The word “Waste” has done society a tremendous disservice; it is a tremendous misnomer. There is no true waste in wastewater or biosolids, only resources in need of recovery and beneficial reuse. There are many valuable constituents in waste and only one is truly toxic – and that toxic constituent is fear.

Generators of societal byproducts around the world are reassessing these materials and finding ingenious methods to recover and reuse constituents with inherent value. Societal byproducts are generated from products and commodities either mined or raised on earth. These commodities required nutrients to grow; energy to mine or to plant, harvest and transport, energy to manufacture, and energy to discard; they required water to produce a value added end product and a cadre of workers, managers, and consumers to assure sustainability. Those components remain in the by-products of their consumption.

- Nutrients as N, P, K, Ca, Mg, S, Fe and the trace minerals
- Energy as food for microorganisms used to produce compost or bioenergy
- Water and a carrier for these materials or as a by-product of their decomposition
- Sustainability and resilience as the workers, managers, and consumers who utilize the resources recovered beneficially

Beneficial use is the key that opens the locks preventing realization of this NEWS paradigm or model. The purpose of this paper is simply to explore some of the opportunities for resource recovery associated with our existing waste management model and to attempt introduction of the NEWS paradigm; one that values Nutrients, Energy, Water and Sustainability.

**Nutrient Source:**

Each of the elements in the NEWS paradigm are inherent in societal byproducts. The challenges associated with recovering and beneficially reusing these seems to get more difficult as societies mature. Subsistence communities exhibit little apprehension to recover and reuse animal manure and some elements of human waste in agriculture. Remember, the plant nutrients concentrated in food and fiber crops are either consumed directly by human populations or by animals that are subsequently consumed. These nutrients supported the growth of those organisms and the levels of these nutrients are adequate to support crop growth when beneficially reused. Nitrogen is present in high concentrations in urine and at lower levels in feces. This nitrogen can be used directly to support plant growth or it can be mixed with organic sources of carbon to produce compost – a valuable soil conditioner.

Phosphorus is present in urine and feces. Phosphorus is a vital element in the production of energy in living organisms and it is metabolized and recycled through the biological energy
cycle or is discharged in urine or feces in animals or is retained in plant tissue only to degrade and return to the plant/soil system as organic matter decomposes.

Potassium is vital in adjusting salinity in cellular fluids and in transmission of nerve signals. Potassium is discharged in urine and feces or is retained in plant tissue and returns to the plant/soil system as organic matter decomposes.

Carbon is the basis of all organic life forms on earth. Carbon is a predominant component of feces and is present in plant tissue. Carbon returns naturally to the environment where it is degraded by a host of microorganisms and returned to the plant/soil system.

Each of the essential plant nutrients is accumulated into plant and animal tissue naturally. Under natural conditions, these are returned to the receiving environment as the organism dies. Human populations have had significant impact on this natural cycle – denying the value of natural processes in sustaining healthy ecosystems. Modern societies collect and treat waste only to place it into dedicated landfills or back to receiving environments with little recognition of the resource values contained in these societal by-products. We do this in the name of public health and environmental protection and nobody denies the value of effective public health and environmental protection efforts. Resource recovery and beneficial reuse efforts are long overdue in our efforts to promote sustainability and resiliency in society.

The various sources of nutrient can be recovered safely and returned to agricultural and silvicultural production sustainably. Resource managers report that the available stores of high quality phosphorus for agricultural use and product manufacture are in danger of extinction in as little as 50 years. Phosphorus recovery is accomplished from wastewater through a series of chemical processes and several municipalities are examining these – what about the onsite industry?

**Energy Source:**

Societal by-products contain organic carbon. Carbon forms the basis of all organic material: sugars, proteins, ADP and ATP all contain organic carbon. As is metabolized, it is either retained in plant material or excreted as gas (CO2) or in urine and feces. Carbon makes up most of the material we handle on a daily basis and many of us simply ignore it’s value through unsustainable land application programs.

Why not recover and reuse that carbon through production of value added products like compost or add it to soil and create custom soil blends that meet local demands for quality landscaping media? Why not team with local transporters to develop a digester and recover heat and power?

Compost is the organic matter left following a sophisticated degradation process involving biological energy sources as feed for microorganisms. This process is so complex that it occurs on the forest floor most every day. Today we have farsighted individuals in this industry who manufacture valuable compost from septage and FOG. How, the process is relatively simple. It involves a dewatering operation to concentrate the solids (carbon and nutrients) then a process to mix and blend these dewatered materials with a dry carbon source and air to produce compost. The compost operation recovers the biological energy from the feedstocks (septage, FOG, food waste, etc.) and utilizes that energy to sustain the
“decomposers” involved in the compost process. Yes, it does take time, but the end product is a valuable soil conditioner – one capable of increasing soil organic matter levels and soil organic matter is increasingly lost from field sites. Small companies operating on small sites can produce high quality compost. Compost produced from domestic sludge and FOG contains moderately high levels of carbon and nutrients as described in Table 1, below

<table>
<thead>
<tr>
<th>Source</th>
<th>O.C.</th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>S</th>
<th>Fe</th>
</tr>
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<tbody>
<tr>
<td>Septage</td>
<td>20-40</td>
<td>2-3</td>
<td>1-2</td>
<td>0.5-1</td>
<td>2-3</td>
<td>0.5</td>
<td>0.25</td>
<td>0.1-0.2</td>
</tr>
<tr>
<td>FOG</td>
<td>30-50</td>
<td>3-5</td>
<td>1-2</td>
<td>0.5-1</td>
<td>1-2</td>
<td>0.25</td>
<td>0.25</td>
<td>0.1</td>
</tr>
</tbody>
</table>

In some instances that organic carbon can be degraded into biogas - a methane rich energy source that can produce heat and power. This cannot be done on a small scale. Digestion with energy recovery requires significant volumes organic carbon. The biogas generated in the process can be marketed through power companies, but that is challenging. It does require cooperation between power companies and waste handlers and that may be difficult to obtain. Alternatively waste haulers might enter into cooperative arrangements with local wastewater facilities actively operating or planning to develop Combined Heat and Power (CHP operations utilizing municipal waste. An operating example is the Catawba County Solid Waste facility where landfill gas is collected from a solid waste landfill; and the landfill operator is in discussion with a liquid waste handler to augment the organic matter levels in the landfill to increase biogas production.

**Water:**

How could we make a presentation to the National Onsite Water Recycling Association without discussing the value of water. Clearly water is a component of wastewater. The typical concentration of suspended solids and organic matter in wastewater is less than 1000 mg/l this means that wastewater is over 99.9% water with a little extra stuff added for odor and color. The bulk of the material we handle as wastewater, septage and FOG is water. The intent of our treatment efforts is to separate the solid material from the water to render the constituent materials suited for discharge into designated receiving environments. The water fraction can be recycled and reuse through local recharge as effluent from a well designed, properly installed and operated onsite wastewater system, it can be treated to a suitable standard are irrigated on a site to support plant growth, it can be treated to a reuse standard (see NSF 350, NCDEQ DWR 2U, or other state standard) and utilized indoors as source water for plumbing or outdoors for irrigation.

Examples of onsite reuse are emerging in the popular and technical literature and onsite systems permitted by local health agencies are entering the array op allowable options. Wilkerson Park in Wake County, NC utilizes a MBR for wastewater treatment and the treated liquid is utilized to supply flush water for plumbing fixtures in the buildings. The Solaire and Visionaire residential facilities in New York utilize a MBR permitted by the city building code enforcement office and the treated liquid is pumped through the facilities for use in non-potable applications. Clearly the technology and the ability to design, install, operate, maintain, and manage the technology are all available. What is missing is the commitment to have all involved in the permitting, installation, operation, maintenance and management sectors involved. These systems are a part of the infrastructure for a building and the community. These assets MUST be viewed as infrastructure and managed
accordingly – that means for the life of the facility. Trained and certified individuals must be available to assure sustainable management. And this leads to the final component of the NEWS model – sustainability.

State agencies have established Standards for Wastewater Treatment. These are summarized in the USEPA Guidelines for Water Reuse. Please note the reference here is to water reuse. Not wastewater treatment and wastewater reuse. This is a signal that the federal agency charged with responsibility for water protection recognizes the value of reclaimed water in the overall water management portfolio. These standards vary from state to state simply because the USEPA was not assigned responsibility for reclaimed water by congress – only water that is discharged through the NPDES Permit Program.

Selected water quality standards are presented in Table 2, below.

<table>
<thead>
<tr>
<th>Standard</th>
<th>TSS</th>
<th>BOD</th>
<th>Turbidity</th>
<th>TN (NH4)</th>
<th>Coliform</th>
<th>Coliphage</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSF 40</td>
<td>25</td>
<td>30</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Level 2</td>
<td>15</td>
<td>15</td>
<td>NS</td>
<td>&lt;20</td>
<td>10000</td>
<td>NS</td>
</tr>
<tr>
<td>Level 3</td>
<td>10</td>
<td>10</td>
<td>&lt;5 NTU</td>
<td>&lt;10</td>
<td>&lt;14</td>
<td>ND</td>
</tr>
<tr>
<td>Reuse</td>
<td>5-10</td>
<td>5-10</td>
<td>&lt;5 NTU</td>
<td>&lt;10</td>
<td>&lt;14</td>
<td>ND</td>
</tr>
</tbody>
</table>

In addition to combined wastewater (graywater and blackwater) there has been continuing interest in graywater separation, treatment and use. In most jurisdictions graywater is considered wastewater and must be treated appropriately before use. NSF 350 Standards contain standards for the combined wastewater stream as well as the graywater stream. The standard for indoor reuse is equivalent to the standard imposed on the combined wastewater stream, simply because of the risk associated with indoors exposure. Graywater collected, treated and reused for outdoor irrigation may be subjected to a lesser standard depending on the method of use and the potential exposures. For example, surface spray irrigation has a higher risk of exposure than sub-surface drip irrigation, consequently surface spray standard are stricter than those for sub-surface drip.

The final permitting for reclaimed water programs rests with a variety of agencies depending on state rule and regulation. Reuse is typically permitted through health or environmental quality agencies, but in one jurisdiction of which I am aware, indoor reuse is permitted through buildings. In cases where reclaimed water is utilized indoors to supply plumbing fixtures, that use is regulated through building (plumbing) code. Typically two plumbing codes are recognized nationally, the ICC code or the IAPMO code. Both recognize provisions for reclaimed water.

The ICC code contains specific provisions for commissioning studies whenever a non-potable source is utilized within a building for plumbing. This commissioning requirement is reflected in Chapter 9 of the ICC Green Code (effective 2015).

**Sustainability:**

Onsite and distributed systems have been a part of the wastewater management portfolio for over 100 years. Little attention has been devoted to the sustainability component until
the USEPA Response to Congress (1997) and the USEPA Guidance for Onsite Wastewater Systems (2003). The elements of sustainability are most difficult to achieve simply because they do not always involve science and technology rather sociology, economics, political science, business and management and policy.

In 2004, the USEPA described management issues for onsite and decentralized systems. These included the following elements public involvement, planning, performance standards, training/certification/licensing, site evaluation, design construction, o and m, residuals management, inspection and monitoring, corrective action, record keeping/reporting, financing. In addition, operators and managers of small, decentralized systems must consider a variety of sustainable and effective criteria for effectively and sustainably managing the assets and resources necessary to assure long term operation – remember these systems are the infrastructure for the client. Attributes of sustainable utility management as defined by the USEPA with potential application to distributed systems might include:

**Product quality** – assuring the quality of wastewater and residuals meet or exceed permit requirements. This requires monitoring and testing, maintenance, and management. Water fit for purpose is the goal – regardless of the dispersal option.

**Community engagement** - the onsite and decentralized approach is their infrastructure, the client’s and the community’s; they must comprehend the need for developing a sustainable approach to assure the proper operation of these onsite and distributed systems.

**Leadership** – Representatives from the community, the local unit of government with responsibility for issuing building or occupancy permits, water/wastewater service permits and the responsible operating entity must demonstrate the leadership necessary to sustain the installed infrastructure for the life of the community.

**Financial Viability** – there are real and legitimate costs for providing service and there are real benefits that accrue to a community as a result of properly developed and managed distributed infrastructure. Costs of operation must be recovered and the private sector understands this well. Similarly the tax benefits of properly managed infrastructure must be communicated effectively to the residents and the local unit of government.

Customer Satisfaction and support – who is the customer? The property owner hosting the system? The community? Regardless of the final definition, service providers and managers of distributed systems must satisfy the dictates of a wide variety of customers. To assure customer satisfaction the clients must be involved at all levels of the program.

**Operational Optimization** – to be recognized as infrastructure, distributed systems must be managed appropriately. That requires proper siting, sizing, design, installation, operation, monitoring and management. The varied activities involved in optimizing the operations require system managers to forecast, schedule, implement, and finance the various functions necessary to sustain systems in a service area.

**Operational resiliency** – by nature, onsite and distributed systems are resilient. They are capable of responding to changes in operating conditions and changes to operating
environments. Proper management maintains this resilience and assures systems can provide effective treatment as operational challenges emerge.

**Infrastructure stability** – the flow and quality into a system is generally below that specified and designed, but that is not the stability necessary. The necessary stability involves assurances that the onsite and decentralized infrastructure will be managed through time as the option of choice for the area. Once a community commits to this level of infrastructure, that commitment must continue through provision of appropriate levels of funding, personnel, and management.

**Resource adequacy** – Human resources, technical resources, and fiscal resources must be present to support the selected infrastructure. Periodic element-by-element program review and program modifications are necessary to support the distributed infrastructure.

Examples of distributed system sustainability are obvious. The systems serving the SFPUD Offices, Solaire, Visionaire, Foxboro Stadium, Wilkerson Park and many others demonstrate the value of the water resources recovered and reused beneficially. More importantly distributed systems offer the community an opportunity to treat water to appropriate levels and recharge aquifers and help maintain base flows in receiving streams.

Examples of energy recovery are evident in literature. There are examples – often located at industrial operations – where anaerobic digesters recover and reuse energy for a variety of heat and power applications.

Nutrients are recovered and reused through both land based residuals operations permitted through 40 CFR Part 503 and the emerging compost production facilities which treat and condition wastewater residuals into value added products. The compost, dry pelletized residuals, and lime stable biosolids derived materials generated from waste retain the nutrients initially derived from plants and offer the potential to return those to beneficial agricultural and silvicultural plant production.

Sustainability and resilience are critical to assure the future of all infrastructure.

References:


USEPA Handbook for Onsite Wastewater Management Systems, USEPA OWM, Washington, DC, 2005

USEPA Primer on Effective Utility Management for Water and Wastewater System Sustainability, USEWPA OWM, 2008