Sustainable Design for Water Pollution Engineering
Part II of a 3-Part Series: What's the Goal? Or a Matter of Degree?

By: Bill Heasom, P.E., Member of the Sustainable Design Subcommittee of the Water Pollution Engineering Committee

Defining Sustainable Design

In Part I of this series, a definition of sustainability similar to the one below was offered:

Sustainable water resource systems are those designed and managed to fully contribute to the objectives of society, now and in the future, while maintaining their ecological, environmental, and hydrological integrity. (ASCE, 1998; UNESCO, 1999).

It was suggested that the term ***sustainable design*** obliges the engineer to meet specific ethical criteria that were not necessarily spelled out in the past. Part II of this series considers implications of sustainability and emphasizes the importance of the "big picture" that led to international adoption of current sustainability goals.

Nature's Sustainable Designs

For the ensuing discussion, let's temporarily set aside some of these accepted definitions of sustainability for a more primitive one: we might say that something is sustainable if it can continue for a very long time without degrading. There are natural models for sustainable systems (they hydrologic cycle, the carbon cycle, etc.) as well as for the forces that maintain their integrity and equilibrium (evolution, gravity, conservation of energy, etc.) As humans, we all have a strong innate will to survive. That drive lies very near the core of what determines the "objectives of society" and "ecological integrity".

Such a systemic view offers an opportunity for organizing the attributes of sustainability and for understanding the ethics of its practice directly. It is an alternate view that reveals the difficulties in the design of systems that are truly sustainable— difficulties which may be obscured by the ASCE/UNESCO definition.

A Natural Model

Consider an enduring natural system like a stream or river, one which might be connected to a city for purposes of water supply or treatment plant discharge. In geological time, we know the stream appears and disappears. But, without some dramatic event, we expect it to endure for a very long time—changing in response to the changes around it. At various times, it may be subjected to extended periods of flooding or drought; temperature extremes; or variations in water chemistry. Different species of flora and fauna that inhabit it may flourish or disappear. Yet throughout these changes, it is supported by mechanisms that maintain an equilibrium of form and of ecology that allow it to persist.

The sustaining stream does not exist in isolation. Without sunlight, and the sun-driven hydrologic cycle, it would disappear. Without the tectonic warping of the earth, there would be no hydraulic gradient to form it and maintain its flow. Without its connection to the global web of life, there would be neither organisms to inhabit nor biological mechanisms to keep their populations in balance. The stream is connected to and dependent upon all of the earth's natural systems-some immediately and others weakly. We see that the stream is sustaining. Many of the supportive connections that sustain the stream we know about, and over time our science and observation tell us more and more about the streams' ways of enduring. But we also know that there are vital relationships in the natural world that are often concealed until something goes wrong.

Relating the Natural Model to Water Pollution Engineering

Now consider the addition of the wastewater treatment plant. The human-beings that designed, built, and are served by it are a part of the natural order and, therefore, so is the plant. Is it something that nature will long support, or will it be edited by unyielding and impartial rules of nature?

The plant was no doubt designed by expert engineers, intent on removing pollutants from the raw sewage. The designers knew the volumes in and out and the energy requirements. They knew the capacity for pollution removal and the effluent quality. They could offer a cost/benefit/risk analysis of sanitizing the discharge sustainable water pollution engineering design now encouraged within the profession, they can offer additional services: life cycle analyses; LEED scores; suggestions for improved material choices or energy efficient equipment; reduction, re-use, and recycling strategies; etc. They may recommend that the sludge, after additional treatment to stabilize some troublesome pollutants, be placed on a reclaimed strip mine or on agricultural lands instead of in a landfill. Perhaps they may design a system to generate energy from some of the waste which could make the plant "more sustainable".

But, what would be required to make a treatment plant sustainable like the stream and landscape to which it is now connected (and which it now may threaten)? A plant that is sustainable in a primeval way would produce energy beyond its operational needs. That extra energy would compensate for the energy required to manufacture all of its component parts - the demands of the citywide piping and pumping network; the employees' transportation needs; etc. Each need of the treatment plant would be met by its own inexhaustible inputs (the waste stream) or by connection to other virtuous cycles for it to operate like a stream rather than like a conveyor belt delivering finite resources to a sink.

Consider the solids leaving the plant. If the plant were as sustainable as the stream, all of the material entering the plant would be returned to a soil ecosystem. The origin of most of this material is agricultural and it is a rich, but contaminated, resource. If these solids went to the fields that feed the city, another sustaining cycle would be established—one which would also have a beneficial effect on other, more distant systems, since the need for manufactured and transported fertilizer would be reduced. But, there are real barriers to closing the nutrient cycle in this way. The city-wide collection system that feeds the treatment plant does not discriminate against the small, but significant, amounts of contaminants (the pollutants of the pollution) that mingle with the waste stream in unpredictable ways. Some are from industrial wastes and some are a part of the household waste stream that contains an ever expanding plethora of compounds and elements that have never before been a part of the agricultural nutrient cycle. The metals that often turn up in this material occur in small amounts and can be stabilized. But, if we are trying to design a sustainable system, can we cycle these wastes onto agricultural lands indefinitely without building up a dangerous concentration? Can we depend on the stabilization process to be permanent? And what about the newly recognized, but poorly characterized, such as endocrine disruptors? Because of such questions, sludge is often delivered instead to reclaimed strip mines as a safer and sustainable practice This use of biosolids to reclaim strip mines is deemed an example of sustainable practice. But, there is no "strip mine cycle" unless you look out over geological time intervals.

There are many other natural cycles that a facility like a wastewater treatment plant can support or disturb. It becomes an important contributor to the local hydrology. It impacts the flora and fauna downstream and around it. It is an enabler of denser human settlement. Considering the web of environmental connections, we can ask whether the treatment plant-stream combination is sustainable in the way the stream was originally. Are we trading cleaner water here for dirtier air at a distant power plant? Are we trucking away material that will poison some distant soil? How much of the commons (the atmosphere, the oceans, the global mix of species, etc.) are we willing to view as dispensable so that we might continue the kind of development for which a partial sacrifice of those things is necessary? We know we have to deal with the human and industrial waste of cities, but are we open-minded about other ways for providing that service? These are questions of distant effects and new possibilities, seemingly removed from them the day-to-day concerns of practice. But shouldn't we raise them?

Expanding Horizons

Is it possible that a conventional wastewater treatment plant can be *tweaked* into “robust” sustainability? We have wastewater treatment plants now and we will need them in the future, so let’s make them better. After all, to envision our world will continue, we need to assume some new and presently unknown technical solutions will emerge. We must believe in future sources of energy that will replace the non-renewables. We are hopeful that the resource now being placed into landfills in a chaotic heap will one day be recoverable. We pray that the concoction of industrial chemicals unleashed so recently and spread so carelessly can be prevented from poisoning great reserves of groundwater. How will it be done? With energy producing arrays of mind-boggling scale? With robots? With nanotechnology? With engineers organisms? Experience supports optimism, to a degree. But, we also must recognize that these solutions are not yet in hand and are likely to bring new troubles with them.

We need to burn the candle at both ends. Engineers work project by project, each with a myriad of details, constraints, and compromises. Within each of those elements are opportunities for incremental improvements. Reduce. Re-use. Recycle. Introduce more efficient technologies. Work harder at specifying materials carefully after consideration of environmental consequences. However, we also need to understand the gulf between what we are able to do now and what a truly sustainable world would look like. We need to deal with our current realities without forgetting our best aspirations. We need to have the courage to form partnerships with other professionals and promote new solutions. If a system composed of small distributed treatment elements proves superior to a large plant at the end of an aging collection network, who will be able to conceive, test, refine, and promote it if the engineer is not involved? If sustainability and the urgent need for its practice is understood in the context of all the relationships that form around engineered works, then the programs, policies, ethics, and actions will follow.