Bellingham Bay Pollution-Sources and Sums

Bellingham Bay has been under siege from a myriad of pollutants since the age of industrialization. Government is slowly acting to clean up (either by removal or capping in place) past contamination—but what about continuing sources of contamination? Ongoing input of pollutants from stormwater, municipal wastewater, and industrial discharges can add up to a potentially unacceptable load of pollution into our water bodies.

RE Sources' North Sound Baykeeper program attempted to tally the type and amount of pollutants entering Bellingham Bay from industrial, municipal and construction sources as reported to the Washington State Department of Ecology (Ecology). The Bellingham Bay watershed - or the entire geographical area from which rivers, streams and other surface waters flow to the bay - includes the Nooksack River watershed and most other drainages in and around the City of Bellingham. (Appendix A shows the mapped area of this watershed.)

The task of calculating contaminant loading into a water body such as Bellingham Bay is difficult at best. Data does not exist for all sources of pollution. However, much information is available from Ecology, which regulates point-source and stormwater (a non-point source) pollution from industrial practices, construction sites and municipalities in Washington State. Ecology regulates this pollution by setting standards, issuing pollution permits, establishing monitoring protocol and collecting the reports, submitted by the permittees. (Ecology does not regulate the discharge of pollutants from tribal lands, a small percentage of which is in the Bellingham Bay watershed).

Ecology currently requires facilities such as wastewater treatment plants, industrial facilities and operations such as fish hatcheries and animal feedlots to monitor point source discharges (discrete discharges from a pipe). These facilities obtain permits from Ecology, which prescribe the maximum amount of pollutants allowed to be discharged and the regimen by which facility-specific parameters must be monitored. Thus, for permitted point sources such as these there is documentation of the type and volume of pollution discharged.

Stormwater, is also a source of pollution in Bellingham Bay. Ecology requires that many industrial facilities, construction sites greater than 1 acre, and larger municipalities obtain stormwater permits and measure concentrations of specified pollutants in their stormwater. These concentrations are then reported to Ecology and compared to a set of regulatory benchmarks, or concentrations of pollutants, most of which are set above water quality standards. An exceedance of a benchmark signals to Ecology that the stormwater effluent may be contributing to the degradation of water quality in the receiving water, and the permit requires facilities to take action to correct the problem. Often, the required action is not taken, and thus, pollutants in stormwater continue to drain to water bodies at the same pace, rather than be abated.

Quantification of pollution from stormwater is not possible at this time because the total volume of stormwater delivered to Bellingham Bay is not known. Only the largest industrial facilities in the Bellingham Bay watershed, such as Brooks Manufacturing and Oeser Company are actually required to report both the concentration of pollutants and the volume of stormwater discharged.

A qualitative picture of stormwater pollution is presented below, showing the frequency of exceedances above the benchmarks. Unfortunately, even this qualitative picture is limited, as many facilities do not have permits or do not sample.

Method of data collection

RE Sources downloaded and compiled data from Ecology's online database of industrial facility Discharge Monitoring Report (DMRs) for Whatcom County, for the time period of September 1, 2006 through August 31, 2007. Due to lower frequency of reporting of stormwater monitoring, the two years of 2006 and 2007 were compiled for analysis. Industrial facilities are required to submit reports every month, whereas stormwater permittees submit reports quarterly.

A database (Microsoft Access) was created and linked to Geographic Information System (GIS) watershed boundary data to filter for discharges within the Bellingham Bay watershed. A map was generated to depict these sources and is included with this report in Appendix A.

The data was then filtered for quantifiable pollution that could be summed for total pounds per day discharged, in effect removing stormwater and other waters that had no measured flow. Remaining records were predominantly of sources holding "individual" permits, usually point sources from industrial discharges as well as outfalls from four municipal wastewater treatment plants (WWTP) and two fish hatcheries.

Further filtering, both programmed and manual, was required to select for mean discharges (vs. maximum recorded values when also reported), whether volume measurements were taken and determine frequency of reporting. Some records required converting a measured concentration, such as by milligrams per liter, and multiplying by the recorded volume of flow at that point and time, so as to ultimately calculate total pounds per year. For some details, the actual permits, when available online, were checked. In particular, permits were checked to determine whether industrial discharges were directed to WWTP's or to Bellingham Bay. Where facilities discharged to a WWTP, their values were removed from the final calculations, since the WWTP treats the wastewaters it receives and issues a DMR for its effluent. In a few cases, facility contacts were called for clarifications.

Stormwater data includes all sampling locations in Whatcom County. Stormwater data was compiled in Excel spreadsheets and analyzed to compare the frequencies at which values exceeded the Benchmarks.

What types of pollutants are entering the Bay?

Many types of pollutants are carried by water into Bellingham Bay. The most common types include:

- **Sediment**, which enters the bay from a myriad of industrial sites, as well as from roadways and construction sites. Sediment carries with it other more dangerous pollutants, such as bacteria, pesticides, and hydrocarbons, and has the potential, in itself, to smother sea life. One approximation of sediment and total loading of organic and inorganic material to Bellingham Bay is called "Total Suspended Solids" or TSS. TSS is one of the more common parameters measured at industrial sites. Sediment in stormwater however, is usually measured by **Turbidity,** or the relative cloudiness of the water. In this case a simple instrument measures how much light is scattered by suspended particles in a sample of water, assigning a value in nephelometric turbidity units or NTUs. Although there is a rough correlation with TSS values, NTUs cannot be simply added up to determine the total amount of suspended material in the water.
- **Organic material,** which enters the bay from wastewater treatment plants, food processing plants, and from natural processes. Loading of organic matter into Bellingham Bay decreases the amount of oxygen in the bay, because bacteria consume oxygen to break down organic matter. Additionally, nitrogen, as a component of organic material, stimulates algal growth whose decomposition also leads to a decrease in oxygen. One approximation of the loading of organic matter is "**Biological Oxygen Demand**" or BOD. The measures of BOD and TSS are somewhat comparable; there being more TSS when the overall loading of matter is more inorganic than organic, and less biodegradable.
- **Metals**, which enter the bay from many industrial sites and roadways. Ecology requires some industrial sites to measure specific metals in their wastewater. Metals can be highly toxic to many aquatic organisms, often interfering with basic biological processes. Metals are often carried by suspended sediment, and tend to accumulate in sediments. **Zinc** and **Copper** are commonly measured metal pollutants.
- **Oil and Grease,** which is generally a measure of petroleum products discharged or carried off a site via stormwater. These pollutants may have been washed off machinery or dripped onto soils before being washed off site to the bay. Petroleum products such as oil are toxic themselves and associated chemicals and metals carried with waste oil in particular can also be highly toxic. In the food industry, disposal of

edible oil and grease is regulated to prevent excessive nutrient loading as with other organic material mentioned above.

How much pollution is entering the Bay?

The total discharges to Bellingham Bay calculated for Total Suspended Solids (TSS), Biological Oxygen Demand (BOD), Zinc, Copper and "Oil and Grease" are summarized in Table 1 below. These values came from industries, municipal water treatment facilities and other operations requiring individual discharge permits where the volume of water was also measured.

Table 1: Summary of total pounds per year of TSS, BOD, Zinc, Copper, and Oil & Grease entering Bellingham Bay from Industrial, Municipal, and Fish permittees.

Pollutant	**TOTAL** lbs/year	Industrial [a] lbs/year	Municipal [b] lbs/year	Fish Hatchery [c] lbs/year
TSS	692,893	65,692	588,599	38,602
BOD	637,885	109,219	528,666	No data
Oil and Grease	5,675	5,675	No data	No data
Zinc	160,356	3.065	160,353	No data
Copper	53,878	0.170	53,878	No data

[a] Industrial dischargers are as follows: Brooks Mfg; stormwater, Darigold Lynden Plant; cow water and non-contact cooling water, Georgia Pacific West Bellingham; process water, Hilltop Woodwaste Landfill; leachate, and Oeser Co; stormwater.

[b] Municipal Dischargers are as follows: Bellingham WWTP, Everson WWTP, Ferndale WWTP, Lynden WWTP, Metals estimates were derived from data required once per permit cycle; Bellingham; 5 samples in 2007, Everson; 1 sample in 2004, Ferndale; recent data not available for this report, and Lynden; 3 samples in 2004.

[c] Fish Hatchery dischargers are as follows: Washington State Department of Fish and Wildlife; Bellingham and Kendall Creek

Total Suspended Solids and BOD

With wastewater treatment plants receiving most of the industrial effluent as well as residential sewage, it's understandable that the municipalities account for over three fourths of the measured suspended solids discharged to Bellingham Bay. Appendix B.1 details the Total Suspended Solids discharged from permitted industrial and municipal sources.

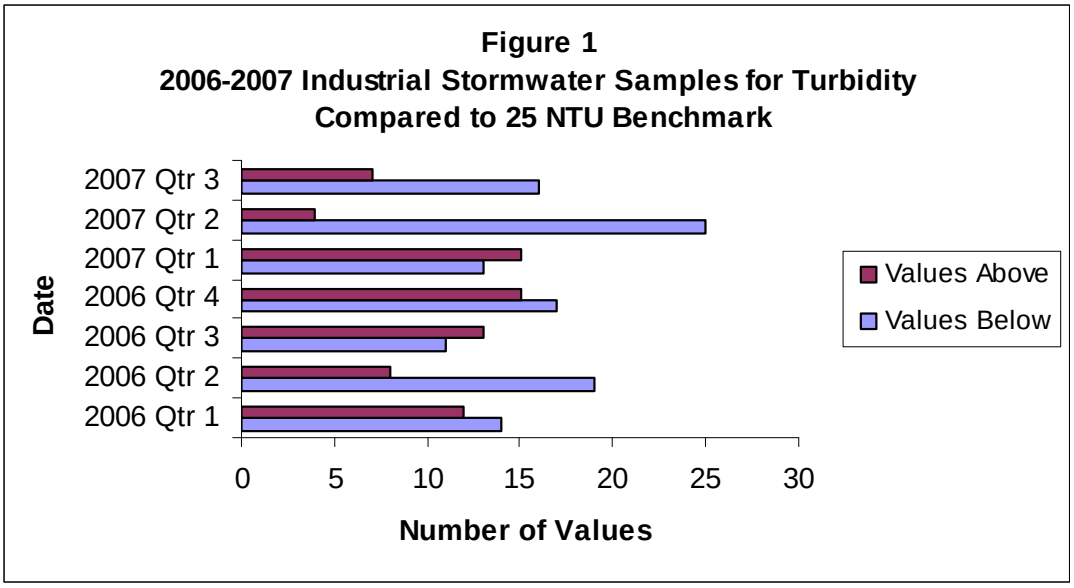
The Bellingham WWTP removes 95% of solids from water before final sanitization and discharge into Bellingham Bay. Nevertheless, the Bellingham WWTP was the single greatest contributor of Total Suspended Solids discharging nearly half the known TSS inputs (351,064 of the 692,893 lbs per year). The Lynden and Ferndale WWTPs followed with 144,673 and 88,482 lbs/year respectively.

As one might expect, the municipal effluent high in TSS was also relatively high in nutrient rich organic matter measured as BOD. Seafood processors in Bellingham and Darigold in Lynden contributed much of the remaining BOD. (See Appendix B.2: Summary of calculated BOD discharges to Bellingham Bay.)

For all the quantifiable solids discharged into the bay, none of the large municipal and industrial permittees exceeded the levels of pollution that Ecology allowed.

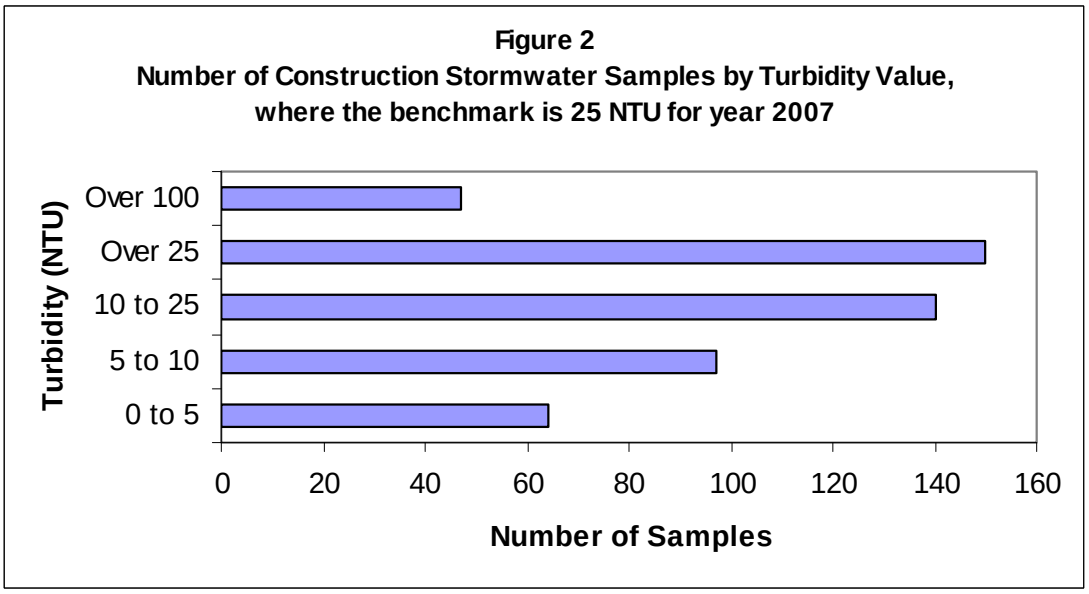
Turbidity

Industrial stormwater turbidity data was compiled from 189 total samplings reported from 65 sites in Whatcom County, most of these in the Bellingham Bay Watershed. Figure 1 below summarizes the data relative to the Benchmark. Nearly 40% (74) of the samplings exceeded Ecology's established benchmark of 25 NTU's. [The benchmark for turbidity is 25 NTU, whereas the water quality standard is 5 or10 NTU above the turbidity of the receiving water, depending on how high or low the turbidity of the receiving water is]



Similarly, samples of construction stormwater also exceeded the 25 NTU benchmark in nearly 40% of the cases (197 of 498 as seen in Figure 2 below).

While the exceedances of the turbidity benchmark for industrial and construction site stormwater can't tell us how much sediment is entering the bay, we can infer that exceeding the standards to this frequency is resulting in sediment being carried to the bay.



Oil and Grease

Industrial permittees discharged 5,675 lbs of oil and grease from Sept 2006 through August 2007. Assuming 7.5 lbs/gallon for crude oil (a minimum volume as refined fuels weigh less), this equate to more than 750 gallons of oil dumped into the bay each year.

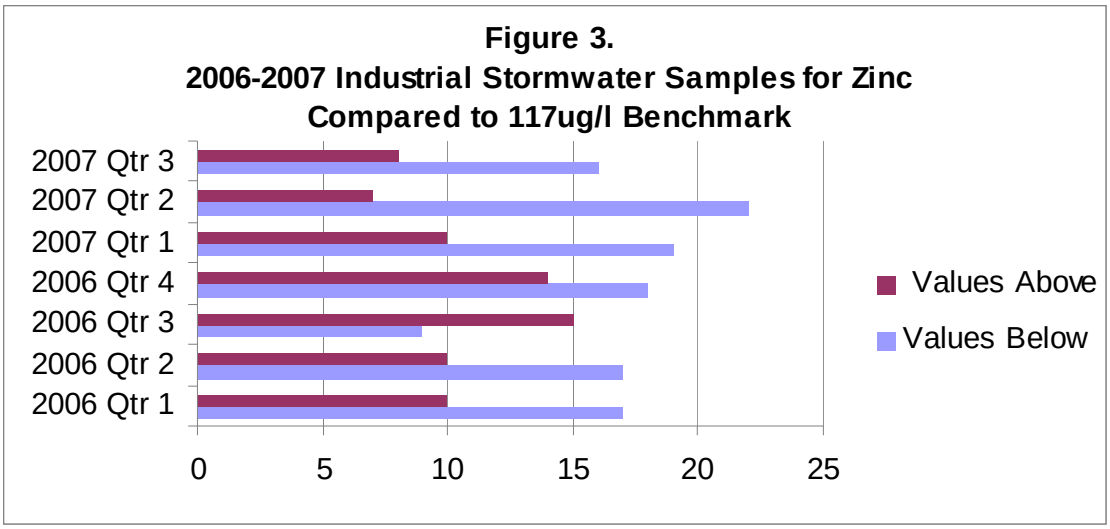
Industrial stormwater exceeded oil and grease benchmark levels only 14 times, or 16% of the 89 samplings. No industry in the Bellingham Bay watershed reported levels over the 15 mg/l benchmark more than once.

Although reporting is limited, Boatyards also sample for oil and grease. Two in eight samples for oil and grease exceeded the benchmark level of 6 g/ml.

Metals

Discharges to Bellingham Bay are summarized in Table 1 above. Known pollutants include Zinc at 160,356 lbs per year and Copper at 53,878 lbs/year, from municipal plants. Metals are particularly toxic and persistent, settling into the sediment and accumulating over a very long time. Thus, the specter of hundreds of thousands of pounds of zinc and tens of thousands of pounds of copper draining into Bellingham Bay every year is alarming at best.

Although precise quantities cannot be determined, metals, especially zinc, that are washed to the bay by stormwater are likely to be significant. Figure 3 shows that the industrial stormwater zinc benchmark value of 117 ug/l was exceeded in 74 of 192 samplings, or nearly 40% of the time. Of note, the water quality standard for zinc is lower than the benchmark; 81 or 90 ug/L for acute and chronic exposures, respectively.



Zinc and copper are also used as anti-fouling agents in many paints for boat hulls. Naturally these metals that kill algae, barnacles and other pests on the bottom of boats also kill the algae, barnacles and other important species that inhabit the bay.

Little sampling is done of Boatyards and Marinas, but boatyards sample for copper and submit reports to Ecology. Occasionally values exceed permit benchmark levels. Three in ten samples for copper in 2006-2007 exceeded the benchmark of 229ug/L.

Summary and Future Needs

Just considering the point-source discharges, the total pounds of BOD and TSS entering Bellingham Bay – 692,893 and 637,885 pounds per year, respectively – seems staggeringly high. Nevertheless, it is difficult to conclude exactly what it means. Several issues are at hand:

1) Is the loading of BOD and TSS into Bellingham Bay significantly higher than under natural conditions? The answer is undoubtedly, yes. While there are sources of naturally occurring BOD and TSS that are discharged into the bay, many of these sources, such as landslides and seasonal leaf litter, still exist but are exacerbated by human clearing of the land and the intentional discharge of pollutants into the bay. In addition, numerous other

sources contribute to BOD and TSS loading that are directly attributable to human activity. Among these are loadings to wastewater plants by residences and businesses.

2) What is the effect of BOD and TSS loading into Bellingham Bay? When BOD and TSS are discharged into the bay, the organic components are degraded by bacteria, which consume oxygen. In addition, nutrients such as nitrogen and phosphorus increase algal growth, whose decay also consumes oxygen. Oxygen depletion can lead to dead zones such as those seen recently in Hood Canal, where high nutrient inputs and poor flushing contributed to the diminishment of oxygen and off of the Pacific Coast, where upwelling of nutrient rich waters and higher temperatures are thought to be responsible for the loss of oxygen. Often, the amount of organic loading, especially nitrogen in marine systems, that will lead to algal blooms and subsequent oxygen depletion is unknown until it is too late. It is still too soon to know what the carrying capacity of Bellingham Bay is. There are, however, reports of decreased oxygen in the late summer months in Bellingham Bay. Quantification of organic, nitrogen, and phosphorus loading from point and non-point sources and a yearly trend analysis of oxygen is necessary to determine what the oxygen levels and nutrient inputs are over time. Modeling of those inputs along with circulation patterns and existing oxygen levels would be necessary to determine the carrying capacity of Bellingham Bay.

3) What are the components of BOD and TSS discharged into Bellingham Bay? BOD and TSS not only contribute nutrients which stimulate algal growth, but some of these components are toxic to life. All of the chemicals that people use to clean and disinfect their homes, perform routine auto maintenance, and ingest as medicine enter the wastewater treatment system. Some of these chemicals degrade, but a fraction of these chemical pass through to the bay. That means that some proportion of disinfectants, degreasers, and drugs are entering Bellingham Bay. Most alarming of these are the drugs, since these are bioactive at very low levels.

The amount of metals entering the bay is also staggering with an estimated 160,000 pounds of zinc and 54,000 pounds of copper every year. Some of these metals will be buried and some will be carried out with current flow. The exact amount of metals remaining in the bay

and their effect is again, unknown. There is a very real potential for metals discharged as part of human activity to affect the health of organisms in the bay, but no one has assessed this.

In addition to the known amounts of organic and inorganic material contributed to Bellingham Bay, we also know that there is an untold amount of material flowing into the bay that has not been quantified. This includes natural material from the Nooksack River and its tributaries, and stormwater runoff from forestry, and agriculture, as well as from roadways, and industry and construction sites.

In sum, the process of tallying pollutant loading into Bellingham Bay has demonstrated a few key points and shown the light on some very big shortcomings in our system of pollution control and knowledge.

- The role of wastewater treatment plants cannot be underestimated. Most quantifiable pollution passes through these plants; thus their performance is very important.
- Ecology's system used to track and control stormwater pollution is lacking. There is almost no quantification of stormwater pollution, the limited reporting that is required is often not done, and the stormwater pollution that is reported routinely exceeds benchmark levels 40% of the time.
- The amount of knowable pollutant loading into Bellingham Bay is on the order of one million pounds per year, but its current and future effect are not known at this time. A full accounting of the volume and type of pollutants (including pharmaceuticals) into the bay is necessary, along with modeling and assessment of the carrying capacity of the bay. Only with this effort, will we know what controls are necessary to limit pollution and how quickly these controls should be implemented.

Thanks to volunteers Sydney Funsin, Lilly McGarry, and Ann Stark for helping compile information and graphs for this report.

Appendix A - placeholder

Appendix B.1: Total Suspended Solids discharged from industries and municipalities to Bellingham Bay (not including stormwater or discharges received by treatment plants)

Facility Name	Calculation Lbs/year
Bellingham Stp Total	351,064
Brooks Mfg Total	10
Darigold Lynden Plant Total	14,833
Everson Stp Total	4,380
Ferndale Stp Total	88,482
Georgia Pacific West Bellingham Total	50,796
Hilltop Woodwaste Landfill Total	53
Lynden Stp Total	144,673
Wa Dfw Bellingham Hatchery Total	4,310
Wa Dfw Kendall Creek Hatchery Total	34,291
Grand Total	692,893

Total by permit type	
Industry	65,692
Stp	588,599
Fish hatcheries	38,602
	692,893

Appendix B.2: Summary of calculated BOD Discharges to Bellingham Bay

Facility Name	Calculation Lbs/year
Bellingham Stp Total	430,633.64
Darigold Lynden Plant Total	65,520.01
Everson Stp Total	4,592.92
Ferndale Stp Total	65,547.92
Georgia Pacific West Bellingham Total	43,678.33
Hilltop Woodwaste Landfill Total	20.31
Lynden Stp Total	27,892.08
Grand Total	637,885.20

Subtotal BOD by permit type	
STP's	528,666.55
Industry	109,218.65
	637,885.20