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Total suspended solids in Las Vegas Wash

Mika Koponen
University of Nevada Las Vegas

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Mika Koponen

Tel. (h) 221-5409

(w) 822-3326

Fax 822-3304

Email: mikakoponen@hotmail.com

Content Advisor: Elizabeth Bickmore

Biologist, LVWCC, SNWA

Tel. 822-3300

Email Elizabeth.Bickmore@SNWA.com

Class advisor: Helen Neill

Chair and Associate Professor

Department of Environmental Studies

neill@ccmail.nevada.edu

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Abstract

Erosion along the Las Vegas Wash (Wash) has increased steadily along with the rapidly increasing population. The focus of this study is to find out if there is a relationship between lower total suspended solids rate (TSS) and the construction of erosion control structures along the Wash. The study was conducted between 7/15/2003 and 11/29/2004.

The method was water sampling on 7 sites and the samples were analyzed at Southern Nevada Water Systems (SNWS) laboratory at Saddle Island in Boulder City. Additional water quality data was also collected using Quanta, a device measuring different parameters in water. In this study 5 parameters were collected: temperature (°C), dissolved oxygen(% and mg/l), pH, conductivity (uS/cm). and turbidity (NTU). The results of the TSS samples reflect considerable decline in sediment level and transport to Las Vegas Bay.

Introduction

Las Vegas Wash Coordination Committee

Southern Nevada Water Authority (SNWA) established Las Vegas Wash Coordination Committee (LVWCC) in 1998 to address the many issues associated with the wash. The committee consists of 28 member entities, representing Federal, State, and local agencies, organizations and citizens. The main purpose for the agency is to stabilize, restore, and manage the Wash.

There are two ways the agency is completing this. One is by building erosion control structures and the other one is by protecting the banks. The purpose of the channel bank protection is to reduce the ability of the Wash flows to erode, undercut, and collapse channel banks. Installation of rock riprap and revegetation of the stream banks is also vital part of the plan.

There are 22 planned erosion control structures in the Wash and 8 completed ones. See map of the structures on the next page.

About 18000 linear feet of bank that has been protected so far with rock riprap, or the total of 3.4 miles. The whole Wash will be completely protected with rock riprap in about 10 to 20 years (Gerry Hester, SNWA).

Desert soils

Desert land formations offer ideal views to what powers flowing water can have. The abrasive forces of the Colorado River carved the Grand Canyon in Arizona over a few million years. The formations in Zion National Park in Utah were carved by the same energy and force of flowing water, the Virgin River. Noticeable similarities in both cases are the narrow, V-shaped bodies of the rivers and the immense amounts of sediments that the rivers moved downstream over the course of eons. The sediment rocks in the region are easily eroded by water flows. The cohesion forces between the small particles that form these desert soils is rather low and thus it makes them more prone for erosion.

The Las Vegas Wash was originally a typical dry wash channel. It may have carried flood waters from sporadic storms to the Colorado River. Another, and steadier, source of water came from several small and a few big springs in the Las Vegas Valley area. Most noticeable occurred in the Big Meadows area. The Las Vegas Valley Water District tapped into the springs in the early days of the city, thus harnessing the flows for the consumption of the early settlers of the valley. In 1928, flows in the Las Vegas Wash were recorded to be one cubic feet per second (cfs) (LVWCC). Examining this area today, one can see how the Wash has changed dramatically. The flow rates have increased with the ever increasing population, and there are now three waste water treatment plants along the Wash that release highly treated effluent into the Wash. Headcutting, erosion done by fast flowing water, is recorded as early as 1957 (LVWCC).

The construction of Hoover in 1937 and Davis Dam in 1963 slowed down the abrasive forces of the Colorado River to about 10% of what it was before any construction started. The once mighty and free River is now harnessed to produce hydroelectric power, and has become the source of water for large agricultural areas and cities in the West. Unlike the harnessed Colorado River, the Las Vegas Wash has been flowing freely into Lake Mead carrying large amounts of sediments to the lake. The soils in the Las Vegas valley area consist of silts and clays that have been deposited over the millenniums (Gerry Hester, SNWA). The narrow wash channel provides a relatively small flow area, where the power of the concentrated running water provides an ideal setting for vigorous headcutting. Without damming the water somehow, the area would start looking more and more like the one around Grand Canyon. It might take ages before creating a deep canyon, but the declining water quality is something to think about. Because headcutting occurs more aggressively with high flow rates in relatively small flow areas, it would be necessary to slow down the flows especially in these areas of the Wash. When the flow is spread out in large areas, the force of the flow is slowed down. For example, by constructing dams and setting them in strategic areas, the volume of the flow would be spread out in a larger area. Sedimentation starts to occur since the flow does not have the same kinetic energy as it did when the flow was more concentrated (Selley, 2000, Tucker, 1988). A good everyday example of this is dust settling in a room. The dust particles enter the room from the outside, where wind velocities are high. Inside the room the air is barely moving and it cannot carry the dust particles as well as it did outside. The gravity pulls the particles down. The sediments in the Wash water will start settling down in the same manner once the flow rates are slow enough..

To continue this discussion, the sections to follow are: a literature review, a method proposing how to complete this study, a data section, analysis of this data, a summary and appendix.

Literature review

The Las Vegas Valley is not a valley in which things are neatly aligned. The elevation of the valley floor rises steadily from the East to the West. Any water released further out in the West has more potential energy than water released in the East. In other words, the water has a longer way to descend to the lower elevations and it also has more abrasive energy to spend. Ward and Trimble (2004) dedicated an entire book on weir structures and suspended solid loads. They define suspended load as, "Fine materials as clay, silt, and fine sand that remain suspended in the water column, but can settle in locations where the travel velocity is low or the settling depth is small." The suspended load can be more than 90% of the transported material. That alone demonstrates why a TSS study is important within the Wash.

John Ciciarelli (1986) provides basic understanding how streams carry the sediments and the developments of erosion. He provides some basic formulas t discharge rate calculations, for example Q=WdV, where Q=discharge in ft3/sec, W=width; d=depth; V=velocity of water. He explains channel geometry briefly and then moves on to stream deposition. He explains graphically terms such as drainage basin, drainage divide

Dr. Howard Chang of San Diego State University (SDSU) completed a sediment study in 2001 from Clark County Water Reclamation District to the Wash discharge points to the intake at Lake Las Vegas.

United States Geological Survey (USGS) has also published a number of journal type publications on studies done in various parts of the country relating to TSS. The naming varies from suspended sediments to suspended loads and generally I have yet to see TSS used within USGS publications. The material states that suspended sediments are highest in agricultural and urban areas, where the ground has been worked on (Lenz et al, 2001, Ebbert et al, 2003)

One USGS study was conducted along the Blue Ridge Parkway near Roanoke, in Virginia. This study is of interest to my thesis, because the land is sloped along the Blue Ridge Mountains of Virginia and it has been studied more thoroughly than Las Vegas Valley. The flora is completely different from that of a desert landscape. However, Virginia experiences high seasonal flood events that are somewhat similar to the ones the Las Vegas Valley experiences. Sediments along Blue Ridge Parkway are derived from the erosion of rock material. Unlike in the Wash, the sediments in Virginia are carried to the rapidly flowing Roanoke River and eventually to the Atlantic Ocean. The actual sedimentation process takes place in a saline environment, which is very different from that of Lake Mead (Ebner et al, 2004).

Calculations for sedimentation rates can be obtained from calculations when the flow rate is slow enough that there is not enough energy in the running water to keep the particles in suspension. This is like the settling of dust particles at home: when the wind is taken away, there is not enough force to keep the dust particles floating around. The same idea and principle can be applied to suspended solids. The book “Applied Math for Wastewater Plant Operators” gives methods and calculations for settleability to flow rates (Price, 1991).

In “Wetland Restoration”, Beth Middleton gives a list of chennelization, which she states as a broad category of channel alteration. She also states that channelization and the consequences of it are little studied from an ecological perspective. Channelization applies to the Las Vegas Wash, because the channel conditions are changing with the increasing flow rates. Also, the construction of new weirs changes the channel completely. Middleton gives eight points to channelization:

1. resectioning by widening or deepening the channel
2. realignment or shortening the channel via artificial cutoff
3. diversion or diverting flow around and area to be protected
4. embankment with a linear levee, bund or dike to prevent channel from overflowing onto the floodplain
5. bank protection or channel stabilization
6. channel lining (concrete in urban areas)
7. culverts and dredging
8. cutting and removal of channel obstructions to reduced the roughness and thus increase water flow rate through the channel

Formation of the fine particles is done by weathering. Hervé Chamley has dedicated a whole book to clay formation and sedimentology. The book focuses on desert dusts, glaciers, and rivers, among many other factors of clay forming and transportation (Chamley, 1989).

Similar to Price's "Math for Wastewater Operators" and Chamley's sedimentology, J. R. L. Allen gives information, graphs, and formulas in his book "Principles of Physical Sedimentology". Unlike the others, Allen focuses specifically on desert soils near the Las Vegas area in the Panamint Range on the Western side of Death Valley.

A wide array of information is published on behalf of the Las Vegas Wash Coordination Committee. The history of the Wash, historical flow rates (along with other important information) can be found there. Most notably the construction of the erosion control structures is important for my thesis (LVWPCT, 2000).

H.G. Deming sheds light on different parts of fresh water management. He applies his knowledge to fresh water resources in Nature, fresh water and the land, climates, winds and weather, and most noticeably water as a carrier of energy, which further explains the forces of running water (Deming, 1975).

Method

Water sampling and data collection in this study takes place on seven sites along the Las Vegas Wash on the last Monday on each month. These sites are named according to the distance from Las Vegas Bay, where the Las Vegas Wash flows into Lake Mead. Generally, this kind of naming is called “the river miles”. A site 2.75 miles from the mouth of the river can be then named RM2.75. However, in this study we use LW instead of RM. The reason is because existing SNWA data is already named in this way. The sites consist of LW0.8, LW3.1, LW4.1, LW5.3, LW5.5, LW6.7, and LW10.75.

Sampling sites

The site selection is such that LW10.75 is above The Clark County Waste Water Treatment Plant, as well as The City of Las Vegas Waste Water Treatment Plant. The two wastewater treatment plants release the treated effluent to the same area of the Wash. Therefore, flows along LW10.75 site will mainly consist of the urban runoff and stormwater runoff. Urban runoff is considered a non-point source of pollution and could be defined as excess water used in watering of the landscape, draining pools to streets, washing vehicles in streets, and hosing down driveways (LVWCC).

LW6.7 site is above any weirs or erosion control structures. The closest landmark is Sam Boyd Stadium and Duck Creek, which joins the Wash upstream from this site. The water in Duck Creek consists mainly of urban runoff and shallow groundwater.

LW5.5 site is just below Pabco Road Weir and above Bostic Weir. This site is also below the Henderson waste water treatment plant. The flows at this site consist of urban runoff, shallow groundwater, stormwater runoff, and treated wastewater from all three treatment plants.

LW5.3 site is on Demonstration Weir, and also downstream from the Historic Lateral Erosion control Structure. This is the only site we collected the samples right on the weir. In all the other sites we collected the samples either before or after the weir.

LW4.1 is in a wide and relatively shallow area of the wash. It is below the Three Kids Wash, where there is a groundwater seep. Area around this site has been especially prone to erosion. The banks are vertical on the northern side of the Wash. The banks on the Western side have been made less steep by bulldozers. This is one of so called Green Up planting sites, which is a bi-annual volunteer planting event organized by Las Vegas Wash Project Coordination Team.

The LW3.1 site is above the tunnel where the Las Vegas Wash goes under Lake Las Vegas. It is also just before the Fire Station Weir. The Wash channel at this site is narrow and the flow is rapid.

LW0.8 is the last site just above Las Vegas Bay. The Wash exits the tunnel here. The area is surrounded by very steep banks. The area has also experienced heavy vertical erosion. The flows at this site are a combination of all the four major parts of the water that make up the water flowing in the Wash. Just less than a mile later the Wash enters the Las Vegas Bay.

Hydrolab readings are collected on each site. These readings include six parameters: water temperature (°C), pH, Dissolved oxygen (DO % and DO mg/l), specific conductivity (uS/cm), and most importantly, the turbidity. The collected data is kept and stored in an Excel data file for analyzing and graphing purposes. A handwritten data sheet is also made on each site for security purposes.

250 ml of water samples are collected on each site. These samples are labeled to record the date, time of collection, site name, and the sampler's initials. These water samples are kept in a cooler at around 4°C temperature while on the field. The water samples are then taken to the SNWS laboratory on Saddle Island for testing of the total suspended solids.

TSS Data

SNWS sends a result sheet of the TSS samples from the laboratory within a week. The detection limit is 5 mg/l. The data from the laboratory reports was inputted into an excel file. The data I used for this study was a combination of old SNWA data and new SNWA data. I also graphed all data in one sheet and added a trend line, which is to show the declining TSS concentrations.

For this study, 17 sampling trips were made and a total of 118 individual samples were collected.

Expected Results

TSS concentrations should lower on all sites. The smallest decline should be on LW10.75 site and the highest on LW0.8 site. The reason is that there are no erosion control structures before LW10.75 site, but LW0.8 is after all the structures and in the end of the Wash. Secondly, the flow rates are lower at 10.75 sites on any sample sites.

Results

The highest value for TSS on LW0.8 site was 306 mg/l on the first sampling date on 7/15/2003. The value was the overall highest of any sites. This number is a little biased and shows a TSS concentration that is too high. The reason for that could be some kind of construction going on further up in the Wash. It could have been the result of some rain event.

The second highest value, 150 mg/l, was recorded on LW3.1 site on the same date. This data shows same kind of pattern. The value is also too high and this piece of data can be considered biased. On the next sampling date the TSS values dropped to 38 and 30 mg/l respectively.

After sampling date 6/11/2003 the highest TSS value was 36 mg/l on LW5.3 site. On the following sampling trip the value at the same site was already 22mg/l. This shows the expected results.

After 7/9/2003 the TSS concentrations remained below 20 mg/l on all 7 sites. This is what we expected to find. The highest value was 10.6 mg/l., which is 3.5 times less than the reliable first collected data (38 mg/l). There has been a lot of construction going on up above this site and this value could have been even less had there been no construction going on.

The lowest overall value was 5 mg/l or less, which was recorded on many sites. This is the detection limit and therefore the actual value is 5 mg/l or less. . Site LW10.75 shows that value many times and that is because the flow rates at that site are the lowest of all the seven sites. The channel at the site is also lined with concrete and there are very little sediments to pick up. This, too, is an expected result because most of the flow occurs below this site.

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LW0.8 showed the best results in declining TSS concentrations. See the graph in the next page. The trendline on LW0.8 data makes it clear how the values are going down.

Discussion

The sampling trips were always conducted on fair weather. 17 Sampling trips were completed and 118 samples were collected.

On rainy days no samples were collected and the collection date was moved a few days ahead. However, on sampling dates 2/15/2003 and 3/15/2003 the values rose up on all sites, except on LW10.75. That could be because of winter rains disturbing the soils and bringing in extra amounts of fine silt and clay. It could also be because of construction in the Wash itself, which is going on in various sites. For example Duck Creek channel has been worked on for well over a year. The channel there has been getting on a new concrete lining. Heavy machinery has been on Duck Creek channel ever since the work started there. A whole new neighborhood close to Hollywood Road and across from City of Las Vegas Pollution control Facility has been under construction. Work has been done in the Wash also. That has been temporarily rising up TSS levels in the Wash.

The fact that the major disturbances in the Wash occurred after LW10.75 site indicates that whatever happened, happened after the City of Las Vegas and the Clark County wastewater treatment plants. Therefore I am fairly certain the increase in TSS levels was due to the heavy machinery in the Wash itself.. The water at LW10.75 is solely urban runoff and just after the sampling site it mixes with the Clark County effluent release.

The data shows that the TSS values clearly drop from the beginning values of the study on 7/15/2003. No value rose anywhere near the beginning values. That can be partly because of the new erosion control structures. It is also good to remember that the flows in the Wash only increase, because of the ever increasing population. Therefore, if the Wash was left alone, the TSS concentrations should only increase. This is not happening, though.

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