

CHAPTER FOUR

The Five Zeroes of Sustainability*Reassessing Sector Beliefs*

When we've been here ten thousand years
 Bright shining as the sun
 We've no less days to sing God's praise
 Than when we'd first begun.

Amazing Grace, Fifth Verse

Thinking Large and Thinking Long

“When we've been here ten thousand years . . .” Looking forward from today, is this but an idle hope, or a realistic way of visualizing humanity's future on planet Earth?

Who can know?

As Americans, as humans, we are not skilled in thinking long, nor do we have much gift for thinking large. We have trouble enough understanding our place on planet Earth, today, let alone ten thousand years from now. This is unfortunate. If we are to be capable stewards of the common good, we shall have to develop some skill at thinking long and thinking large.

So let's begin with some warmup calisthenics. Our Earth, as we all know, is the third planet from the Sun. Its diameter at the poles is 7,901 miles, at the equator, the diameter is 25 miles greater, or 7,926 miles, for an average diameter of almost 7,914 miles. Think large.

The surface area of a sphere is four times the area of its corresponding circle, or four times πr^2 . Running the numbers shows a surface area for our Earth of nearly 197 million square miles. As a rule of thumb, we can think of Antarctica as 5 million square miles, all other land area as 53 million square miles, and the seas and oceans as 139 million square miles. That's our inheritance, and it is an inheritance that never grows and never shrinks.

Think large. Learn to know the size of our whole planet, and its limits, so that we can understand the limits that we as humans must work within. Thinking large is just another kind of mental calisthenics. Repetition counts. Doing it once is not enough; as with any exercise, our abilities improve with practice.

Now think long. Our universe, astronomers tell us, arose from a unique event, known by physicists and cosmologists as a Singularity, and known by the rest of us as the Big Bang. Its timing can now be dated with extraordinary accuracy, and astronomers feel comfortable in saying that this Singularity occurred some 13.7 billion years ago, give or take a few tens of millions of years. It wasn't a point source explosion. It took place throughout an infinity of space, difficult as that is to comprehend, and brought into existence all the energy and mass that make up our universe. Once the overheated cosmic gases of the Big Bang had cooled sufficiently, they congealed

into balls of hydrogen gas, ignited, and become stars, and, in larger aggregations, galaxies. Over a few billion years more, those stars burned through all their fuel, exploded, and expired, leaving behind the heavy elements that now make up much of planet Earth and the other planets of our solar system. Somehow our solar system formed out of this cosmic stew, with our hydrogen fueled sun at the center and our Earth spinning around the sun some 93 million miles away. Scientists infer from many types of concurring evidence that our Earth was formed approximately 4.5 billion years ago.

Somehow, out of all the ingredients that came together at that time, we inherit not only a planet but the lengthy and complex series of blessings that led to the origin of life. Whatever the initial factors that contributed to its launch, we cannot know, but we know that life today depends upon the coding molecules of DNA for its expression and perpetuation.

Life comes from life. The chain of life for every living creature, from bacteria and other micro-species to plants and animals, stretches back and back and back into the mists of time. When different species turn out to share long stretches of matching DNA, it speaks to a common ancestry. At the same time, DNA variations among species with a common past speak to the processes by which they diverged and became as separate and different as they are now.

From studies of modern DNA, geneticists report, one sees clear proof that modern humans and modern chimps both descend from the same ancestors, but split into separate lines about six million years ago. Even today, after six million years of separation and differentiation, human and chimpanzee DNA molecules are 98% identical. It is the remaining 2% whose differences account for the differences between humans and chimps. As one change after another accumulated in the line that evolved into modern humans, our ancestors become progressively more and more capable. At some point in time, all the DNA markers of modern humans fell into place.¹

We also know that the Y chromosome in human males tells of a common ancestry for all human males. And in parallel, the mitochondrial DNA in all human females tells of a common ancestry for all human females.² Diverse as we humans may now seem to be, all human tribes, everywhere on the planet, share a common ancestry. We are all cousins who have originated from a single chain of human life. In other words, there is but one human family, and all of us are members within it.

The point at which modern humans finally emerged is still in dispute. Some think of us as going back a hundred thousand years or more, while others lean toward an estimate of fifty thousand years as the time when modern humans finally emerged. The more recent estimate has intuitive appeal. Had we been around longer, wouldn't our ancestors have learned the arts of civilization somewhat sooner?

Fifty thousand years of humans. At twenty-five years per generation, that implies two thousand generations of ancestral humans walking this earth. Forty more generations each millennium. If we are to be here still, singing Creation's praise, ten thousand years from now, we shall have to keep Earth habitable for another four hundred human generations. Now, perhaps, it will be clear why I emphasize the importance of thinking long. If we descend from two thousand generations of human ancestors, that gives us quite a responsibility. It is upon us to keep the Earth livable for quite some time to come, not just for this decade, or this century, but for generations and generations to come, numbering in the hundreds, in the thousands, or even more. What we have

been blessed to receive, we are morally obligated to preserve and pass along.

Look back, and learn to think long.

Look forward, and think long, and ask what responsibilities we have as a single human family, what responsibilities we have as a species.

The lyrics of *Amazing Grace* promise another ten thousand years. I love the symbolism. Are we up to it?

The central theme of this book is that humans survive on this planet only if we acquire wisdom, and that we acquire wisdom only if we embrace stewardship of the common good as our civic calling. Once we embrace stewardship, once we apply its insights, sector by sector, we will see society's core assets recover their health. We will be over the hump and on our way.

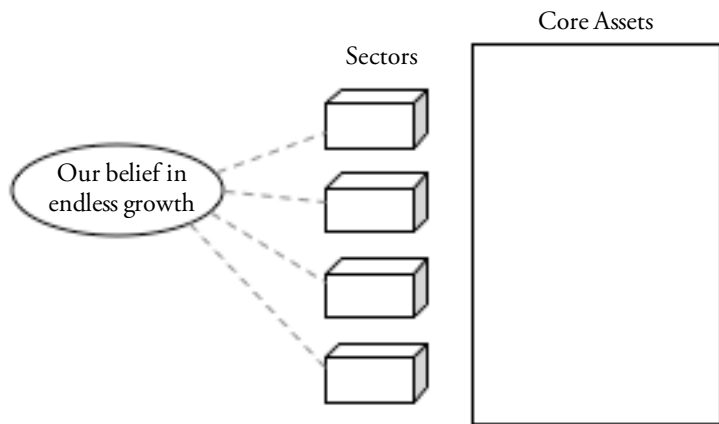
But if we are to be good stewards, first we shall have to learn the art of thinking large and thinking long. It becomes part of our craft.

The Illusion of Endless Growth

As Americans, we cherish our embedded values. Freedom – we celebrate the liberty of individuals. Democracy – we celebrate the sovereign voice of the public in choosing our leaders. Constitutional Government – we celebrate our Constitution as the charter that establishes and defines our federal system, holding us together in a common nation, empowering us to function also as fifty separate states. Capitalism – we celebrate entrepreneurship, opportunity, and free markets; we celebrate service and reward. Prosperity – we celebrate the blessings of endless growth, bestowed by a loving Providence on those who hold to the values of Freedom and Democracy and Constitutional Government and Free Market Capitalism.

Is there a warning bell that goes off when you read this summary? There should be. One of the values expressed above is dangerously misleading. Is endless growth really the foundation of our prosperity? If we say yes, we badly fail the test of thinking long and thinking large.

But fail it we do. We imagine that endless growth is our entitlement, we imagine that each year we shall be wealthier than the year before, and we imagine, because we are Americans, that the cornucopia will always overflow with plenty. It is felt as one of the deep and powerful promises of our culture. And it sinks deeply into the value system of any sector one might name.



It is time to take another look. If we think long, and we think large, we will find that we don't want *any* sector misled by the fiction of endless growth.

What I propose is analogous to the question a major developer might ask. Instead of saying, "Which architect shall we hire?" he asks the deeper question. "From which School of Thought shall we hire the architects we need?" When a challenge is wholly new, Old School tradition steers one wrong.

In yesterday's world, we habitually hired advisers from the school of thought known as Growth. In tomorrow's world, we shall have to hire advisers from the School of Sustainability.

Growth has been with us now for some centuries, but not that long, really, if measures against the full fifty thousand years of human presence on our planet. Technology-driven growth as a way of life goes back little more than five or six centuries, scarcely one percent of the entire human journey till now. It was in the 1400's that monarchs and nobles and merchants and inventors first began to connect the dots of modern life. Power was linked to wealth, wealth was linked to trade, trade was linked to technology, and technology was linked to invention. Sponsor invention, and a resourceful prince might well achieve wealth and power. Princes who wanted to send trading ships to the far corners of the world needed navigation tools. They required telescopes, which in turn depended on the arts of grinding lenses. They required navigation maps and sextants, so that their merchant captains might calculate their positions at sea. And they required accounting tools. A Franciscan friar from Tuscany, Luca Pacioli, formally codified double-entry bookkeeping in the late 1400's. Growth as a way of life had begun to make itself known.

Later on, those who recognized the potential of coal needed a tool for pumping unwanted water out of coal mines. Newcomen was the first to produce a primitive steam engine; a few decades later, James Watt substantially refined the steam engine. We had learned how to magnify the power of human muscle by inventing energy-burning machines. We were mastering the arts of growth, and we were on our way to becoming a race of giants.

One improvement led to another, and another, and another. Better optics in time yielded powerful microscopes and the first scientific understanding of disease. The more we understood disease, the easier it was to master the arts of healing and health. The healthier a population, the more it can accomplish.

Europe became the incubator for modern industry, modern capitalism, modern government, and the missionary church. In its search for wealth, it reached out with all its tools. Missionaries. Merchants. Navies and colonial armies.³ Growth financed imperial power, imperial power expanded the realm of wealth, and wealth stimulated further growth. It was an intoxicating formula. And in its wake, we learned to equate prosperity with growth, and power with prosperity.

Now, though, it is time to think anew about this old love affair. If we think long, and think large, will we continue to grant a place of honor to the belief system that celebrates growth?

Thinking Long: A Few Thought Experiments

Now it is time to think long, not as astronomers do, or human geneticists, but as historians might. When humans grow technology, and wealth, and consumption, and population, where might these trends carry us? What's our prognosis, if Growth remains a central part of our belief system? I have four thought experiments to offer.

Thinking Long about Prosperity. Everyone loves money, and everyone wants to be a millionaire. Let's see what it really means, though, to imagine a world in which prosperity rises, year after year, for centuries on end. My first thought experiment runs the numbers on money.

For the entire global economy, I imagine a GGP, a Gross Global Product, of \$60 trillion a year, which is roughly where the world is today. And I imagine, as well, two percent annual growth in Gross Global Product, compounding every year for the next one thousand years.

Pause for a moment. What does a thousand years mean to you? Is a thousand years forever? Or brief? Or something in between? A thousand years; ten centuries. Annapolis, where I live, is a small city that's three centuries old and counting. We Annapolitans are not unfamiliar with centuries. When the Lord Ligoniere arrived from Africa with a load of slaves, including Kunte Kinte, harbormaster John Ridout signed the manifest, as he did for every newly arrived ship. Ridout family descendants still live in Annapolis, many generations later. The Continental Congress met in Annapolis, in the mid-1780's, and set in motion the Philadelphia convention of 1787 that produced our Constitution. But none of this holds a candle to the Catholic Church, with us now for almost two millennia, just about twice the length of the thousand year period I model here.

Now for the calculations. They are simple, really. The hardest part is keeping track of all those darn zeroes. \$60 trillion, when written out, is \$60,000,000,000,000, the number 6 followed by thirteen zeroes. To grow sixty trillion dollars at 2 percent a year, I simply multiply sixty trillion by 1.02. And again by 1.02. And again, for a thousand iterations in all. Each iteration represents Gross Global Product compounding at two percent a year. $\$60 \text{ trillion} \times 1.02^{1000}$. (On an Excel spreadsheet, one would express such a calculation by typing in $=60,000,000,000,000 * 1.02^{1000}$.)

A thousand years from now, where will we be? The global economy has jumped from \$60 trillion a year to \$24 sextillion per year. From \$6, followed by thirteen zeroes, to \$24, followed by 21 zeroes. \$24,000,000,000,000,000,000,000. As I said, a lot of darn zeroes. Keeping careful track of the zeroes is one of the secrets to thinking large and thinking long.

Suppose, further, that the world's total population has stabilized at 9 or ten billion people, spread across three billion households. Take half of the 24 sextillion dollars to represent household income. Then divide 12 sextillion dollars by 3 billion households. Total product per household weighs in at \$4 trillion a year. Yes, that's \$4 *trillion* a year. *Per family*.

Think of it. In today's U.S., the Gross Domestic Product is roughly \$15 trillion. In a thousand years, according to my imaginary scenario, four average households will have a higher annual income than the entire American economy of 2009. How much would my wife and I have to consume to spend \$4 trillion a year on our family? Is this realistic? Does it make any earthly sense, whatever, to imagine that all the throughput of the current American economy will, ten centuries from now, be eclipsed by the annual incomes of four households? Or to imagine that, worldwide, fifteen households in 3010 will have as much annual income as the entire world of today? It is a fantastical notion. What I argue here is the essence of realism. Growth is not endless; it does end. And it will most likely end in the lifetimes of our children's grand-children, sometime late in this century or early in the next. The perception of eternal growth is an illusion. Somewhere, on the path ahead, the upward slope of endlessly growing prosperity levels off. It no longer rises.

Sufficient prosperity exists for everyone. Nature's hardwired limits set an upper bound to what we can do. Throughput has physical limits. Prosperity has physical limits. We level off, partly because we have to, but also partly because we choose, wisely, a feasible path of sufficient prosperity, not an imaginary path of perpetually rising prosperity.

Thinking Long About Stuff. Let's do the same exercise again, this time with physical Stuff rather than with money. Suppose, for the sake of argument, that some cosmic WeighMaster is commissioned to put all of America's Stuff onto a scales and tell us how much the physical Stuff of American civilization happens to weigh. What might he tell us? I have no idea, but let's make a wild guess: A hundred tons per person. Count all America's roads and streets and highways, all its homes and apartments and other buildings, all its cars and trucks and trains. Weigh it all. Now. Divide the result by three hundred million. Will it actually be a hundred tons apiece? Might be low, here in America. Might be way too high, in a country as poor as Haiti. But let's work with it – it has to be roughly right.⁴

Now. Just as in the previous example, when I imagined endless financial growth at 2% a year, in this example I imagine that Stuff grows at 1% a year, worldwide, and compounds at that rate for the next thousand years. By 3010, the total volume of human Stuff is sufficient to bury all the land area of the planet (excluding Antarctica) under a mound of human stuff that's roughly 85 feet deep. Think of it. Every acre of land, all across the planet, buried under eight stories worth of human Stuff –infrastructure and consumer goods combined. The movie Wall-E visualizes an Earth buried in so much trash the humans themselves had to leave. Maybe its writers were thinking long well ahead of everyone else.

Thinking Long about Population. First Money. Then Stuff. Now let's think long about People.

Start with land area, for all practical purposes a fixed quantity. Omit Antarctica, but include the remaining 53 million square miles, or 33.9 billion acres.

Though land is a fixed quantity, population is not. Herewith, from the US Census, the population numbers, from 1950 forward, and estimated from now till 2050. Notice, beginning with a population of 3 billion in 1959, how quickly we humans have been able to add each new billion. 15 years to reach four billion. 13 more years to reach five billion. 12 more years to reach six billion. 13 years, estimated, to reach seven billion. 13 years, estimated, to reach eight billion. 15 years, estimated, to reach nine billion.

Year	Global Population ⁵ (from US Census)
1950	2,555,000,000
1959	3,000,000,000
1974	4,016,000,000
1987	5,022,000,000
1999	6,015,000,000
2012	7,030,000,000
2025	8,032,000,000
2040	9,005,000,000

2050 9,536,000,000

First, it's interesting to note what happens to land area per person. In 1950, 13.3 acres per person. In 2050, if the Census forecast is borne out, only 3.6 acres per person, barely more than a quarter of 1950's share. Second, note the sheer magnitude of these numbers, and the speed at which human population expands. The compound growth rate, from the beginning of this series in 1950 to the end in 2050, is 1.3% a year.

Let's imagine, then, as in the last two thought experiments, that endless growth is possible, and sustained at the same 1.3% a year. How long till we no longer measure Land Per Person in acres, but switch to Land Per Person in square feet? Or more specifically, how long will it be till we have but *one square foot* of land per person? On all the land area of the planet except Antarctica? Compound growth is an amazing process. Turns out this macabre triumph would take us but 950 years. We'd be there by the year 2960, four decades shy of the next millennium.

Could this possibly happen, one person per square foot? Can human population grow, and grow, and grow, forever, on a finite planet? Obviously not. At some point, *all* of humanity will find itself compelled to accept one of Nature's Iron Laws – To overshoot the environment's carrying capacity is to court extinction.

Thinking Long About Land. Now for an exercise that highlights the American fantasy of endless land and limitless real estate. Americans are particularly susceptible to this one. Our white ancestors looked west and saw a limitless continent for the taking. "The only good Indian," it was said in the day, "is a dead Indian." White America had already dehumanized blacks; dehumanize Native Americans as well and taking over a continent becomes easy. Real Estate is limitless. And there for the taking. It is the ancient and still thriving promise of America. Even today, in our dreams of perfect suburban homes and perfect summer cottages, we like to imagine that Real Estate remains limitless for those who have the means to pay.

Let's grant the premise. The more Real Estate the people of the world consume, the happier we will be. In the decades ahead, in the centuries ahead, as growth continues, as the people of the world become steadily more wealthy, it becomes the fashion for every family to own a second home. And a third. And a fourth. Collectively each family's estate comes to twelve acres or more, featuring fancy homes and paved over with swimming pools and tennis courts and parking lots and basketball courts and outbuildings. It is a blessed world of multi-home opulence for everyone. Not an unreasonable vision, right? Who could possibly object?

Now do the math. Three billion households, each with its various getaway homes, each with twelve acres in country cottages and mountain villas and desert hangouts. Three billion times twelve acres is 36 billion acres, is it not? But wait. We live in a world with only 33.9 billion acres, and a lot of that territory is rather unwelcoming.

Is this scenario still believable? At one level, yes. We believe growth to be unlimited, we believe that prosperity is an endlessly rising entitlement. Why not reach a point where every household owns several parcels of country land?

The math says that it cannot work. Not enough land for every household in the world to have its twelve acres and a four car garage. But the math isn't my point. What worries me is our belief system. Will we, in our hearts, pay the slightest attention to limits? Our ancestors completely

ignored the Indians and took from them an entire continent. Will our descendants be any more decent about the use of land? Won't Nature be just as invisible, tomorrow, as Native Americans once were? Some dark voice from inside our culture will call the score. "Thirty four billion acres for Real Estate. Zero acres for Mother Nature. That's the Rule. Now get out of the way, the world's real estate developers have work to do."

Endless Growth, in other words, implies an endless right to convert Nature's ecosystems into human Real Estate. The wealthier we become, the more Nature's realm will shrink.

Adjusting Our Core Beliefs

It is time to start work on a replacement belief system. Endless Growth, as we have known it, has nearly run its course. The endless growth in earnings someday levels off. The endless growth in consuming Stuff levels off. The endless growth in population levels off. And the endless growth in humans converting Nature's lands into human Real Estate? That, too, levels off.

We need a smarter alternative. I urge us to start with the basics. We know them well. As humans, we have babies. We occupy land. We acquire resources. We produce goods – food, clothing, shelter, and many others. We consume those goods. And we generate waste. Babies, land, resources, production, consumption, waste – these are the basics of human existence. They've always been with us, and they'll be with us till the end of time.

What makes our current era unusual is that all of these basics are being acted out on a very steep growth curve. More babies every year. More land. More resources. More production. More consumption. More waste. More, more, more, driven by the illusion that endless growth is the key to endless prosperity.

It is the Ultimate Bubble, and it portends the ultimate Crash.

In our hearts, I believe we know the truth. Growth as an exponential curve is not forever. Instead, growth as we have known it for the past five centuries is but a comparatively brief phase in humanity's journey. It may be several centuries long, but it is still just a phase. Anyone who's proficient at thinking long and thinking large already knows this. The larger contour of the human journey is the S-Curve. Flat, at first, for hundreds of centuries. Then with gathering speed, the curve turns upward, higher, higher, higher. Soon it will flatten out, either because we were wise enough to do it for ourselves, or foolish enough to invite Mother Nature to set us straight in her own ways.

Now the question is: Can we bring the curve to a crest, and level out? Can we do it for ourselves?

The basics are forever – having babies, occupying land, and so on. It is the growth phase that cannot last. So our new belief system has to marry these two realities. I call the replacement belief the *Five Zeroes of Sustainability*. The very name, *five zeroes*, reminds us to stay with the practice of thinking long and thinking large.

The First Zero: Zero Net Increase in Population. We humans have always had babies, and of course we always will. But something important has changed over the past century or more. We have markedly lowered the death rate. That wouldn't affect the size of the human population if at the same time we had also lowered the birth rate. And, indeed, many countries have done just that.

But too many have not. More than eighty countries have fertility rates above 2.4, and those are the countries from which demographers expect the greatest increase in population in the decades ahead.

Adding a billion people every twelve to fifteen years is a frightening rate of increase. It puts pressure on agricultural land, on sources of water, on ocean fisheries, and on many other resources vital to the well-being of both nature and humanity.

Stability is essential, both at the earliest possible date, and at the lowest feasible population. Only in a world with population stability can we ever hope to protect Nature's inheritance properly and pass it along to future generations.

The Second Zero: Zero Net Loss of Habitat. From our earliest days, we have always occupied land, and we always will. The more numerous we are, and the higher our consumption demands, the more pressure we put on the land. The more pressure humans put on the land, the faster the likely loss rate for Nature. Habitat shrinks and disappears. Ecosystems crumple. Species die off as they lose the territories for which evolution has fitted them. Climate change accelerates the loss rate. The faster humanity strips away natural habitat, the more we cheat on the common good, the weaker Nature becomes.

In the new belief system, in our new cultural story, we live by a new rule. Not one acre of habitat can be seized from Nature and converted to Real Estate without a compensating shift in the other direction. Only by giving an acre of Real Estate back to Nature do we earn the right to take an acre of Nature's land and convert it to Real Estate. Live by this principle, Zero Net Loss of Habitat, and our planet will remain healthy for hundreds and thousands of years to come. Violate the principle, and the world of Nature steadily disappears. Cheating the common good becomes wholly off limits if nature's key habitat regions are to be protected in perpetuity. *Zero Net Loss of Habitat* becomes the second iron law of sustainability.

Now to the perennial human activities of getting resources, producing goods, consuming goods, and throwing away the waste. They are the constants of human life on Earth, and they feed into the third, fourth, and fifth zeroes of sustainability.

The Third Zero: Zero Net Loss of Resources. Can humans afford to cut down forests faster than we replace them? Dare we pump water out of aquifers at a rate that exceeds the replenishment rate? Is it acceptable for agribusiness to use up topsoil faster than it can be restored? Is it admissible to mine the ocean for fish so voraciously that fish populations shrink and shrink and never recover? Shall we applaud the mining of minerals for uses that eventually become tomorrow's landfill? Can we tolerate a global energy sector whose modus operandi is one of using up irreplaceable resources at the fastest and most profitable rate? Those who understand the principles of Total Quality will recognize in all these activities the pervasive acceptance of waste as a rule of life. Waste is not our friend. Humanity survives for generations and generations by learning the art of wasting nothing. *Zero Net Loss of Resources* is, in effect, a rule of zero waste. It is one of the iron rules of long-run human survival and prosperity.

The Fourth Zero: Zero Cumulative Pollution. At every step in any manufacturing process, pollution is a possible byproduct. When we mine, we pollute. When we transport, we pollute.

When we manufacture, we pollute. When we consume, we pollute. When we discard, we pollute. At every step of the chain, if we have been careless in the templates by which our manufacturing sectors operate, we will pollute. And what is the price we pay? Auto-immune diseases are up. Asthma is up. Obesity is up. Diabetes is up. Too many alien chemicals in nursing mothers and their infants. Water tables become polluted. Streams and rivers carry terrible pollution loads. Bays and oceans develop extensive dead zones, areas of water so stripped of oxygen that no fish can survive within them. The problem of drug resistant bacteria grows and grows. The combustion of fossil fuels adds more and more to the carbon dioxide overload in the atmosphere. It isn't just an issue of pollution; the issue here is that pollution accumulates. Humans throw pollutants into the environment far faster than natural forces can remove them. The issue here is additive pollution. New pollution, every year, that adds to the pollution load we already had. A species that insists on fouling its nest by accumulating heavier and heavier pollution loads will in time succumb to the toxins it is so fond of accumulating. And much of nature is likely to succumb as well. There is but one alternative, and that is the one that embraces rigorous common sense. Like the previous zeroes, *Zero Cumulative Pollution* is the standard that emerges from thinking long and insisting that we will no longer cheat on the common good.

The Fifth Zero: Zero Cumulative Waste. If I want to mine coal in West Virginia, my cheapest path to the coal might be the ugliest and the most wasteful. Tear the top off the mountain, extract the coal, and toss what's left of the mountain into the valley below. If I operate a molybdenum mine in Colorado, I might do the same. Rip down a mountain, extract the molybdenum, and fill the nearest valleys with massive heaps of left-over slag. If I sell consumer goods, and I take no interest in their post-consumer outcome, odds are that much of what I have sold eventually becomes landfill. When we are heedless of the common good, we are likely to generate waste at every point on the value chain, from start to finish. This is not a smart way to run a sustainable world. Sustainability templates assure us that we will bequeath an inhabitable planet to our descendants; dirty technology templates undermine our ability to promise a livable Earth to any of our future generations. Dirty technology templates create waste, sustainability templates eliminate waste. *Zero Cumulative Waste* is our fifth standard, every bit as essential as the previous four.

These five principles give us the star by which we set our course. They are principles that speak of a new sort of prosperity, a prosperity based on templates that honor Nature's limits while also assuring human well-being.

What they give us is a brighter and healthier future – a sensible vision of human prosperity that leaves behind the fantasy of endless growth. Reason counsels us that a species as powerful as ours, with technologies beyond measure, will have to teach itself to walk softly on the Earth. Gardens are to be tended, not trampled. It is time to hit the Reset button on what we mean by prosperity. Prosperity within a Five Zeroes discipline will serve us well, generation upon generation

Sector by Sector

Every sector in modern society faces distinct challenges. The belief in endless growth is a reassuring one. Operate as you like. We will always have resources, and we will always have places

to throw them away when we've finished with them. But it is, as we see, a childish notion, reassuring if we are in the habit of thinking short and thinking small, but appalling once we develop the knack of thinking long and thinking large.

In every sector, there are new questions on the table. Is endless growth part of this sector's current belief system? Can such a scenario ever meet the Five Zero Test of Sustainability? How should this company, this industry, this sector, organize itself to prosper in a Five Zeroes future? How can investors best support a Five Zeroes approach to sustainability?

No two sectors will have quite the same answers. But the firms that are the smartest about the future gain a competitive edge. Those who find the best route to a future of Five Zeroes sustainability will be more attractive as places to work, more attractive as companies to buy from, and more attractive as companies to invest in.

¹ Katherine S. Pollard, "What Makes Us Human?" *Scientific American*, May 2009.

² For more discussion of this point, explore The Genographic Project, sponsored by The National Geographic.

³ Stanford professor Thomas Simons argues that Europe's mastery of a three-pronged strategy for colonization, based on state penetration, church penetration, and trade penetration, explains much of its 1500's through 1800's success in taking over other countries and turning them into European colonies. Lecture, Stanford in Washington event, March 2002.

⁴ I assume 100 pounds per square foot, a bit heavier than the specific gravity of water. This produces a volume estimate of 20 cubic feet per ton. At 100 tons per person, I get 2000 cubic feet of Stuff per person, for Americans. Worldwide I assume a population factor of 3 billion – most people are not as Stuff-happy as American – for a starting amount that is seemingly rather small – 40 cubic miles of Stuff, for all of humanity. Then I apply a compound growth rate of 1 percent a year for the next thousand years. This gives us 854,000 cubic miles of stuff, which would if spread equally across the land areas of the planet be more than eight stories deep.

⁵ <http://www.census.gov/ipc/www/idb/worldpop.html>