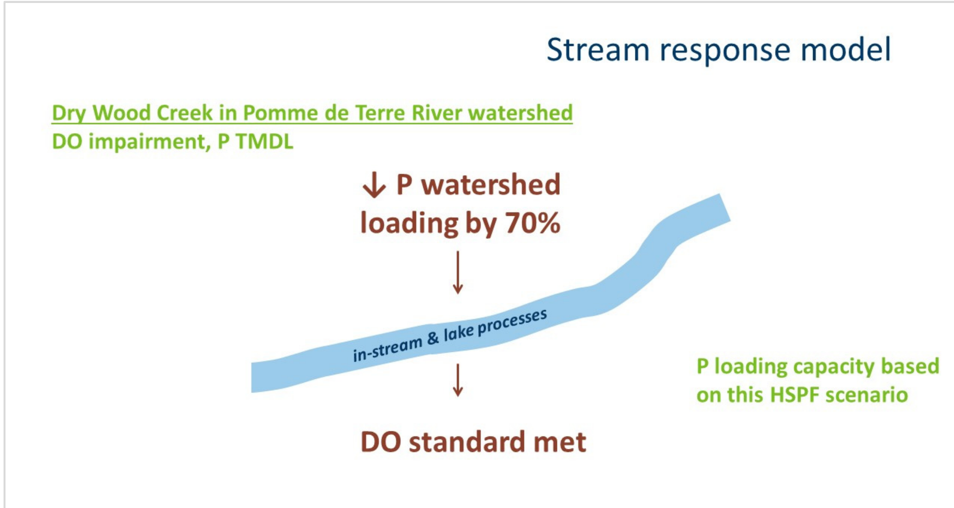


Let's look at the stream response model diagram again. The concept is the same as with the lake model scenario, although the inputs and the outputs might be more complicated (that is, more outputs and on a shorter time scale). You take the calibrated existing conditions model and vary the inputs until the outputs show that the stream meets the standard. The varying inputs could be land use changes, point source

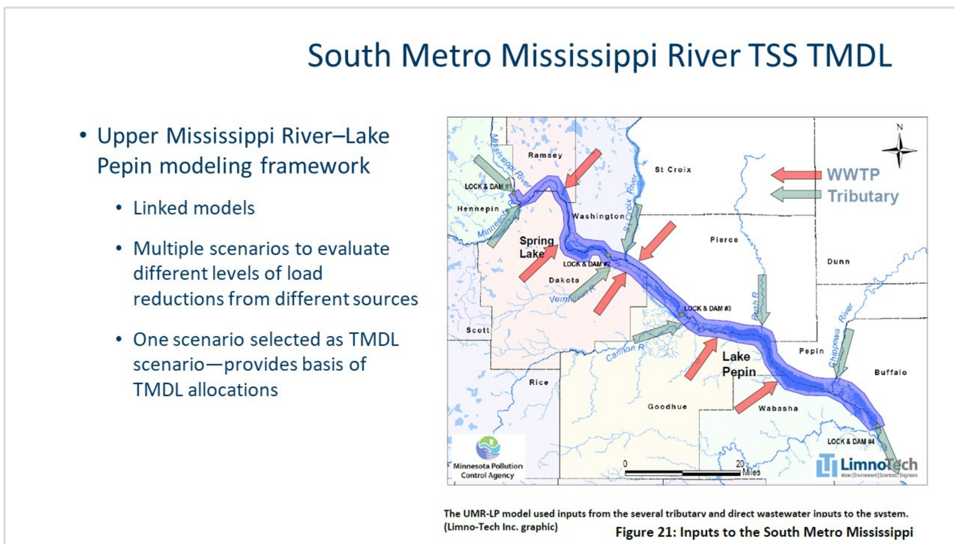


reductions, alterations to weather, or addition of BMPs. Once you have the scenario where the water body meets the standard, whether it's TSS or phosphorus or dissolved oxygen, that TMDL model scenario is then used to build the TMDL table.

One example where the HSPF model was used to develop a TMDL in Minnesota is in the Pomme de Terre River watershed. The stream has a DO impairment, and a P TMDL was developed to address the DO impairment. Using an HSPF model scenario, P loads in the watershed were reduced, and the effect on DO daily minimum concentrations was evaluated. When P loading in the watershed was reduced by 70%, the simulated DO concentrations in the impaired stream met the DO standard. The P loading capacity was then based on this HSPF scenario.



Here's another example of where a model scenario was used to develop a TMDL—this is from the South Metro Mississippi River TSS TMDL. A set of linked models were developed for the TMDL, and multiple scenarios were developed to evaluate different levels of load reductions from different sources. One scenario was selected as the TMDL scenario, and this scenario provides the basis of the TMDL allocations.



Another example is Wyman Creek, which is a cold-water stream in the St. Louis River watershed. For the temperature TMDL, a QUAL2K model was developed to simulate hourly temperature and DO over a 24-hour period. The critical conditions in this case were low flow, warm conditions, so monitoring data from a low flow period in late summer were used for model development.

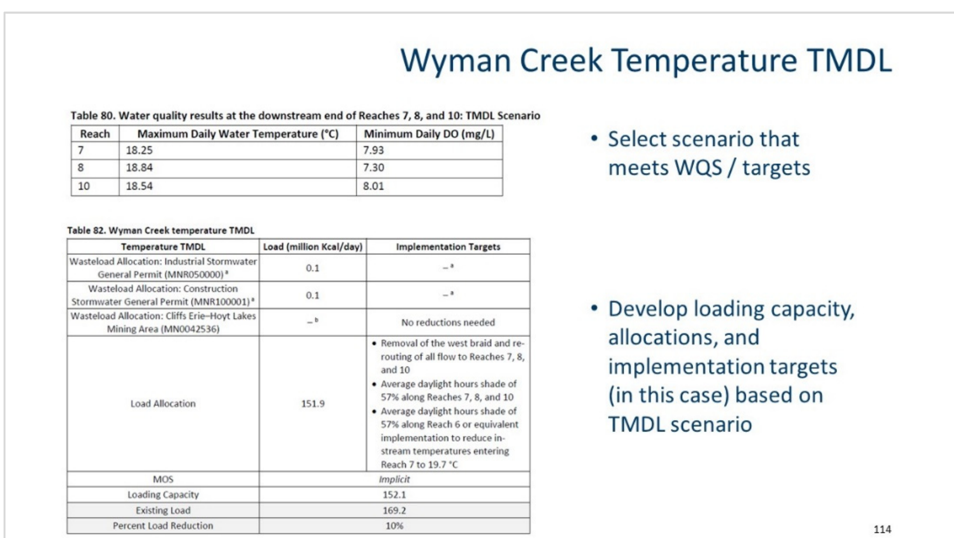


Table 80. Water quality results at the downstream end of Reaches 7, 8, and 10: TMDL Scenario

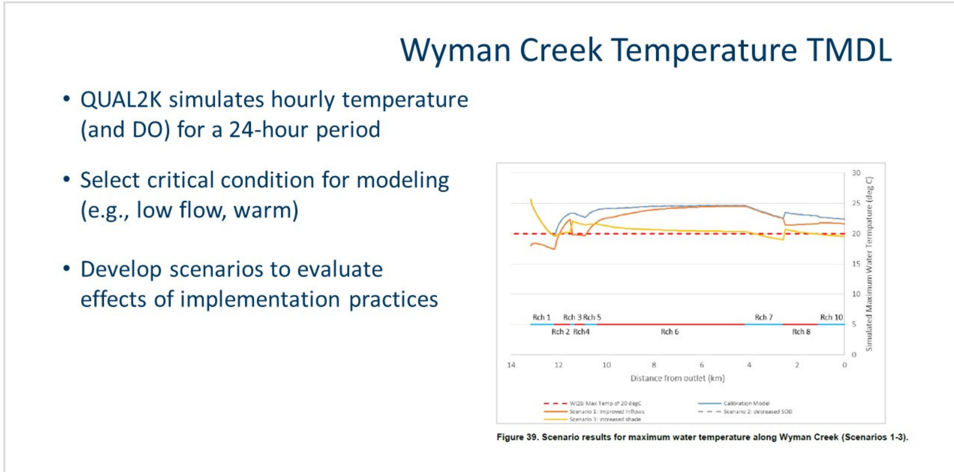
Reach	Maximum Daily Water Temperature (°C)	Minimum Daily DO (mg/L)
7	18.25	7.93
8	18.84	7.30
10	18.54	8.01

Table 82. Wyman Creek temperature TMDL

Temperature TMDL	Load (million Kcal/day)	Implementation Targets
Wasteload Allocation: Industrial Stormwater General Permit (MNR050000)[a]	0.1	–[a]
Wasteload Allocation: Construction Stormwater General Permit (MNR100001)[a]	0.1	–[a]
Wasteload Allocation: Cliffs Erie–Hoyt Lakes Mining Area (MN0042536)	–[b]	No reductions needed
Load Allocation	151.9	• Removal of the west braid and re-routing of all flow to Reaches 7, 8, and 10 • Average daylight hours shade of 57% along Reaches 7, 8, and 10 • Average daylight hours shade of 57% along Reach 6 or equivalent implementation to reduce in-stream temperatures entering Reach 7 to 19.7 °C
MOS	*Implicit*	
Loading Capacity	152.1	
Existing Load	169.2	
Percent Load Reduction	10%	

Implementation options were explored through model scenarios, and one scenario was selected to represent the TMDL.

The selected Wyman Creek model scenario indicates that the temperature and DO targets would be met in the stream. The TMDL table is somewhat unique in that implementation activities are included directly in the TMDL table to represent the TMDL model scenario. This is just to show that implementation scenarios can be used in different ways in a TMDL.



Section Summary

Understand the approach that was used to develop the TMDL(s).

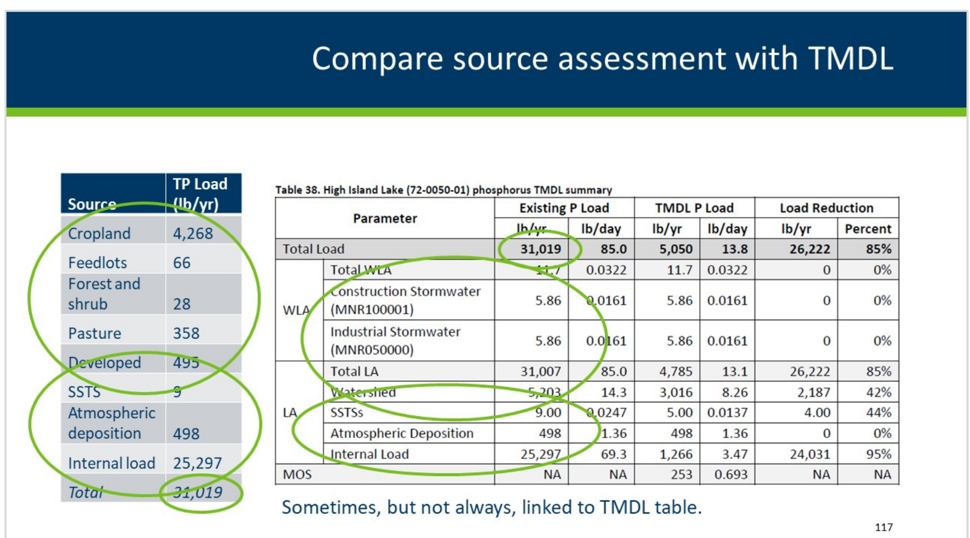
Other

There are a few other items that I wanted to mention, although they are not directly related to TMDL approaches.

Compare source assessment to TMDL

You want to make sure that the different parts of the TMDL report build upon one another and are consistent with one another. One primary way to do this is to compare the source assessment to the TMDL.

This is typically easier to do with lake TMDLs, because we often have existing loads in lake TMDL tables. If there is a separate source assessment section where loads are reported, make sure that the loads in the source assessment are consistent with the loads in the TMDL table. In this example, the table on the left is from the source assessment section of a lake TMDL—the watershed runoff loads are provided by land cover type, and then loads are also provided for septics, atmospheric deposition, and internal load. In the TMDL table on the right, the existing loads aren't reported using the same source categories, but the values are consistent: the total loads are the same, and the loads for these three sources are also the same. If you were to add up the watershed runoff loads in the source assessment table and in the TMDL table (i.e., CSW, ISW, and watershed runoff), the values would be the same.

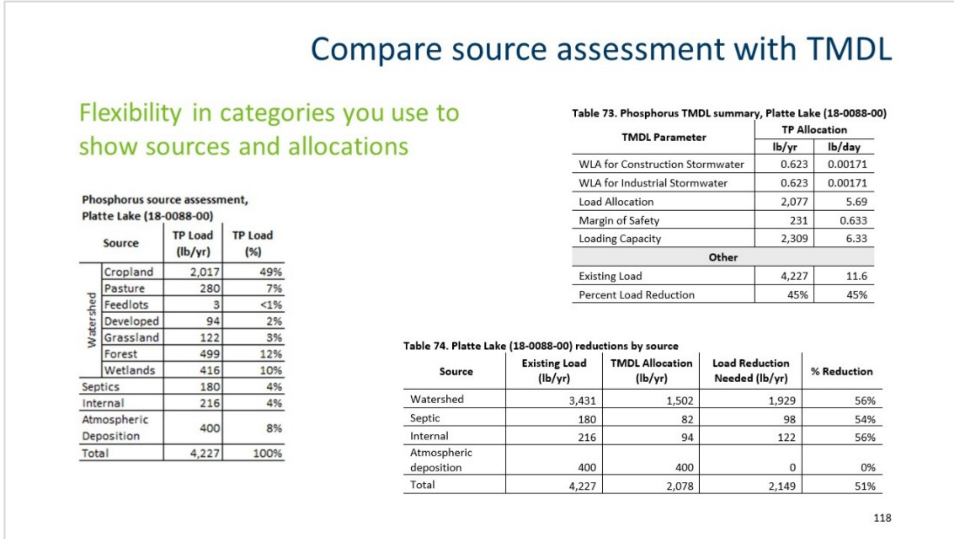


Source	TP Load (lb/yr)
Cropland	4,268
Feedlots	66
Forest and shrub	28
Pasture	358
Developed	495
SSTS	9
Atmospheric deposition	498
Internal load	25,297
Total	*31,019*

Table 38. High Island Lake (72-0050-01) phosphorus TMDL summary

Parameter		Existing P Load		TMDL P Load		Load Reduction	
		lb/yr	lb/day	lb/yr	lb/day	lb/yr	Percent
Total Load		**31,019**	**85.0**	**5,050**	**13.8**	**26,222**	**85%**
WLA	Total WLA	11.7	0.0322	11.7	0.0322	0	0%
	Construction Stormwater (MNR100001)	5.86	0.0161	5.86	0.0161	0	0%
	Industrial Stormwater (MNR050000)	5.86	0.0161	5.86	0.0161	0	0%
LA	Total LA	31,007	85.0	4,785	13.1	26,222	85%
	Watershed	5,203	14.3	3,016	8.26	2,187	42%
	SSTSs	9.00	0.0247	5.00	0.0137	4.00	44%
	Atmospheric Deposition	498	1.36	498	1.36	0	0%
	Internal Load	25,297	69.3	1,266	3.47	24,031	95%
MOS		NA	NA	253	0.693	NA	NA

There are other ways to link the source assessment with the TMDL. For this lake TMDL, the table on the left is the source assessment, and is similar to the one that we just looked at, with different land cover categories for watershed runoff and a few additional source types. The TMDL table, on the top right, only shows the TMDL allocated loads, it doesn't show the existing loads. An additional table was added to the report, on the bottom right, that shows existing loads, allocated loads, and the load reductions needed by source category. The source types are similar to the source assessment table, although all of the watershed runoff is in one category. And note that the table does not separate out CSW and ISW the way the TMDL table has to. This approach provides load reductions in a way that is meaningful to watershed managers. Sometimes a lake TMDL table can get crowded with point sources that need to be broken out for the EPA, but that aren't really important from an overall loading and implementation perspective. The summary table on the bottom right restates the information in a useful manner, and in a way that is consistent with the other tables. For purposes of reviewing TMDLs, once you've established that the information is presented in a useful way to your audience, make sure that the actual numbers in the different tables are consistent with one another.



Phosphorus source assessment, Platte Lake (18-0088-00)

Source		TP Load (lb/yr)	TP Load (%)
Watershed	Cropland	2,017	49%
	Pasture	280	7%
	Feedlots	3	<1%
	Developed	94	2%
	Grassland	122	3%
	Forest	499	12%
	Wetlands	416	10%
Septics		180	4%
Internal		216	4%
Atmospheric Deposition		400	8%
Total		4,227	100%

Table 73. Phosphorus TMDL summary, Platte Lake (18-0088-00)

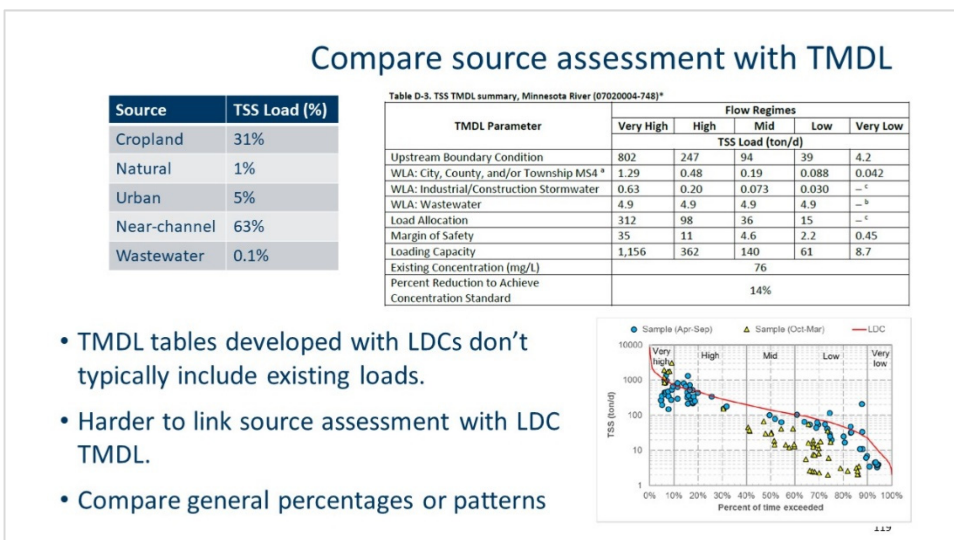
TMDL Parameter	TP Allocation	
	lb/yr	lb/day
WLA for Construction Stormwater	0.623	0.00171
WLA for Industrial Stormwater	0.623	0.00171
Load Allocation	2,077	5.69
Margin of Safety	231	0.633
Loading Capacity	2,309	6.33
Other		
Existing Load	4,227	11.6
Percent Load Reduction	45%	45%

Table 74. Platte Lake (18-0088-00) reductions by source

Source	Existing Load (lb/yr)	TMDL Allocation (lb/yr)	Load Reduction Needed (lb/yr)	% Reduction
Watershed	3,431	1,502	1,929	56%
Septic	180	82	98	54%
Internal	216	94	122	56%
Atmospheric deposition	400	400	0	0%
Total	4,227	2,078	2,149	51%

[TMDL allocation (2,078 lb/yr) is equal to the loading capacity (2,309 lb/yr) minus the MOS (321 lb/yr)—values from Table 73. The overall percent reduction (51%) takes into account the MOS, and therefore is greater than the percent reduction presented in the TMDL table (45%).]

Linking the source assessment with the TMDL is usually harder for TMDLs developed with LDCs, because the TMDL tables don't typically include existing loads by source and by flow zone. But you can still compare the two sections to make sure that they are consistent. In this example, the table on the left shows the TSS source summary, with the majority of the load coming from cropland and near-channel sources. Both of these sources are unpermitted and therefore part of the LA in the TMDL table. In the TMDL table, after you set aside the upstream boundary condition, the majority of the loading capacity is allocated to the LA. While this doesn't necessarily mean that the allocations were done correctly, at least it does not raise a red flag.



Source	TSS Load (%)
Cropland	31%
Natural	1%
Urban	5%
Near-channel	63%
Wastewater	0.1%

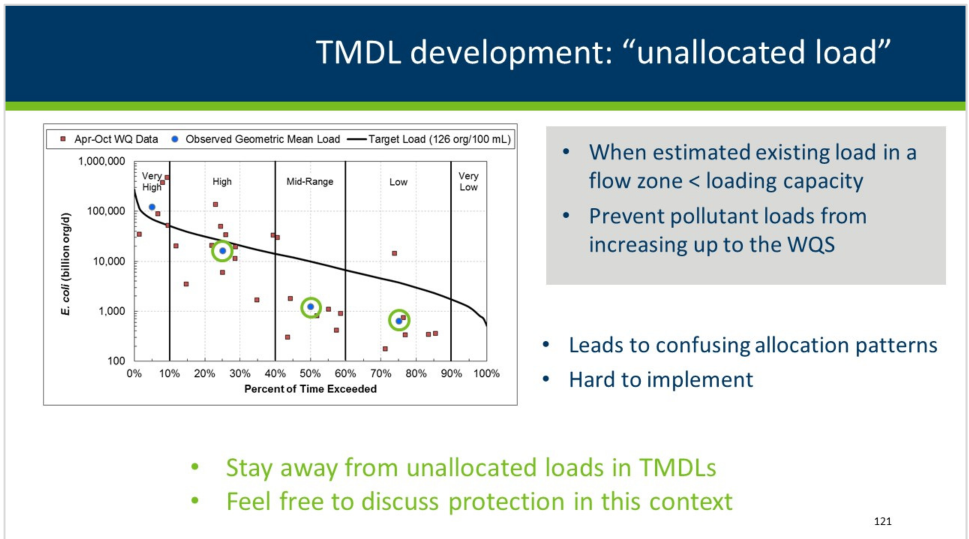
Table D-3. TSS TMDL summary, Minnesota River (07020004-748)*

TMDL Parameter	Flow Regimes				
	Very High	High	Mid	Low	Very Low
	TSS Load (ton/d)				
Upstream Boundary Condition	802	247	94	39	4.2
WLA: City, County, and/or Township MS4 [a]	1.29	0.48	0.19	0.088	0.042
WLA: Industrial/Construction Stormwater	0.63	0.20	0.073	0.030	– [c]
WLA: Wastewater	4.9	4.9	4.9	4.9	– [b]
Load Allocation	312	98	36	15	– [c]
Margin of Safety	35	11	4.6	2.2	0.45
Loading Capacity	1,156	362	140	61	8.7
Existing Concentration (mg/L)	76				
Percent Reduction to Achieve Concentration Standard	14%				

Section Summary

Compare the source assessment to the TMDL table to check if they are consistent.

TMDL development: "unallocated load"



Sometimes in a stream TMDL, there are flow zones where the WQS is being met. In this example, the load duration curve shows that the average existing load in the middle three flow zones is less than the loading capacity. A TMDL sets the loading capacity in each flow zone and would essentially "allow" an increase in loading, because the existing load in the water body is less than the loading capacity.

However, we don't want to allow pollution to increase up to the WQS. The concept of unallocated load was to align TMDLs with the protection part of the MPCA's Watershed Approach. This concept has been used in some TMDLs and it has caused some confusion because of challenges in implementing the approach. We recommend not using this concept directly in TMDLs. However, the concept is a good one—you can include the concept in text of the report. Pollutant sources should not be allowed to "load up to" the standard, but it's best to not incorporate an unallocated load in TMDLs.

Section Summary

- **Don't use "unallocated loads" in TMDLs**
- **Do discuss protection in TMDL reports**

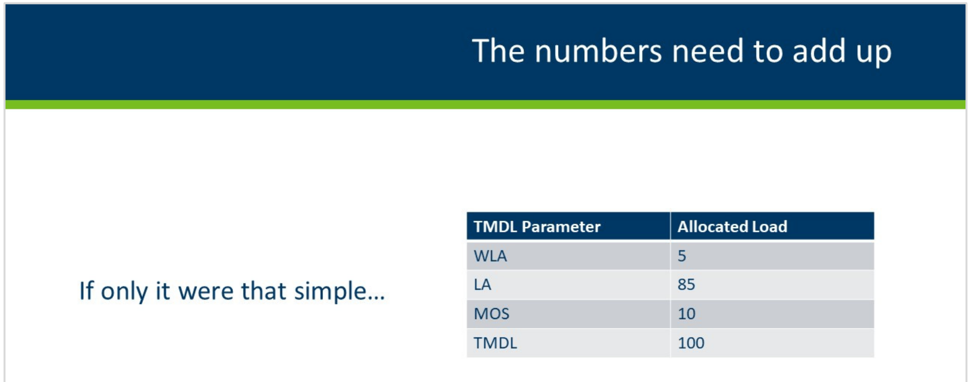
Part 3: Checking the math and putting it all together

Checking the math

Now we're going to focus in on the numbers in the TMDL tables. Now that we understand all of the parts of the TMDL, and we more or less understand the approach that was taken, we need to make sure that the numbers in the table all add up.

The numbers need to add up

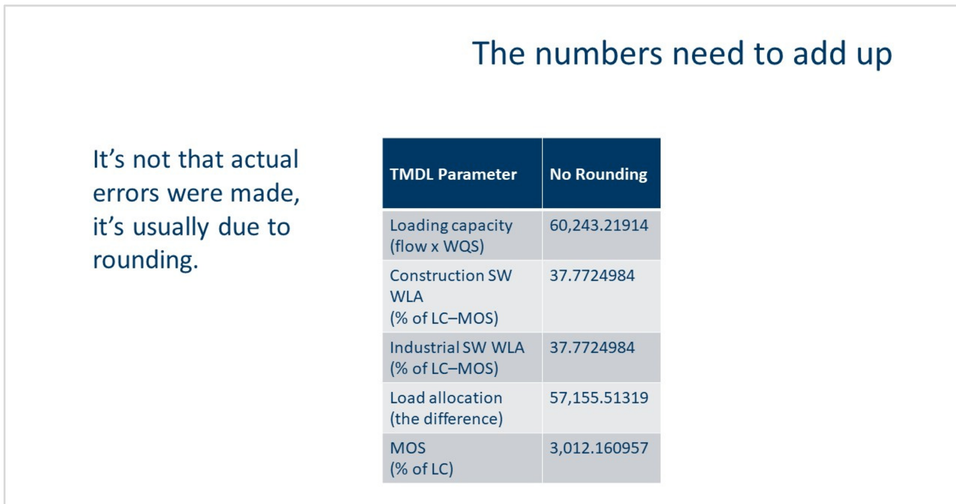
At its most basic, the sum of all of the allocations, including the MOS, need to equal the TMDL, or the loading capacity, in the TMDL table. Although this may seem simple and straightforward, there are often mistakes in TMDL tables. Sometimes it's an actual error where the wrong number was entered, but sometimes it's just that the numbers don't *exactly* add up.



TMDL Parameter	Allocated Load
WLA	5
LA	85
MOS	10
TMDL	100

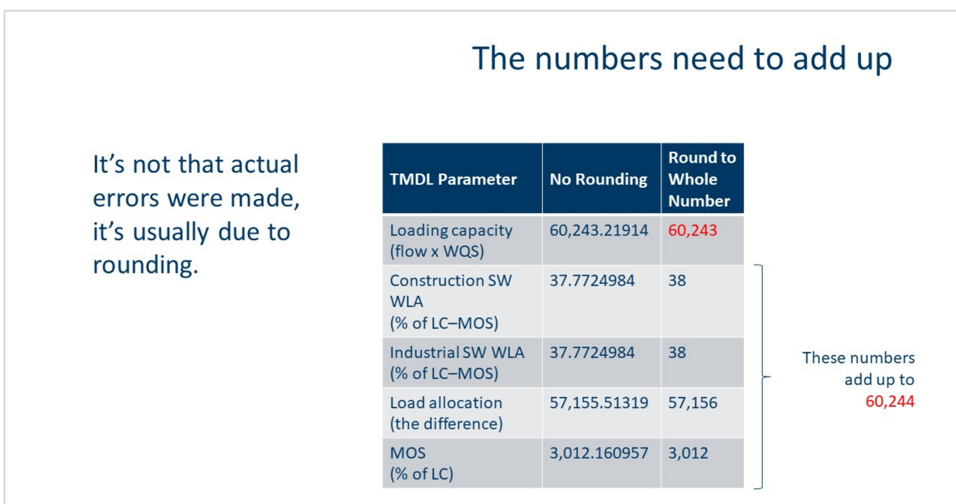
The loading capacity is often calculated using formulas that are linked to other cells in Excel. Then the allocations are often calculated based on an equation that uses the loading capacity. The point is that these equations are interrelated, and the values need to be cleaned up in the end. What happens is that, after you round, the allocations don't always exactly add up to the loading capacity, so you have to make adjustments.

For example, in the "no rounding" column of this table, these are the initial values that were calculated with the equations.



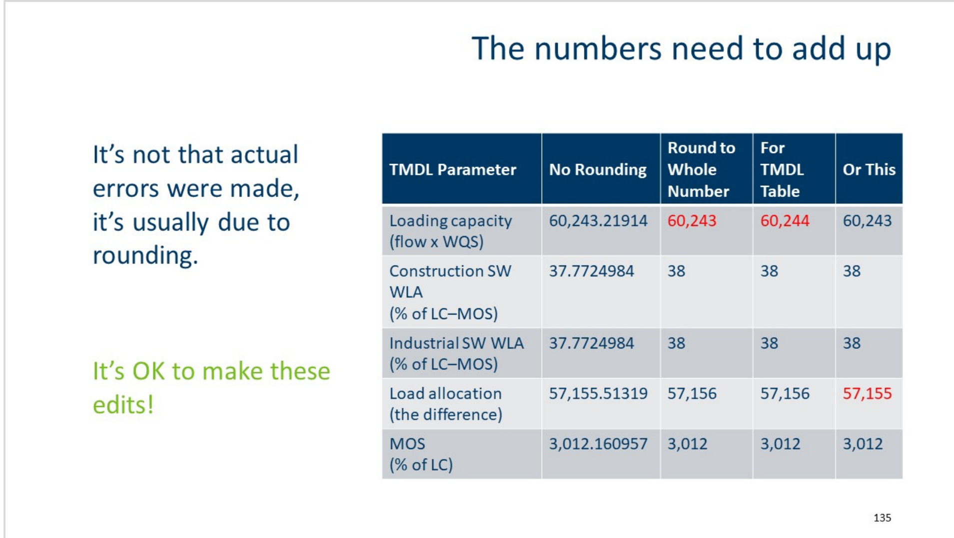
TMDL Parameter	No Rounding
Loading capacity (flow x WQS)	60,243.21914
Construction SW WLA (% of LC–MOS)	37.7724984
Industrial SW WLA (% of LC–MOS)	37.7724984
Load allocation (the difference)	57,155.51319
MOS (% of LC)	3,012.160957

In the next column, we've rounded to whole numbers. But then see what happened—if you add up all of the individual allocations and MOS, it comes to 60,244, but the table says 60,243. So we need to fix that—and this is okay to do!



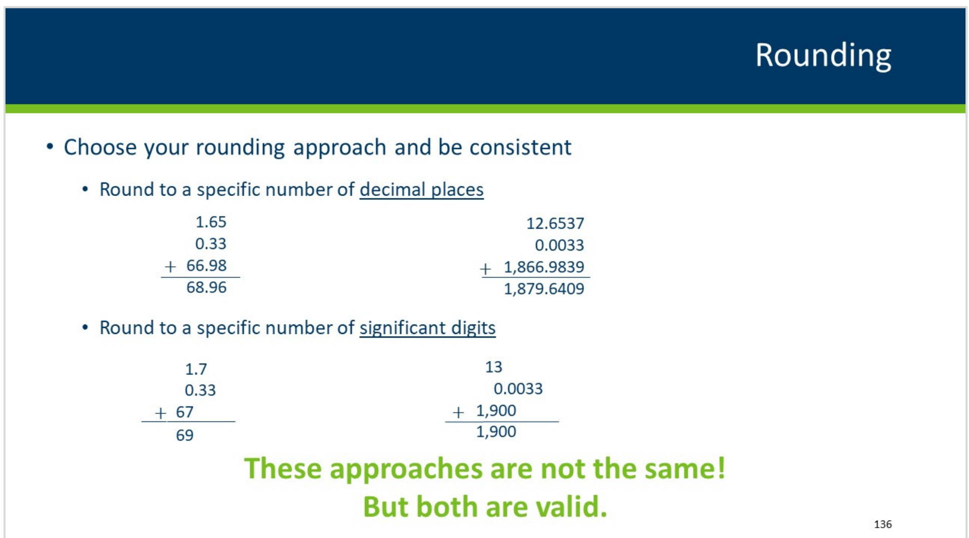
TMDL Parameter	No Rounding	Round to Whole Number
Loading capacity (flow x WQS)	60,243.21914	60,243
Construction SW WLA (% of LC–MOS)	37.7724984	38
Industrial SW WLA (% of LC–MOS)	37.7724984	38
Load allocation (the difference)	57,155.51319	57,156
MOS (% of LC)	3,012.160957	3,012

We need to either increase the LC by one or reduce one of the allocations by one. I usually adjust the loading capacity or the LA, as long as it's a relatively large number; therefore the adjustment will be a negligible percent change. It's best not to adjust the WLA, because of the permit implications and because it's usually a smaller number and therefore the adjustment would be a larger percent change of the WLA itself.



Rounding

When you're checking a TMDL table, first you need to understand how the values were rounded—was it arbitrary, or was there a method? You want the rounding approach to be consistent throughout the table. There are many ways to round, and I'm not going to dictate a formula about how you should do it. But it should be consistent.



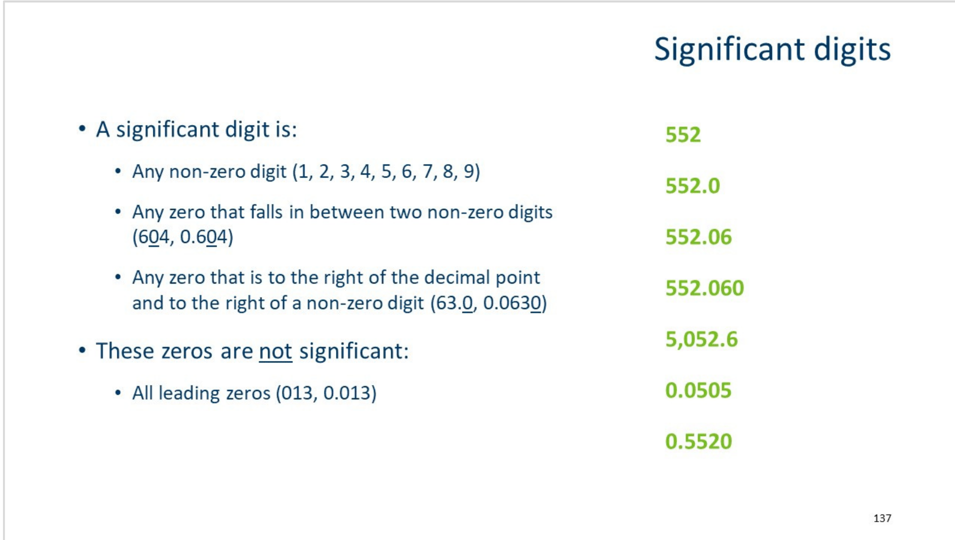
A little background information on rounding: There are two basic ways of rounding numbers consistently. You can round to a specific number of decimal places, or you can round to a specific number of significant digits. Many people use the "decimal place" approach because it is the most simple. In the first example we rounded to two decimal places.

But what if your allocations had values with a much wider range, like the example on the right? Because of the one really small value (0.0033), you'd have to extend all of the other allocations out to 4 decimal places in order to be consistent. But with the other values, using that many decimal places makes it look like we can be really precise with our estimate, that we know that the value is exactly 1,879.6409. I don't think that we should be giving that impression. This is why I like rounding to a consistent number of significant digits instead of a consistent number of decimal places.

Basically, a significant digit is a non-zero number. In this example the values are rounded to two significant digits. This approach provides the greater level of precision that we need with the smaller value, yet the precision isn't over-stated with the larger numbers. The same goes with the second example on the right, where each of these numbers has two significant digits.

If you do chose to round to a specific number of significant digits, here's a little more information on them. The most simple definition is any non-zero digit. But, a zero is a significant digit if it falls in between two non-zero digits. A zero is also a significant digit if it is to the right of the decimal point AND to the right of a non-zero digit. All leading zeros are not significant.

How many significant digits are in these numbers? (answers: 3, 4, 5, 6, 5, 3, 4)

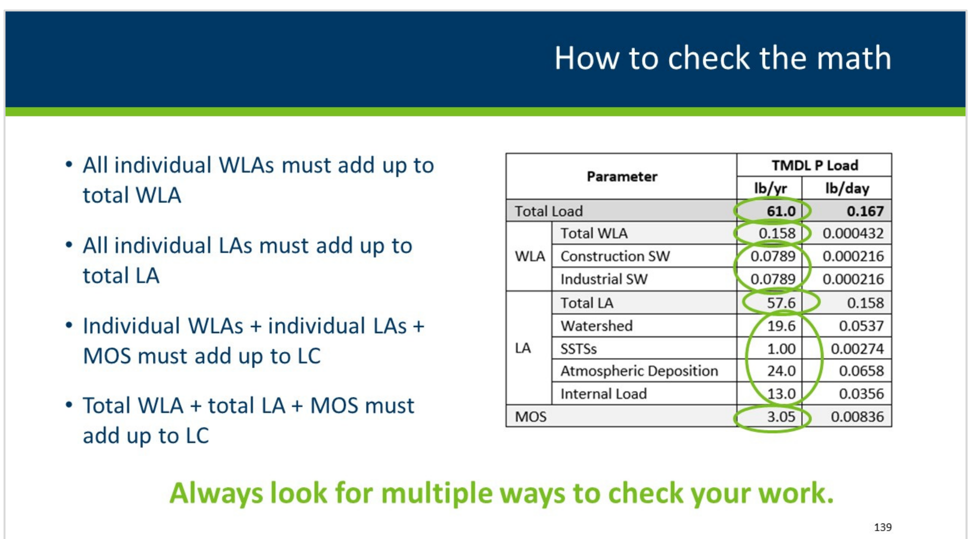


Section Summary

- **Choose your rounding approach and be consistent**
  - **Consistent number of decimal places.**
  - **Consistent number of significant digits**

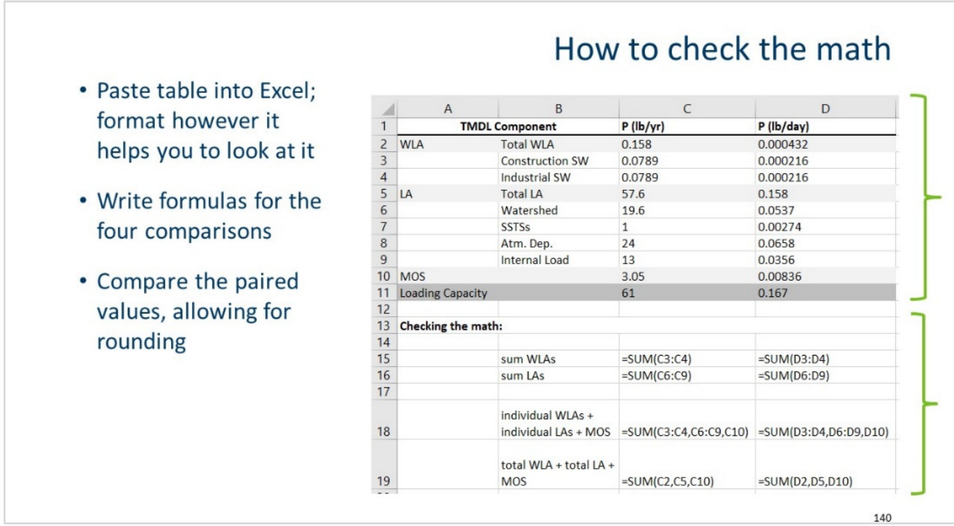
How to check the math

Getting back to checking the math. After you're happy with the rounding approach in your TMDL table, here are the specifics of how to check the math. All of the individual WLAs must add up to the total WLA, and all of the individual LAs must add up to the total LA. Then we check the loading capacity in two different ways. The individual WLAs plus the individual LAs plus the MOS must add up to the loading capacity, and the total WLA plus the total LA plus the MOS must also add up to the loading capacity. This might feel redundant, but it's a way to double check your work and sometimes you find errors looking at it this way. In general, always look for multiple ways to check your work.



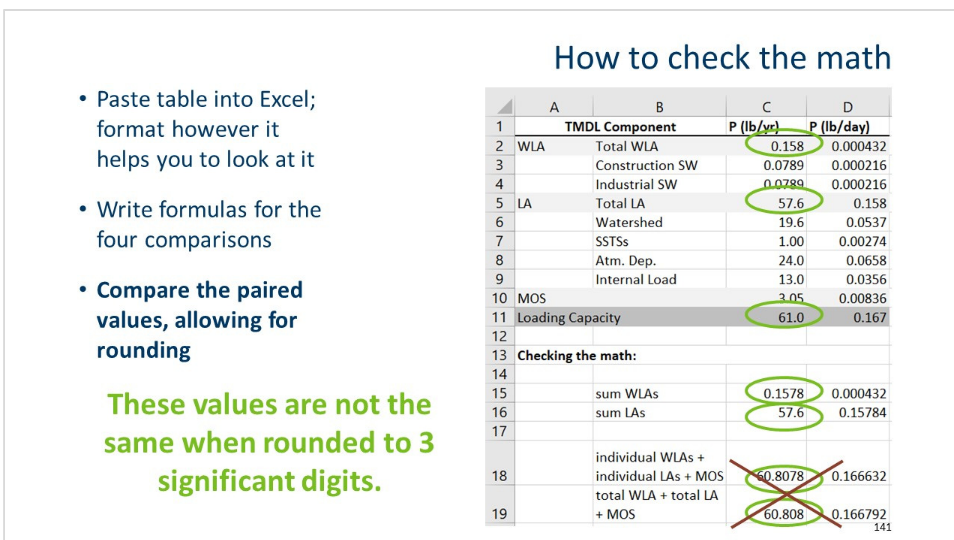
Parameter		TMDL P Load	
		lb/yr	lb/day
Total Load		**61.0**	**0.167**
WLA	Total WLA	0.158	0.000432
	Construction SW	0.0789	0.000216
	Industrial SW	0.0789	0.000216
LA	Total LA	57.6	0.158
	Watershed	19.6	0.0537
	SSTSs	1.00	0.00274
	Atmospheric Deposition	24.0	0.0658
	Internal Load	13.0	0.0356
MOS		3.05	0.00836

What's the best way to check the math? A good approach is to copy the table from Word and paste it into Excel. If the TMDL writer provides the tables to you directly in Excel, you need to be careful about how the values are being displayed. In Excel, even if you're only **showing** two decimal places, additional decimal places could still be there in the background and therefore would still get added up if you use formulas in Excel to check them. This is one of the main causes of numbers not adding up. So you need to recreate the table in Excel by copying it from the Word document back into Excel to check math.



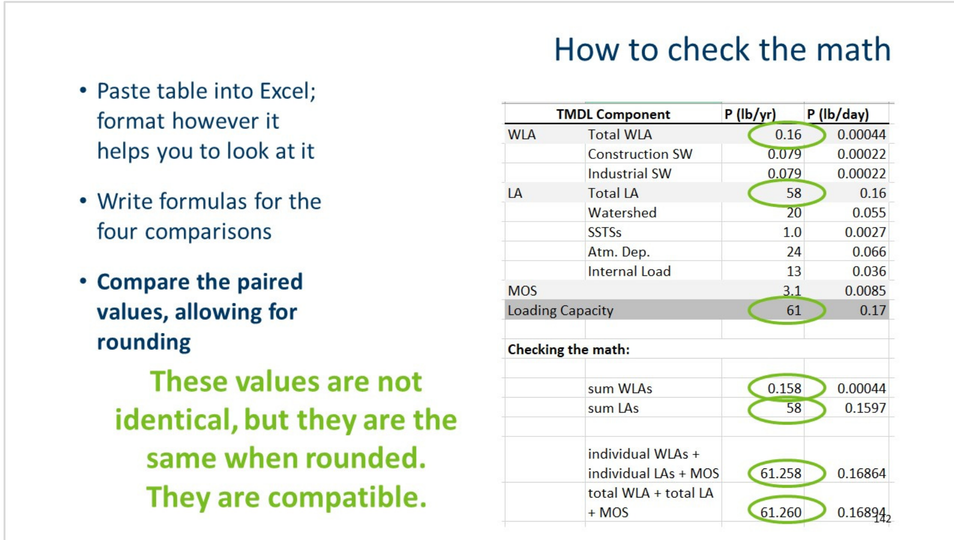
After you've copied the table into Excel, write formulas for the four comparisons that were listed on the previous slide—I've provided examples here.

Then you can compare all of the paired values. First, the sum of the individual WLAs add up to the total WLA in the table. Notice how the total WLA in the table was rounded to 0.158, and the sum of the individual WLAs comes to 0.1578. To see if these values are compatible, round the second value. 0.1578 rounded equals 0.158, which is what is in the TMDL table. Therefore, these values are compatible with one another and this passes the "checking the math" test. Now check the sum of the LAs; these values are exactly the same.



Now look at the next two sums. If we round the sums to three significant digits, we get 60.8, which is not equal to 61.0—in this case the sums are *not* compatible. What should you do in this case? Usually the easiest way to resolve this is to decrease the number of significant digits to two. You can do that for all of the numbers, or you can do it just for the loading capacity—in this case the LC would be rounded to 61 and the comparison would be equal, because the summed values on the bottom are 61 when rounded to two significant digits.

Here's what the entire table would look like if rounded to two significant digits instead of three. Going through all of the comparisons, note that they are all compatible, even the ones that didn't work out with three significant digits. Now the math of this table is correct.



If there are multiple sets of allocations in a TMDL table with different units, make sure that you do the same checks for the other set. Just because one set looks correct, it doesn't necessarily mean that the second set will be correct.

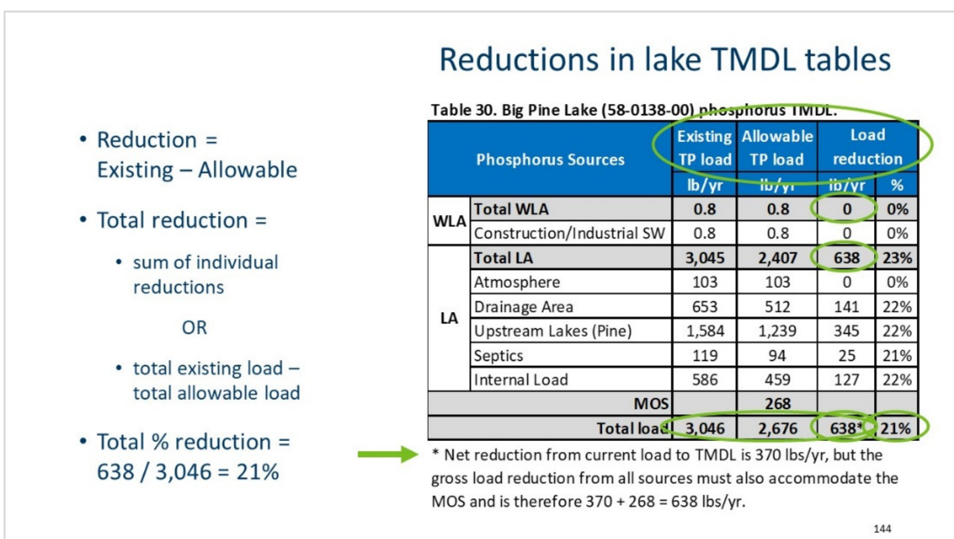
However you round the numbers, it's a good idea to explain the rounding approach in the methods section of the report.

Section Summary

- **Paste table from Word to Excel**
- **Write formulas for comparisons**
- **Compare the paired, rounded values and check for compatibility**

Reductions in lake TMDL tables

When checking the math of lake TMDLs, there are a few extra steps, because the tables often contain existing loads and percent reductions in addition to the allowable loads. You should also check the existing loads to make sure they add up, and compare them to the source assessment to make sure that they are consistent. For the load reduction column—the individual load reductions should equal the existing minus the allowable loads. This is pretty straightforward. However, notice that there are two ways that you can calculate the total load reduction. You can sum the individual load reductions, which in this case equals 638 lb/yr. Or you can subtract the total allowable load from the total existing load, which in this case is 370 lb/yr. Why are they different?



They're different because of the MOS. To calculate the allocations, we set aside the MOS of 268 lb, which isn't allocated to any source. In effect, this means that we need to reduce the total load by an additional 268 lb in order to reach our individual loading targets. So the total load reduction could be calculated in two different ways: as either the sum of the individual load reductions (638 in this case), or as the total existing load minus the total allowable load (370 in this case). The sum of the individual load reductions is equal to the total existing load minus the total allowable load plus the MOS, so it will always be the larger of the two options. Whichever option you use, please be consistent and describe the approach used, as was done in this table footnote.

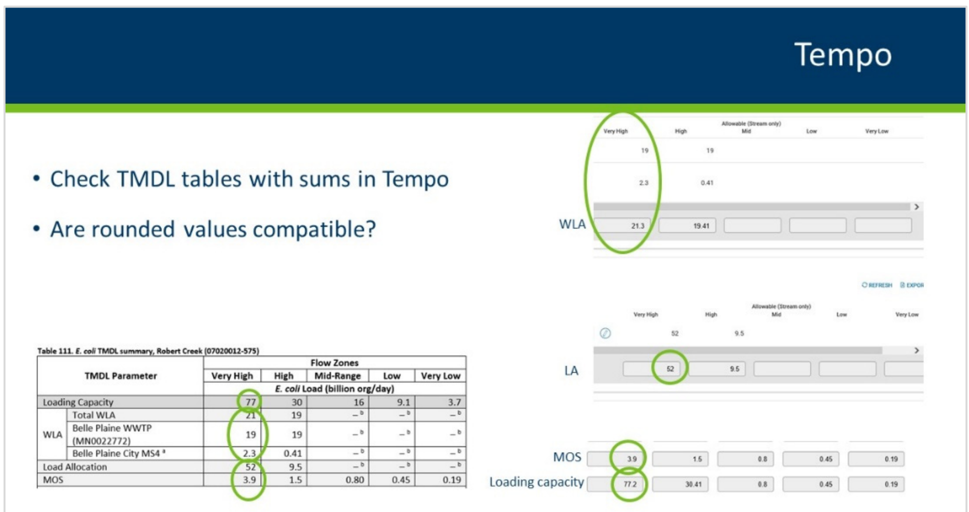
The total percent reduction should use the total load reduction that you just came up with—divide that by the total existing load.

Section Summary

- **For lake TMDLs, be aware of the approach used to calculate the total load reduction, and make sure that it is described in the report**

Tempo

How does this integrate with Tempo? You will enter the individual allocations into Tempo. You don't enter the sums, because Tempo sums them up internally.



Therefore, you also need to compare the total WLA, total LA, and loading capacity from the TMDL table to the values in Tempo and make sure they are "compatible." Again, they don't need to be exactly the same in terms of numbers of decimal places or significant digits, but if you round one, it should equal the other. If it does not, then that probably means that some of the values in the table need to be adjusted. Tempo has been a good check on the math in TMDL tables; it has found some math errors that had not been found during report review.

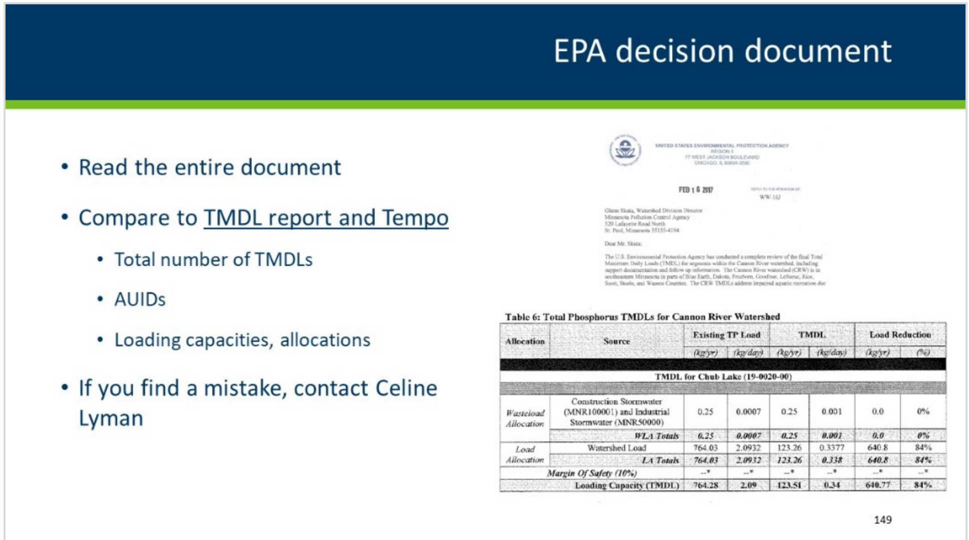
In this example, the allocations in the TMDL table were rounded to two significant digits. The individual WLAs are exactly the same in the TMDL table as they are in Tempo, because they were entered based on the TMDL table. But Tempo adds the individual values for a total WLA of 21.3, but the TMDL rounded that to 21. Because 21.3 rounded to two significant digits is 21, these values are compatible with one another. The LA and MOS are exactly the same in both places. The loading capacity is 77 in the TMDL table and 77.2 in Tempo—these values are compatible with one another and therefore OK. If the loading capacity in Tempo were a totally different number, that would be a red flag and you should check the TMDL table and the math in more detail.

Section Summary

- **Compare sums in Tempo to sums in TMDL table. Make sure that they are compatible.**

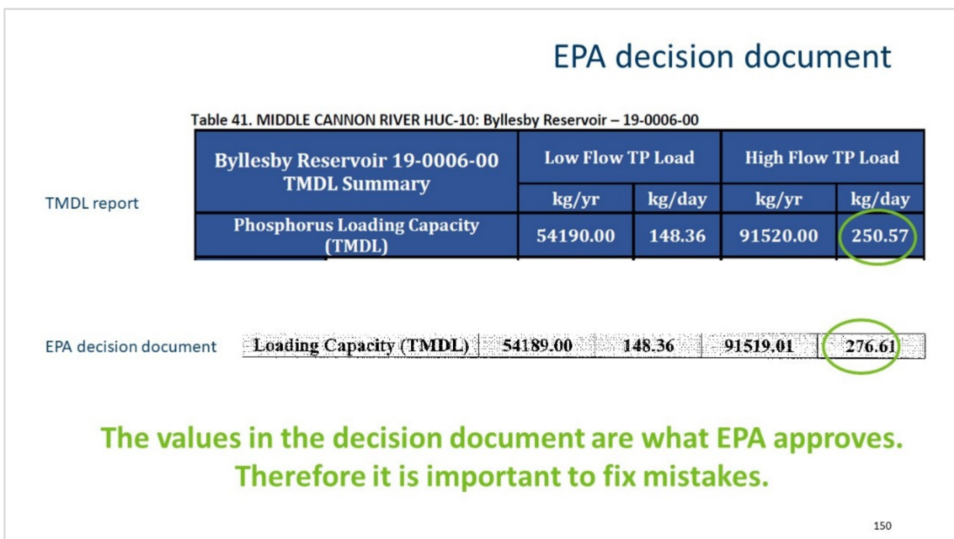
EPA decision document

When you get the decision document, you need to review it and make sure that it matches with the TMDL report and with the information that is in Tempo. Please read the entire decision document and make sure that it is consistent with the TMDL report *and* Tempo. Check the total number of TMDLs. Check each AUID to make sure that the correct AUID is associated with the correct TMDL table. And check the actual loading capacities and allocations. The EPA will take the loading capacities and allocations from the TMDL report and compile them in a different format, so they sometimes make mistakes.



If you find a mistake, please contact Celine Lyman to determine how to proceed. Celine is our primary contact with EPA Region 5 on these issues.

Here's an example of a mistake in a decision document. In the Byllesby Reservoir TMDL in the Cannon River watershed, the loading capacity in the decision document was different from the loading capacity in the TMDL table. Because the decision document states that these are the allocations that the EPA is approving, these mistakes need to be fixed.



Other examples of mistakes include the wrong AUID in the TMDL table, the wrong water body name, and incorrect allocations.

Section Summary

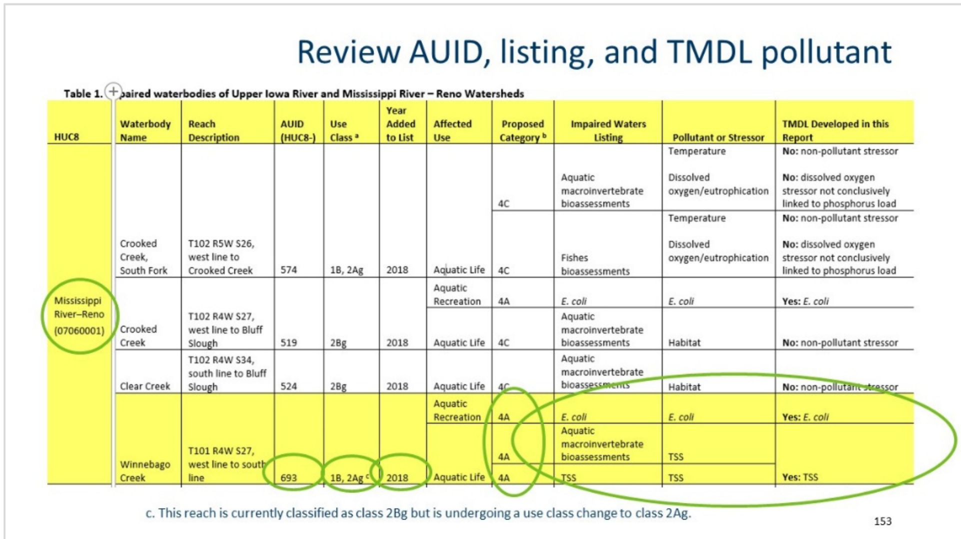
- **Read the entire decision document**
- **Compare to TMDL report and Tempo: total number of AUIDs, AUIDs, LCs, allocations**
- **Contact Celine Lyman if you find a mistake**

Putting it together

Now that we feel confident that all of our TMDL report sections are complete, we also want to make sure that they make sense with one another, that we don't have contradicting information. This is a way to really get to know your impairments.

I'll be using the Upper Iowa River and Mississippi River Reno TMDLs to show a TMDL report example. We're going to pick one of the impairments in the project and follow it through the whole report, to see if the data and our message are consistent.

First, make sure that the AUID is listed correctly in the impairment table: If only the last 3 digits of the AUID are used in the table, make sure that the HUC-8 is also clear; it should also be in the table. Also check the use class, year listed, the impairment, what the TMDL is written for, and the proposed EPA category. And for all of these, don't just check that these items are listed, but cross-check them against the 303(d) list.



Review AUID, listing, and TMDL pollutant

Table 1. [+]paired waterbodies of Upper Iowa River and Mississippi River – Reno Watersheds

HUC8	Waterbody Name	Reach Description	AUID (HUC8-)	Use Class [a]	Year Added to List	Affected Use	Proposed Category [b]	Impaired Waters Listing	Pollutant or Stressor	TMDL Developed in this Report
Mississippi River–Reno (07060001)	Crooked Creek, South Fork	T102 R5W S26, west line to Crooked Creek	574	1B, 2Ag	2018	Aquatic Life	4C	Aquatic macroinvertebrate bioassessments	Temperature Dissolved oxygen/eutrophication	**No:** non-pollutant stressor **No:** dissolved oxygen stressor not conclusively linked to phosphorus load
							4C	Fishes bioassessments	Temperature Dissolved oxygen/eutrophication	**No:** non-pollutant stressor **No:** dissolved oxygen stressor not conclusively linked to phosphorus load
	Crooked Creek	T102 R4W S27, west line to Bluff Slough	519	2Bg	2018	Aquatic Recreation	4A	*E. coli*	*E. coli*	**Yes:** *E. coli*
						Aquatic Life	4C	Aquatic macroinvertebrate bioassessments	Habitat	**No:** non-pollutant stressor
	Clear Creek	T102 R4W S34, south line to Bluff Slough	524	2Bg	2018	Aquatic Life	4C	Aquatic macroinvertebrate bioassessments	Habitat	**No:** non-pollutant stressor
	Winnebago Creek	T101 R4W S27, west line to south line	693	1B, 2Ag [c]	2018	Aquatic Recreation	4A	*E. coli*	*E. coli*	**Yes:** *E. coli*
						Aquatic Life	4A	Aquatic macroinvertebrate bioassessments	TSS	**Yes:** TSS
							4A	TSS	TSS	

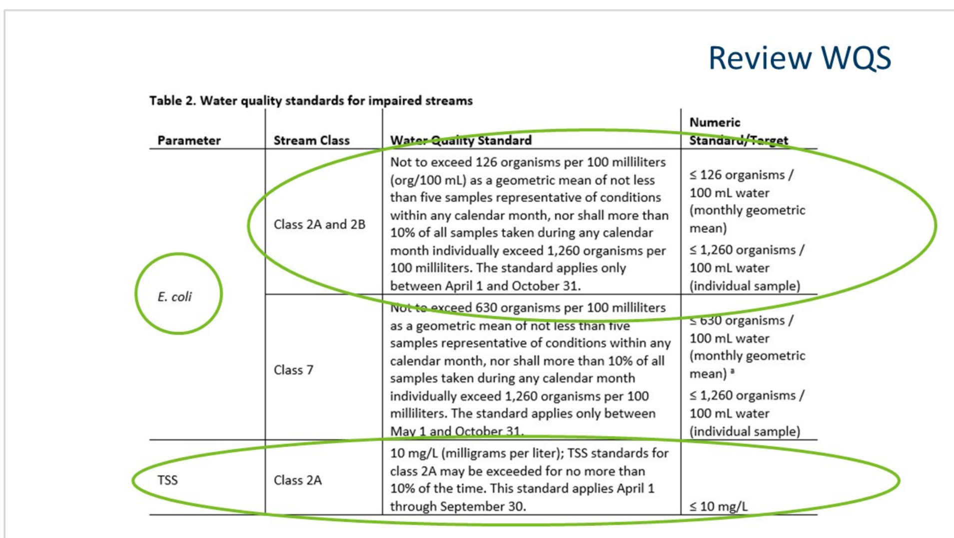
c. This reach is currently classified as class 2Bg but is undergoing a use class change to class 2Ag.

153

For this AUID, there should be an *E. coli* TMDL to address the *E. coli* impairment, and a TSS TMDL to address the macroinvertebrate and the TSS impairments. Both of these TMDLs, which address three impairments, should be in this report.

The proposed EPA categories for these three impairments are all 4A, because, after this TMDL report is approved, all three impairments will be addressed with TMDLs, and additional TMDLs are not warranted.

Next, we look at the WQS to make sure that they are clearly laid out and that it's clear which standard applies to this water body. Because Table 1 stated that this is a class 2A water, we look for the 2A standards in this table and note that the TMDLs should be based on these numeric values.

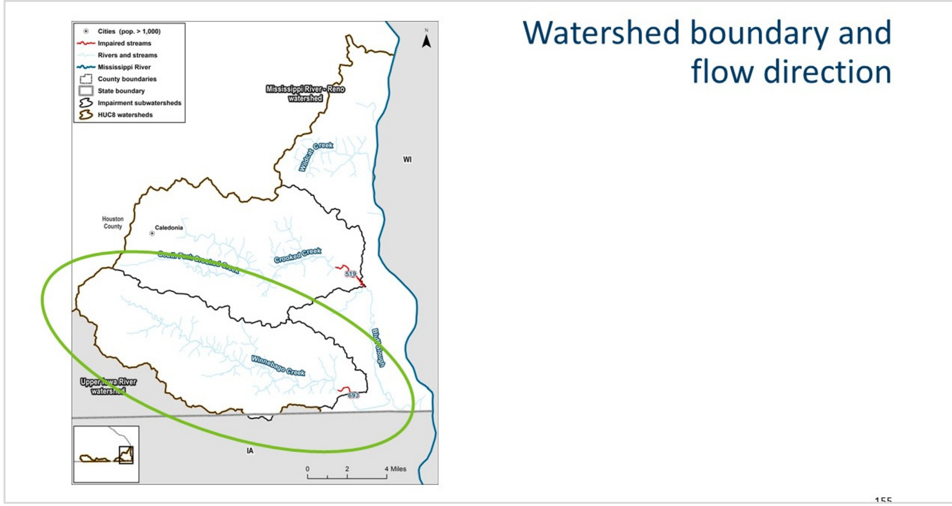


Review WQS

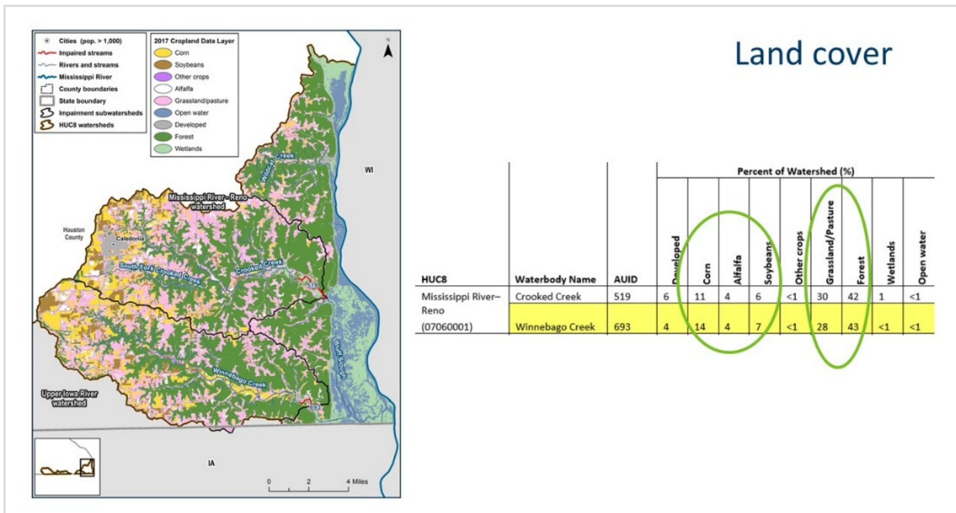
Table 2. Water quality standards for impaired streams

Parameter	Stream Class	Water Quality Standard	Numeric Standard/Target
E. coli	Class 2A and 2B	Not to exceed 126 organisms per 100 milliliters (org/100 mL) as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than 10% of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between April 1 and October 31.	≤ 126 organisms / 100 mL water (monthly geometric mean) ≤ 1,260 organisms / 100 mL water (individual sample)
	Class 7	Not to exceed 630 organisms per 100 milliliters as a geometric mean of not less than five samples representative of conditions within any calendar month, nor shall more than 10% of all samples taken during any calendar month individually exceed 1,260 organisms per 100 milliliters. The standard applies only between May 1 and October 31.	≤ 630 organisms / 100 mL water (monthly geometric mean) [a] ≤ 1,260 organisms / 100 mL water (individual sample)
TSS	Class 2A	10 mg/L (milligrams per liter); TSS standards for class 2A may be exceeded for no more than 10% of the time. This standard applies April 1 through September 30.	≤ 10 mg/L

We move on to the watershed and water body characterization section, to learn a bit more about the setting and the impairment. We see the watershed boundary and note that the impaired reach is a relatively short reach at the bottom of a larger watershed.



We see that the land cover is primarily forest towards the downstream part of the watershed, with grassland/pasture in the more upstream areas, and some cropland in the upper parts of the watershed. We also look at the table and check to see if the values make sense based on what we see in the map.



HUC8	Waterbody Name	AUID	Percent of Watershed (%) Developed	Corn	Alfalfa	Soybeans	Other crops	Grassland/Pasture	Forest	Wetlands	Open water
Mississippi River–Reno (07060001)	Crooked Creek	519	6	11	4	6	<1	30	42	1	<1
	Winnebago Creek	693	4	14	4	7	<1	28	43	<1	<1

We review the WQ summary table, noting the years of data that are summarized, checking the AUID again, and taking a look at the WQ data summary. Exceedances were observed for both impairments, and the frequency of exceedance confirms the impairment.

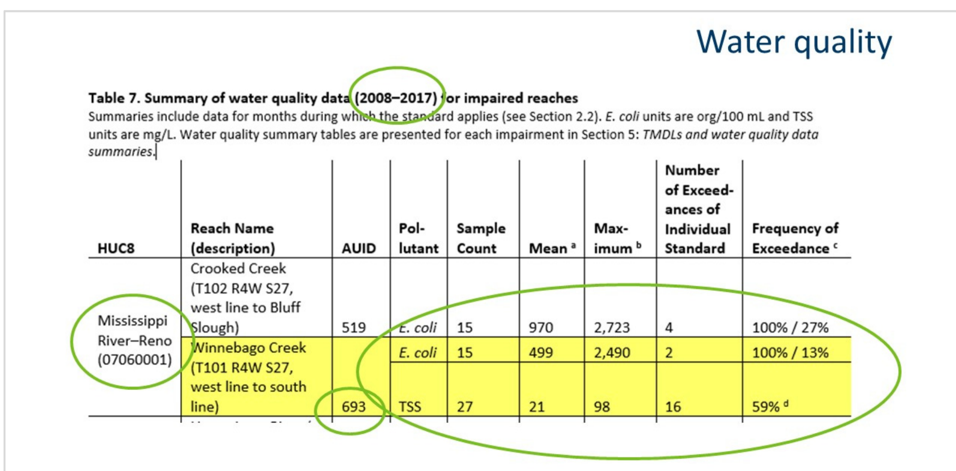


Table 7. Summary of water quality data (2008–2017) for impaired reaches

Summaries include data for months during which the standard applies (see Section 2.2). *E. coli* units are org/100 mL and TSS units are mg/L. Water quality summary tables are presented for each impairment in Section 5: *TMDLs and water quality data summaries*.

HUC8	Reach Name (description)	AUID	Pollutant	Sample Count	Mean [a]	Maximum [b]	Number of Exceedances of Individual Standard	Frequency of Exceedance [c]
Mississippi River–Reno (07060001)	Crooked Creek (T102 R4W S27, west line to Bluff Slough)	519	*E. coli*	15	970	2,723	4	100% / 27%
	Winnebago Creek (T101 R4W S27, west line to south line)	693	*E. coli*	15	499	2,490	2	100% / 13%
			TSS	27	21	98	16	59% [d]

Sometimes there are figures that go along with the WQ data summary. We see this TSS concentration duration curve, and see that most of the exceedances were observed during mid to high flows, although there is one exceedance at low flow.

Water quality

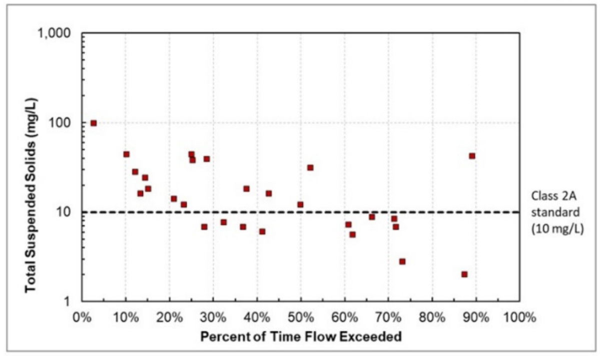


Figure 10. TSS concentration duration curve for Winnebago Creek.
Note log scale on y-axis.

Moving onto pollutant sources, I'll focus on the TSS impairment for the rest of this review. The primary sources were identified as cropland runoff, pasture/grassland runoff, and near channel sources. The loads from runoff are reasonable, given the relatively large area of cropland and pasture in this watershed.

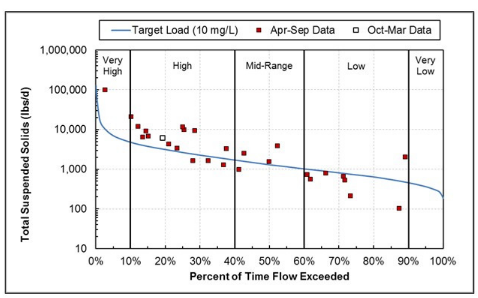
Pollutant sources

Table 15. TSS loading in Winnebago Creek Watershed (07060001-693) from HSPF model results (Tetra Tech 2018)

TSS Source	Land cover area in watershed model (% of watershed) [a]	Percent of mean annual load (%) [b]
Cropland runoff	27%	27%
Pasture/grassland runoff	33%	22%
Developed runoff	3%	4%
Forest runoff	36%	13%
Barren land runoff	<1%	2%
Near channel [c]	--	32%
Point sources	--	<1 %

And now moving onto the TMDL section. In the LDC we see again that most of the exceedances are during mid to high flows. We compare that with our source assessment and see that it makes sense—both runoff and loads from near channel sources would be greatest under higher flows.

TMDL table



Primary sediment sources

- Cropland runoff
- Pasture/grassland runoff
- Near-channel

In the TMDL table, we check the AUID, the listing year, and the baseline year, and we make sure that the sources match the source assessment table. This one is pretty simple, because the LA is lumped into one line. But we do see the wastewater treatment plant WLA in the table, note that it is a relatively small percentage of the loading capacity, and check the source table and see that loading from point sources represents <1% of the TSS load to this reach.

In this example, the project managers decided not to include the percent reduction; instead the existing concentration was included to provide an overall sense of the extent of impairment, relative to the standard. Also, note that the standard in both the LDC and the TMDL table matches the standard that was in the WQS table at the beginning of the report.

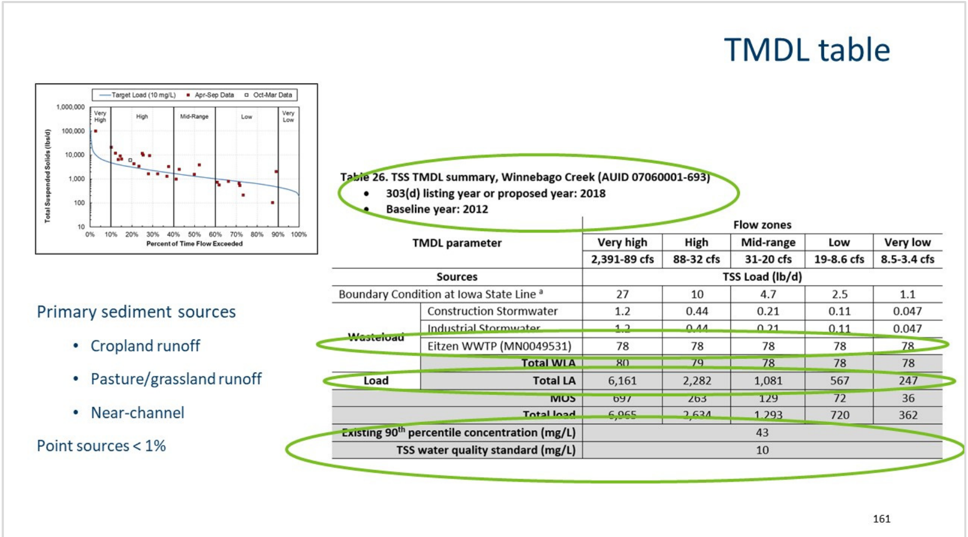
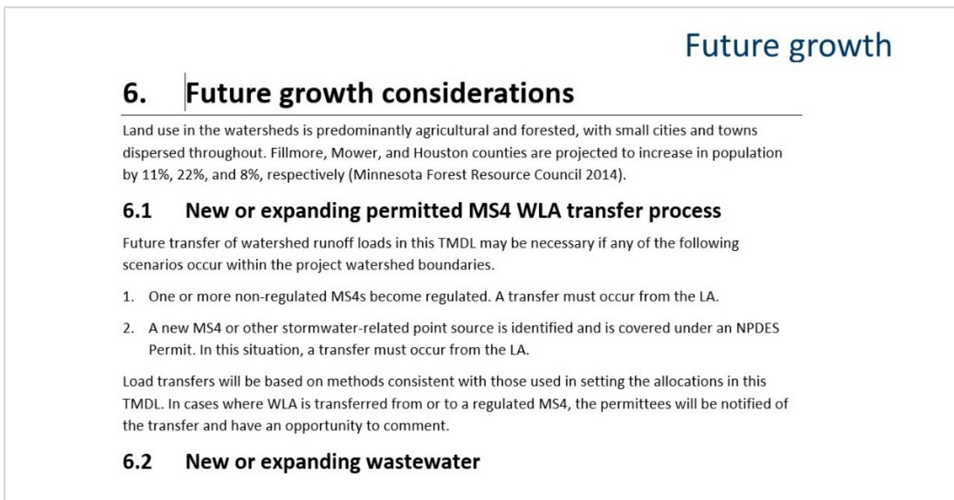


Table 26. TSS TMDL summary, Winnebago Creek (AUID 07060001-693)

- 303(d) listing year or proposed year: 2018
- Baseline year: 2012

TMDL parameter		Flow zones				
		Very high	High	Mid-range	Low	Very low
		2,391-89 cfs	88-32 cfs	31-20 cfs	19-8.6 cfs	8.5-3.4 cfs
Sources		TSS Load (lb/d)				
Boundary Condition at Iowa State Line [a]		27	10	4.7	2.5	1.1
Wasteload	Construction Stormwater	1.2	0.44	0.21	0.11	0.047
	Industrial Stormwater	1.2	0.44	0.21	0.11	0.047
	Eitzen WWTP (MN0049531)	78	78	78	78	78
	Total WLA	80	79	78	78	78
Load	Total LA	6,161	2,282	1,081	567	247
MOS		697	263	129	72	36
Total load		6,965	2,634	1,293	720	362
Existing 90th percentile concentration (mg/L)		43				
TSS water quality standard (mg/L)		10				

The "future growth" section of this report includes a short description of expected population increase, followed by the MS4 WLA transfer language from the template, but adapted for this watershed, which currently does not have regulated MS4s. The section on new or expanding wastewater was also included from the template, because the report includes both TSS and *E. coli* TMDLs.



6. Future growth considerations

Land use in the watersheds is predominantly agricultural and forested, with small cities and towns dispersed throughout. Fillmore, Mower, and Houston counties are projected to increase in population by 11%, 22%, and 8%, respectively (Minnesota Forest Resource Council 2014).

6.1 New or expanding permitted MS4 WLA transfer process

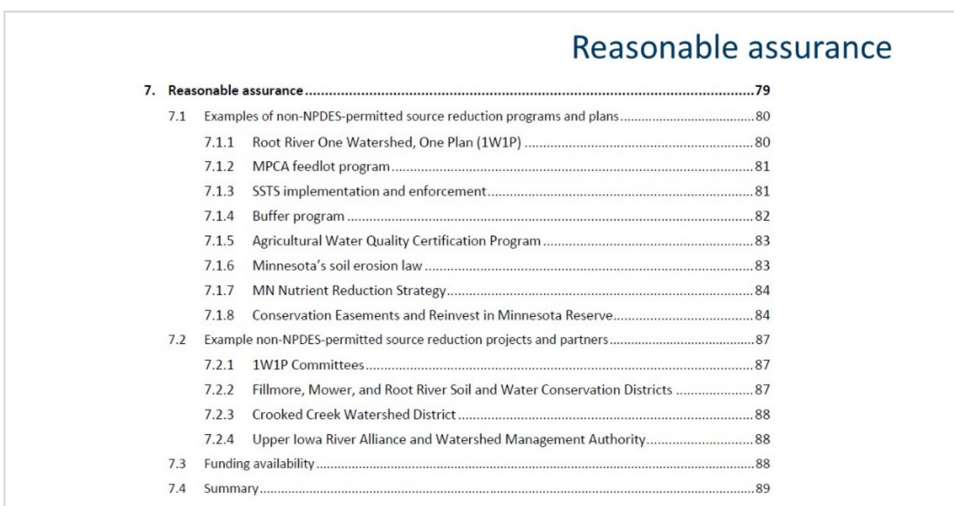
Future transfer of watershed runoff loads in this TMDL may be necessary if any of the following scenarios occur within the project watershed boundaries.

1. One or more non-regulated MS4s become regulated. A transfer must occur from the LA.
2. A new MS4 or other stormwater-related point source is identified and is covered under an NPDES Permit. In this situation, a transfer must occur from the LA.

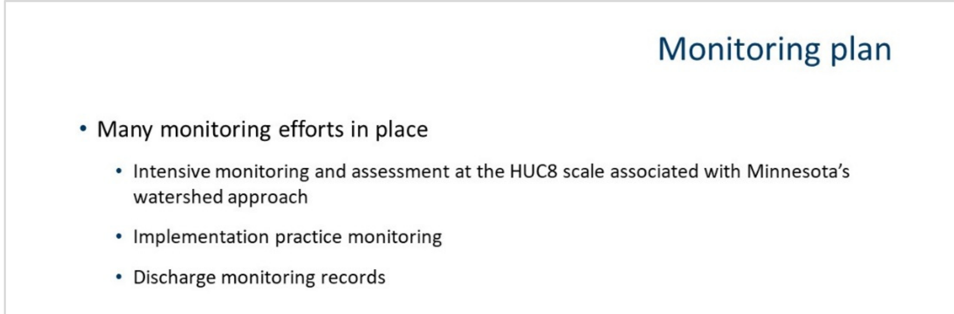
Load transfers will be based on methods consistent with those used in setting the allocations in this TMDL. In cases where WLA is transferred from or to a regulated MS4, the permittees will be notified of the transfer and have an opportunity to comment.

6.2 New or expanding wastewater

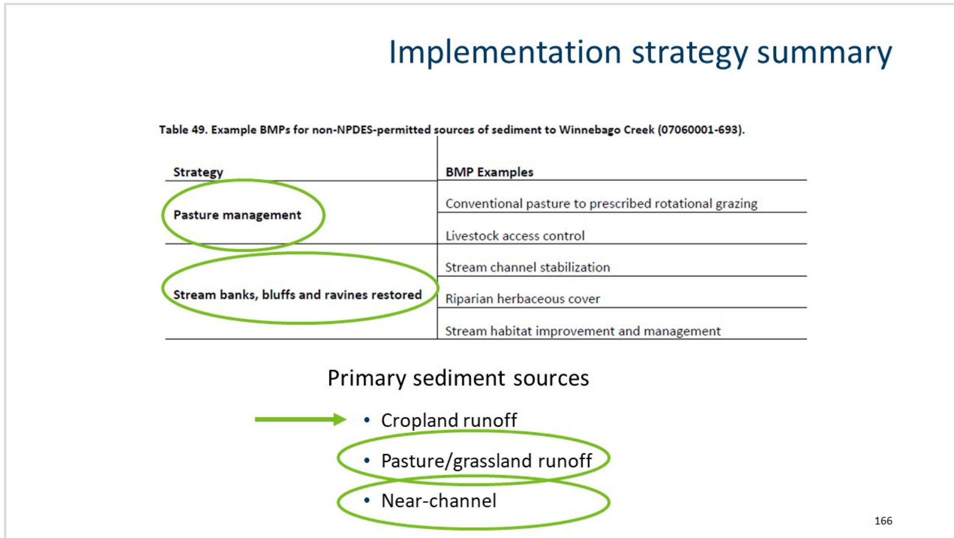
The reasonable assurance section provides descriptions of many of the nonpoint source reduction programs and projects. The report was written before the new sample text was provided in the revised report template, so it doesn't exactly match the language in the new template.



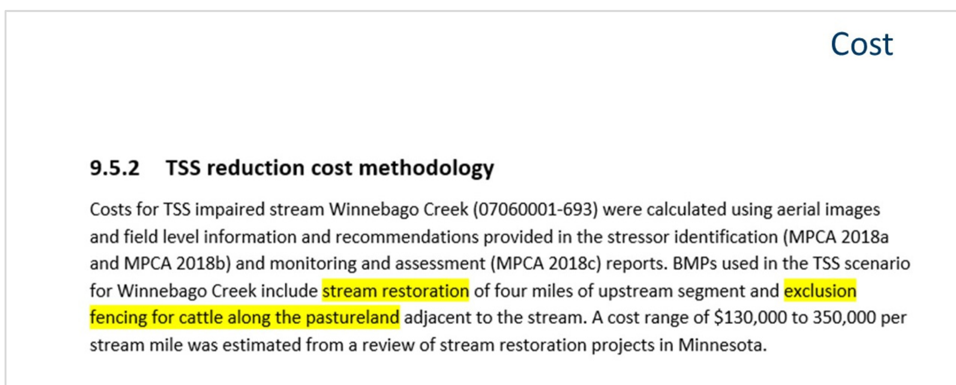
There is a relatively brief monitoring plan, which describes the existing monitoring programs in place. Whether you want to expand on this will depend on the specifics of your watershed.



In the implementation strategy summary, there is a table of example BMPs for the non-permitted sediment sources. Go back to the pollutant source summary to review the primary sediment sources; in this case it is cropland runoff, pasture/grassland runoff, and near-channel sources. Make sure that the BMPs in the implementation strategy are tailored to address the primary sources. In this case, we see pasture management BMPs and BMPs for near channel sources, but there aren't any BMPs that address cropland runoff. There might be a reason that this was left out, but this would be something to follow up on to determine if additional BMPs should be added to the table.



The cost section in this report provides a cost range and an explanation of how the costs were estimated. The BMPs mentioned in this section—stream restoration and exclusion fencing for cattle—match the BMPs in the implementation strategy summary.



And, lastly, public participation. A brief summary of the meetings that were held with stakeholders is included, in addition to the language from the template regarding the public notice period. Again, the information in this section will depend on the specifics of the watershed.

Public participation

Multiple meetings were held with stakeholders throughout the TMDL development process. Throughout March and April of 2019, the MPCA attended four meeting with local stakeholders in the watersheds. These meetings provided a summary of the impairment status of streams in the watersheds and the identified stressors and pollutants impacting those streams. Local stakeholders included SWCD staff and board advisors from Mower and Houston counties, and Fillmore county staff and township officials. MPCA also attended a Root River 1W1P Advisory Committee meeting on March 19, 2019, to discuss TMDL project updates. In attendance were advisory committee members including staff from BWSR, Fillmore SWCD, Root SWCD, Winona SWCD, The Nature Conservancy, and DNR. On May 15, 2019, two meetings were held in Mabel, Minnesota with county and SWCD staff to provide an overview of the TMDL and discuss implementation activities for the TMDL and WRAPS.

An opportunity for public comment on the draft TMDL report was provided via a public notice in the State Register from December 30, 2019 through January 29, 2020. There were xxx comment letters received and responded to as a result of the public comment period.

Thank you!

Andrea Plevan

Andrea.Plevan@state.mn.us

651-757-2672

MINNESOTA POLLUTION CONTROL AGENCY

126

Appendix: summary guidelines for reviewing TMDLs

As you review a TMDL, use the TMDL report template as a guide, in addition to the information presented in this training.

Module 1: TMDL report components

Accounting for impairments

- What will be the status of the impairment upon approval of the TMDL report?
- One proposed category per impairment.
- With multiple stressors:
  - 4A overrides 4C
  - 5 overrides all others

Water quality standards

- Are WQS presented for all impairments for which TMDLs are developed?
- Is it clear which standard applies to which water body?

Watershed and water body characterization

- Lakes, streams, subwatersheds: is all of the required information included?
- Land cover and/or land use maps and tables.
- Water quality: description of data sources, sites, date range, months.

Pollutant sources

- Are the primary sources of each pollutant identified?
- Does report describe where each source comes from and how it is delivered to surface waters?
- Is there a list of all permitted feedlots and CAFOs?
- Look at the WQ data summary and compare it to the source assessment and see if they are consistent with one another.

TMDL development

- Is it clear which methods were used to calculate TMDL components?
  - Loading capacity
  - Margin of safety
  - Wastewater WLA: Involve wastewater liaison early in the project; include all individual WLAs in TMDL table
  - MS4 WLA: How was regulated area determined? How was WLA calculated? Table of regulated area per MS4 per impairment
  - Permitted feedlots and CAFOs: WLA of zero (stated in text, not in table)
  - Load allocations
  - Percent reductions
- Discussion of seasonal variation and critical conditions.
- Complete TMDL tables.

Future growth, reasonable assurance, monitoring, implementation strategy, public participation

- Review remaining sections, continuing to keep in mind the existing water quality, pollutant sources, and load reductions needed for each impairment.

Module 2: Technical approaches and models

Common TMDL approaches and averaging periods

- What approach was used to calculate the TMDL? Is it flow-based? Is it a model scenario?
- What is the appropriate averaging period for the pollutant? Is the appropriate averaging period used in the approach and the TMDL table?

Flow-based TMDLs and model scenarios

- Understand the approach that was used to develop the TMDLs.

Compare source assessment to TMDL

- Compare the source assessment to the TMDL table to check if they are consistent.

Unallocated load

- Do not use unallocated loads in TMDLs.
- Do discuss protection in TMDL reports.

Module 3: Checking the math and putting it all together

Rounding

- Choose your rounding approach and be consistent.
  - Consistent number of decimal places
  - Consistent number of significant digits

How to check the math

- Things to check:
  - All individual WLAs must add up to total WLA
  - All individual LAs must add up to total LA
  - Individual WLAs + individual LAs + MOS must add up to LC
  - Total WLA + total LA + MOS must add up to LC
- Paste table from Word to Excel.
- Write formulas for comparisons.
- Compare the paired, **rounded** values and check for compatibility.

Reductions in lake TMDL tables

- For lake TMDLs, be aware of the approach used to calculate the total load reduction, and make sure that it is described in the report.

Tempo

- Compare the sums in Tempo to sums in the TMDL table.
- Make sure that they are compatible.

EPA decision document

- Read the entire decision document.
- Compare to TMDL report and Tempo.
  - Total number of AUIDs
  - AUIDs
  - Loading capacities, allocations
- Contact Celine Lyman if you find a mistake.