

Runoff: Stopping the Flow

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Even with the availability of mass transit, many cities still face the problem of cars packed tightly within their streets and driving along the highways leading into them. This causes a variety of problems, including congestion, air pollution, noise, and pedestrian and bicyclist safety issues. One of the problems most detrimental to the city and its surrounding areas is the runoff from the roads and into the surface and groundwater it and the area around it depend on. While sewage overflow is often discussed in relationship to heavy rains, it is important to look at what is actually washing off of roads and not only what is flooding out of sewers.

Road runoff occurs when pollution from traffic, for example, from the combustion of fossil fuels; salts from deicing the roads in the winter; and spills from various sources lay in a thin layer on the asphalt until a rain event occurs. When it rains, all of the myriad chemicals are lifted from the pavement and washed off of the roads. These chemicals eventually make their way into surface water supplies and can even seep into groundwater supplies. From water supplies, the chemicals can go on to contaminate drinking water as well.

It is important to understand not only where the chemicals involved in runoff come from, but also what they are. When the types of chemicals are known, one can make a clearer determination of where specific chemicals are coming from and how to prevent their spread or lessen their intensities. Often found in runoff are volatile halogenoorganic compounds from the

burning of fossil fuels (1). Additionally, fuels contribute petroleum hydrocarbons and aromatic hydrocarbons, such as benzene, which is used as a lead substitute and octane booster in gasoline (1). Cations, such as sodium, potassium, ammonium and calcium ions and anions, such as



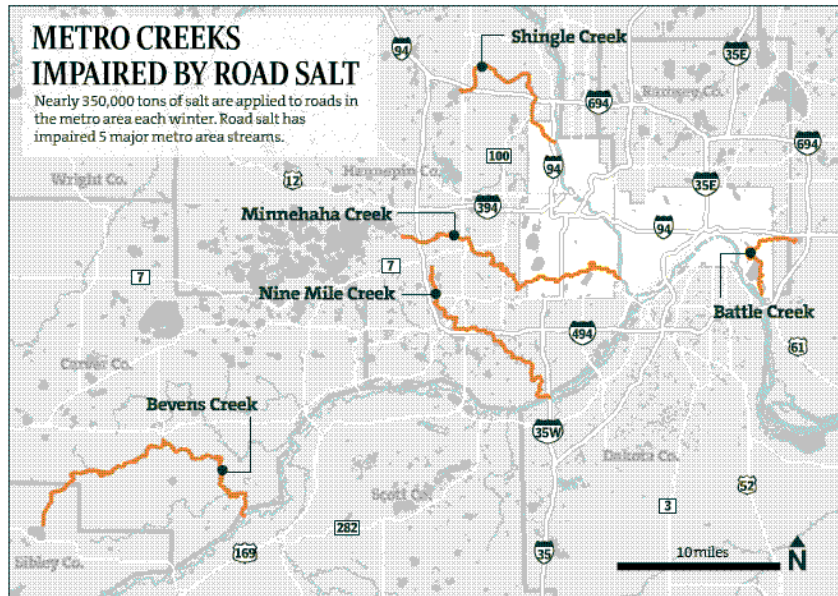
Salting roads contributes to runoff (3)

fluorine, chlorine, nitrite, nitrate, phosphate, and sulfate ions, have frequent occurrences in road runoff (1). Some of these, especially sodium, chlorine, and calcium ions occur with greater frequency in the winter due to salting of roadways (1). Others, such as

nitrate and sulfate ions occur year round as a result of the burning of fossil fuels (1). There are also fine particles of copper, zinc, cadmium, chromium, and lead that appear in runoff (2). These heavy metals are more frequent in areas of heavy road use, which means that they appear in cities and near highways, and are released by a variety of sources, including fuels, tires, and flares (2). Finally, there are also occurrences of nitro-, phospho-, and chloroorganic pesticides (1).

The cocktail of chemicals present in road runoff is startling, as are the effects that it has on the environment. Interestingly, the effect depends on the time of year, primarily due to deicing and salting of the roads. In the colder months, vast quantities of salt are placed on the road in order to prevent unsafe driving conditions. A study described in a

Twin Cities area newspaper, the Star Tribune, related that 350,000 tons of salt are used on roads in the Twin City area alone every winter (3)! Unfortunately, this method of making driving safer also has devastating effects on the environment. The



Twin Cities area study found that 39 lakes in the area had increase in salinity steadily over the past 22 years (3). This coincided with the increase of salt-use over those years. The main problem with lakes becoming saltier is that the saline solution that enters lakes is heavier than the water in the lakes. This causes the saline solution to sink to the bottom of the lake, resulting in changes in lake chemistry and causing changes in plant growth and communities and loss of aquatic insect life (3). The same study also found five areas streams to be impaired (3). In addition to impairing surface water, ions from road salt can create issues with ground water as well. Road salt ions can reach unacceptably high

levels in groundwater drinking supplies, rendering them unusable, and also increase the alkalinity and decreases the permeability of the soil that stores the groundwater (4).

Much like the ions in dissolved road salt, the other chemicals in road runoff can



Insect larvae, like this caddisfly larvae, are affected by chemical changes (9)

cause problems. Heavy metals are of great concern as they have the potential to cause cancer and developmental disorders. Particles of heavy metals can get into the flesh of various fishes, and high enough doses can cause medical problems to anyone who may eat the fish. Additionally, with enough of the various chemical found in runoff in a body of water, swimming or playing in it may be unsafe.

Besides medical concerns, there are also environmental concerns, such as changes in water chemistry. Even a slight change in water chemistry can cause population drop offs in benthic macroinvertebrates, or aquatic insect larvae. These organisms, often used to determine the health of a body of water, serve an important role in the consumption of leaf litter. Conceivably, without the invertebrates to consume leaf litter, there could be a build up of these materials, resulting in blockages of streams (5).

Even the fact that the runoff comes off of roads can cause problems. Mud, dirt, and other substances washed off of roads increase the sediment load carried by streams and dumped into lakes and ponds. Additionally, in the summer, the pavement is hot and the first water rinsed off of it and into small nearby streams can cause temperature changes in them.

Many of the same groundwater problems caused by road salts are also caused by the other chemicals found in road runoff. Drinking water standards can be exceeded for heavy metals, pesticides, and organic compounds, all of which can cause or contribute to various medical problems if consumed.

Clearly, there are many reasons why something needs to be one to control the runoff of chemicals from heavily used roads into surface and groundwater supplies. A variety of methods can be considered when attempting to break the flow. Perhaps the most obvious is to decrease traffic. It is easy to understand how less traffic on a road would result in fewer chemical leftovers from fuel combustion, tire marks, and spills, but it is significantly more difficult to make people leave their cars at home. Besides, even

with fewer cars, there would still be a chemical residue left behind by buses and other modes of public transportation that would eventually be washed off of the roads and into various bodies of water by a rain shower. Similarly, decreasing the amount of salt would be very difficult because simply not salting would result in very unsafe driving condition in most scenarios. Perhaps, then it would be wisest to try to find another way to decrease or control the chemical load of road runoff beyond simply decreasing the initial amount of pollutants laid down on the road.

One method of decreasing the chemical load of runoff, specifically of the chlorine ion which can cause acidification, is to use chlorine free salts in de-icing. This seems likely, until one considers that the replacement for the chlorine would be phosphorous, which can cause problems of its own (6). Clearly, it makes little sense to exchange one set of problems for another, but perhaps by following this idea, better and less detrimental chemical combinations can be created.

If it is unlike to be easy to decrease the amount of detrimental chemicals, the better option at this time may be to filter the flow to remove as much as possible. If one considers that statistically, the first 20% of the flow contains 80% of the chemicals and particles, simply filtering a fifth of the flow would result in significant reduction. If this portion could be contained and filtered, it is possible that it would result in a strongly positive change.

In fact, filtering in general seems like it might offer the greatest benefits. A study in Switzerland using a sewered section of road traveled by 17,000 vehicles daily shows clear benefits to filtering runoff from heavily used roads, specifically in regards to heavy metal content (7). In this study, runoff water from the sewers was pumped into a treatment plant which filtered it in two to three steps using various combinations of fleece filters and absorbers (7). It was found that between 70% and 97% of heavy metals could be removed from the runoff, depending on the step and filter/absorber combination used (7).

Another study showed how natural filters could also be used in place of pumping water off to a treatment plant. In this study, a section of the I-40/I-640 interchange had peat filters installed along its edges (8). The peat filters were found to remove significant amounts of polyaromatic hydrocarbons and heavy metals, though the amount removed

seemed to depend on the amount of contaminants contained in the runoff being filtered and more study would be needed to determine how efficient and reliable the method actually is (8).

While the chemical contaminants of runoff are a significant problem with effects on both environmental and human health, it appears that research into their reduction is headed in a positive direction. Cities do need to take a look at reducing traffic within their limits, but it would make sense to attempt filtration methods along highways that are frequently traveled and difficult to use without a car. Additionally, developing better deicing substances would be of great benefit, as would using less salt to deice roads whenever possible, as there does not seem to be a reason for a thick layer of salt if a thinner one would do the job equally well.

Overall, it seems that a combination of methods (fewer, cleaner vehicles; less or environmentally healthier salt; filtration) would work best to decrease the amount of contaminants entering water supplies from road runoff. This is because different methods seem to help to reduce different chemical components of runoff and, therefore, a combination of these methods is needed to reduce the runoff most efficiently.

Works Cited

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