

**d2.1** BASICS\_SUSTAINABILITY

**d2.2** BASICS\_SOIL

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**SUSTAINABILITY-quick general thoughts**

**\*TRADITIONAL DEFINITION\_** IS THE ABILITY TO EXIST CONSTANTLY- TO BE MAINTAINED. REGARDING PLANET EARTH IT IS FAIR TO SAY WE ARE ALL ON BOARD WITH THIS AS A GOAL.. WE NEED THE PLANET TO HANG AROUND AND KEEP FUNCTIONING. WE NEED TO BE RESPONSIBLE CARETAKERS.

**\*BUILDING-THE MAN MADE ENVIRONMENT\_** EVERYTIME WE BUILD SOMETHING WE ARE CHANGING THE PLANET. WE ARE REALLOCATING THE EARTH'S RESOURCES. ANY SITE CONSTRUCTION IS ALTERING THE STATUS QUO. SOIL, VEGETATION, INSECT AND ANIMAL LIFE, ALL GET CHANGED-NO WAY AROUND IT. ALL BUILDING REQUIRES MATERIALS. ALL BUILDING MATERIALS ARE NECESSARILY CREATED FROM NATURAL RESOURCES FOUND IN OR ON THE EARTH. FINDING, REMOVING, TRANSPORTING, MANUFACTURING, DISTRIBUTING, INSTALLING THESE MATERIALS IS DISRUPTING THE STAUS QUO. THE SUSTAINABILITY DEMAND HAS US ASKING- WHAT ARE THE CONSEQUENCES TO ALL THESE DISRUPTIONS?

**\*WHAT TO DO?** CONSEQUENCES OF OUR ALTERATIONS/REUSE OF NATURAL RESOURCES ARE VARIED. SOME HARMFUL, SOME NEUTRAL, SOME BENEFICIAL. ONE WISHES THERE WERE A DEPENDABLE SCORECARD THAT TOOK INTO ACCOUNT EVERYTHING AND MADE AVAILABLE A SUSTAINABILITY RATING FOR ALL PRODUCTS AND PROCESSES THAT INVOLVE BUILDING. IT IS THE TAKING INTO ACCOUNT OF EVERYTHING THAT MAKES THAT KIND OF 'SCORECARD' EVALUATION DIFFICULT. THERE ARE RESOURCES THAT IN ONE WAY OR ANOTHER DO THIS. FOR THE BUILDING INDUSTRY BUILDINGGREEN.COM IS ONE RESOURCE THAT HAS A PRODUCT SUSTAINABILITY EVALUATION PACKAGE.

**\*EMBODIED CONSEQUENCES\_** ALL MANUFACTURED PRODUCTS AND PROCESSES HAVE EMBODIED CONSEQUENCES. KNOWING WHAT IS GENERALLY INVOLVED IN THAT MANUFACTURING PROCESS IS NECESSARY. ESTIMATING A USEFUL LIFE SPAN AND MAINTENANCE REQUIREMENTS OF THE PRODUCT IS NECESSARY. KNOWING IF IT CONTAINS HARMFUL CHEMISTRY IS NECESSARY. AND KNOWING IF ANY OF THE ORIGINAL RESOURCES CAN BE REPLENISHED IS NECESSARY. AN ILLUSTRATION OF THIS THINKING IS IN COMPARING STEEL, CONCRETE, AND WOOD AS GENERIC BUILDING MATERIALS. STEEL AND CONCRETE ARE SIMILAR IN THAT THEY TAKE MINERALS FROM THE EARTH THAT CANNOT BE REPLENISHED (NOT GOOD), THEY USE A CONSIDERABLE AMOUNT OF ENERGY IN THEIR PRODUCTION (NOT GOOD), THEY LAST A LONG TIME (GOOD) AND REQUIRE LIMITED MAINTENANCE (GOOD). THEY ACCOMPLISH TASKS NO OTHER MATERIAL CAN (NOT GOOD, BUT NECESSARY). WOOD (FOR BUILDING) IS A CROP AND IS REGULARLY REPLENISHED (GOOD), WOOD IS A CARBON SINK (GOOD), WOOD REQUIRES MODEST ENERGY IN PRODUCTION (GOOD), WOOD TYPICALLY HAS A LIMITED LIFESPAN (NOT GOOD), WOOD CAN REQUIRE REGULAR MAINTENANCE (NOT GOOD). THE WHAT TO PICK HERE IS NOT FAIR BECAUSE THESE MATERIALS USUALLY DO DIFFERENT JOBS, AND REAL SELECTIONS ARE MORE NUANCED.

**\*EMBODIED ENERGY\_** DEFINES A MORE SPECIFIC EVALUATION. EMBODIED ENERGY 'SUMS' THE ENERGY REQUIRED FROM RESOURCE TO FINAL PLACEMENT. AN EFFECTIVE ILLUSTRATION OF THIS ANLYSIS IS THE PV SOLAR PANEL. ONCE IN PLACE IT PRODUCES A GOOD AMOUNT OF CLEAN ENERGY. BUT THE SOLAR PANEL IS A COMPLICATED ITEM. FOLLOW THE MANY SUPPLY CHAINS TO THE PRIME MANUFACTURER AND THEN THE SUPPLY CHAIN TO THE END USER, AND THE ENERGIES REQUIRED TO ACCOMPLISH THAT- AND THE PICTURE CHANGES. ENERGY IS REQUIRED TO MAKE SOMETHING DESIGNED TO SAVE ENERGY. IN FACT WITH SOLAR PANELS THE NET POSITIVE RENEWABLE ENERGY TO BE GAINED DOES COMFORTABLE EXCEED THE EMBODIED ENERGY TO BRING IT ABOUT.

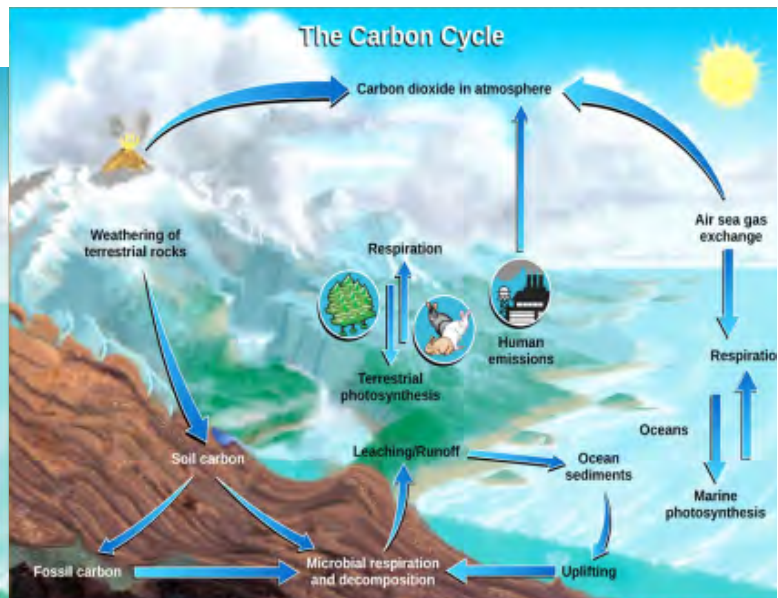
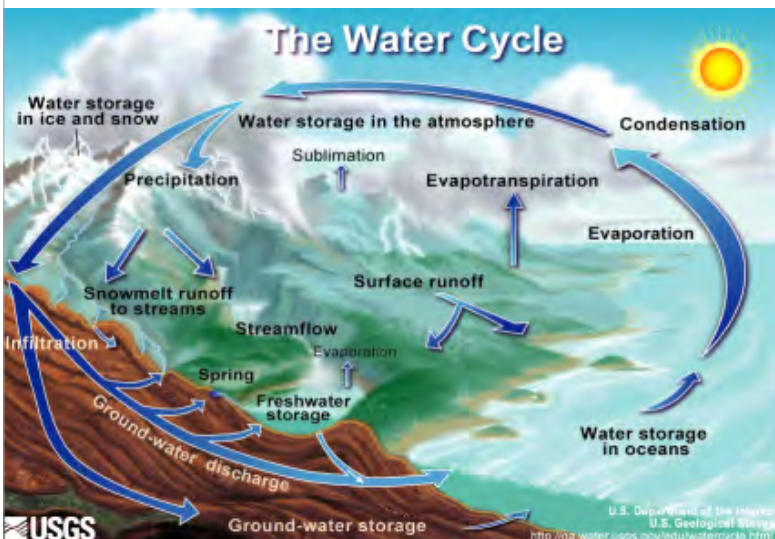
**\*FIY THIS PROJECT\_** BEYOND THIS INTRODUCTORY PAGE THE WORDS SUSTAINABLE- OR GREEN- OR ORGANIC WILL SELDOM BE MENTIONED FOR A COUPLE OF REASONS. ONE IS THAT THERE ARE FAR BETTER AND MORE COMPETE RESOURCES OUT THERE ECECUTED BY MORE KNOWLEDGABLE PEOPLE. ANOTHER IS THAT THESE GUIDES FOCUS ON DESIGN AND BUILDING THINKING AND NOT PRODUCTS/PRODUCT SELECTIONS.

**SUSTAINABILITY-no real reason to be ignorant**

**\*SCIENCE\_** SUSTAINABILITY IS A HUGE TOPIC (AND ONE THAT GOES WAY BEYOND BUILDING AND THE BUILDING INDUSTRY). THERE IS NO SHORTAGE OF INFORMATION AND SCIENCE OUT THERE ALL OF WHICH IS EASY TO ACCESS. IN REALLY UNDERSTANDING SUSTAINABILITY ONE IS SERVED BY GETTING INTO THE SCIENCE OF HOW THE EARTH WORKS. MOTHER NATURE'S NATURAL CYCLES ARE A PLACE TO START. THIS IS SUGGESTED BECAUSE THESE EARTH SUSTAINING CYCLES OCCUR QUITE WITHOUT MANKINDS INPUT OR EVEN EXISTENCE. SO THEY MUST EXIST FOR A BIGGER REASON. IF ONE GETS THE GIST OF THE NATURAL CYCLE, ONE CAN THEN GRASP HOW IT CAN BE EITHER SUSTAINED OR NEGATIVELY MESSED WITH. THE DECISIONS WE MAKE WITH OUR BUILDING PROJECTS, SMALL AS THEY MIGHT BE, NECESSARILY PLAY A PART IN THE CYCLE.

**\*RESOURCES\_** ARE MANY. ONE VERY WORTHWHILE RESOURCE IS THE USGS (UNITED STATES GEOLOGICAL SURVEY) WHICH IS A PART OF THE DEPT. OF THE INTERIOR. IF ONE VISITS THEIR SCIENCE AND EDUCATIONAL WEB SITES IT BECOMES CLEAR THEIR MISSION AND RESPOSIBILITIES ARE MUCH EXPANDED. THE CYCLE MAPS BELOW, ALONG WITH MANY OTHERS, ARE PRODUCED BY THE USGS AND AVAILABLE ON THEIR EXTENSIVE WEBSITE. NOTE THAT SOME OF THE INFORMATION MAPPING THIS CHAPTER ALSO COMES FROM THE VARIOUS USGS MAPPING SYSTEMS. SO IT A GOOD RESOURCE FOR ALL ENVIRONMENTAL/WEATHER BASED INQUIRIES FOR BUILDING SITE SEARCHES.

**\*WATER+CARBON CYCLES\_** ARE 2 OF MOTHER NATURE'S CRITICAL AND MORE WELL KNOWN CYCLES THAT WE PARTICIPATE IN DAILY. THESE GRAPHIC ILLUSTATIONS ARE FROM THE COLLECTION OF USGS ILLUSTRATED NATURAL CYCLES. THESE AND THE MANY OTHER SIMILAR CYCLE MAPS TYPICALLY COME WITH EXPLANATORY TEXT. WHAT IS REALLY GREAT IS THAT FREQUENTLY THESE ARE WRITTEN FOR CHILDREN- SO ALL OF US HAVE A CHANCE OF UNDERSTANDING THEM.



**EARTHSCAPE'S DIVERSITY**

\*MAP\_THIS MAP IS INCLUDED BECAUSE OF ITS QUICK GRAPHIC LESSON. WE HAVE A DIVERSE EARTHSCAPE. DRIVE ACCROSS THIS COUNTRY AND ONE CAN SEE ALL THIS DIVERSITY- IN ITS REAL SHAPE, COLOR, TEXTURE.

\*EARTH+BUILDING\_SOME OF THIS EARTHSCAPE CAN READILY BE BUILT UPON. SOME CAN BE BUILT UPON WITH A LITTLE MORE CARE AND SOPHISTICATED TECHNIQUE. SOME SHOULD BE AVOIDED. THAT IS COMMON SENSE

\*EARTH'S SOILS\_THE TERM THE BUILDING INDUSTRY USES FOR EARTH'S 'TOP SURFACE' THAT WE BUILD UPON IS SOIL. SOILS ARE GRADED AND RATED BY THEIR COMPOSITION. BELOW RATINGS AND CONSEQUENT CLASSIFICATION SYSTEM IS FOR BUILDING. NOTE THAT THIS TERM 'SOILS' IS USED QUITE GENERICALLY IN BUILDING, AGRICULTURE, AND THE ENTIRE WORLD OF PLANTING HAS ITS OWN SOILS DEFINITIONS AND GRADING AND RATING SYSTEMS.



**SOIL CONDITIONS**

\*WHATS DOWN THERE?\_KNOWING WHAT KIND OF SOIL IS UNDER AND AROUND A HOME SITE IS IMPORTANT. LOCAL KNOWLEGDE IS USEFUL. DIGGING A HOLE CAN ALSO BE USEFUL. HAVING ENGINEERED TEST DONE IS SOMETIMES USEFUL AND NECESSARY.

\*CONSISTENCY\_SOILS ARE SOMETIMES TOTALLY CONSISTENT, SOMETIMES 'LAYERED', AND SOMETIMES FOUND IN POCKETS OR VEINS, AND THERFORE NOT CONSISTENT. SO THIS COMPOSITION IS ALSO USEFUL TO KNOW.

\*SEE\_(c2.3)

**SOIL AND BEARING**

\*BUILDING WEIGHT\_A MODEST SIZED HOME MAY WEIGHT 20 TONS IN DEAD WEIGHT (aka DEAD LOAD). SAME HOME MAY ADD A POSSIBLE LOAD FOR PEOPLE, FURNISHINGS, AND SNOW(aka LIVE LOAD) OF 8 TONS. 28 TONS SITTING ON THE SOIL. THAT SOIL MUST BE ABLE TO SUPPORT THAT WEIGHT WITHOUT SINKING. WEIGHT 'BEARING' IS THE BUILDING TERM.

\*BEARING CAPACITIES \_SOILS ARE RATED IN THE POUNDS PER SQAURE FOOT THEY CAN RESIST WITHOUT SINKING OR COMPRESSING. THE BUILDINGS TOTAL WEIGHT WANTS TO BE UNDERSTOOD IN TERMS OF THE WEIGHT PER SQUARE FOOT THAT IS DISTRIBUTED TO THE SUPPORTING FOOTINGS. THE BUILDING WEIGHT PER SQUARE FOOT CANNOT EXCEED THE BEARING CAPACITY PER SQUARE FOOT OF THE SOIL.

\*SEE\_(c2.4)

**SOIL AND DRAINAGE**

\*WATER MANAGEMENT\_ IS A REQUIREMENT IN ALL HOME BUILDING PROJECTS.

\*SOIL AND WATER\_SOILS HAVE THEIR OWN WATER RETENTION CHARACTERISTICS. GRAVELS AND SANDS ARE USUALLY POROUS AND DO NOT TEND TO HOLD WATER. SILTS AND CLAYS ARE COMPOSED OF (MUCH) SMALLER PARTICLE SIZES,ARE NOT NOT AS POROUS, SO TEND TO HOLD WATER. SOILS THAT HOLD WATER ARE PESKY FOR A VARIETY OF REASONS AND WANT TO BE CAREFULLY MANAGED.

\*ALL MIXED UP\_THIS RELATIVELY SIMPLE CONDITION GETS COMPLICATED A LITTLE BY THESE VARIOUS 'CAKE MIXES' OF SOIL PARTICLE TYPES AND SIZES. READ ANY OF THE DESCRIPTIONS IN THE CODE SOILS CHART AT RIGHT AND THE DIFFICULTY IN SOILS IDENTIFICATION AND THEREFORE IN PINPOINTING SOIL BEHAVIOR IS EVIDENT\_\_

**SOIL GASES**

\*SEE\_(d2.14)



TABLE R401.1  
PRESUMPTIVE LOAD-BEARING VALUES OF FOUNDATION MATERIALS-

CLASS OF MATERIAL	LOAD-BEARING PRESSURE (pounds per square foot)
Crystalline bedrock	12,000
Sedimentary and foliated rock	4,000
Sandy gravel and/or gravel (GW and GP)	3,000
Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC)	2,000
Clay, sandy, silty clay, clayey silt, silt and sandy silt/clay (CL, ML, MH and CH)	1,500*

TABLE R405.1  
PROPERTIES OF SOILS CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM

SOIL GROUP	UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL	SOIL DESCRIPTION	DRAINAGE CHARACTERISTICS*	FROST HEAVE POTENTIAL	VOLUME CHANGE POTENTIAL EXPANSION*
Group I	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Good	Low	Low
	GP	Poorly graded gravels or gravel-sand mixtures, little or no fines	Good	Low	Low
	SW	Well-graded sands, gravelly sands, little or no fines	Good	Low	Low
	SP	Poorly graded sands or gravelly sands, little or no fines	Good	Low	Low
	GM	Silty gravels, gravel-sand-silt mixtures	Good	Medium	Low
	SM	Silty sand, sand-silt mixtures	Good	Medium	Low
Group II	GC	Clayey gravels, gravel-sand-clay mixtures	Medium	Medium	Low
	SC	Clayey sands, sand-clay mixtures	Medium	Medium	Low
	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	Medium	High	Low
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Medium	Medium	Medium to Low
Group III	CH	Inorganic clays of high plasticity, fat clays	Poor	Medium	High
	MH	Inorganic silts, miscellaneous or distasteful fine sandy or silty soils, elastic silts	Poor	High	High
Group IV	OL	Organic silts and organic silty clays of low plasticity	Poor	Medium	Medium
	OH	Organic clays of medium to high plasticity, organic silts	Unsatisfactory	Medium	High
	PT	Peat and other highly organic soils	Unsatisfactory	Medium	High

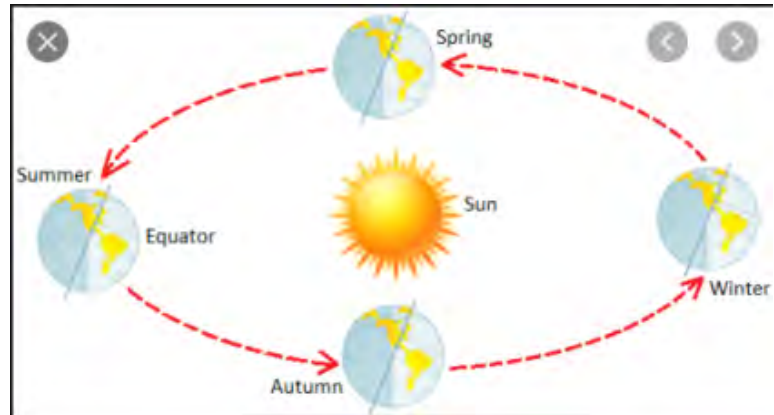
## SUN

**\*INTRO**\_THE SUN NEEDS NO INTRODUCTION AS LIFE SUSTAINER FOR WE EARTHLINGS. IT IS A PRIME SOURCE OF HEAT AND LIGHT. IN AN EFFORT TO MAKE BETTER USE OF THAT HEAT AND LIGHT IT IS HELPFUL TO GRASP THE RELATIONSHIP BETWEEN EARTH AND SUN WITHIN OUR SOLAR SYSTEM, AND TO GRASP THE SUN PATH AS WE EXPERIENCE IT STANDING ON OUR FEET.

## EARTH'S PATH AROUND THE SUN

**\*OUR SOLAR SYSTEM**\_IT SEEMS WE DO FORGET WHAT IS REALLY HAPPENING WHICH IS WE ARE BOTH SPINNING 360° EACH DAY AND REVOLVING AROUND THE SUN EVERY 365 DAYS. AND ALL ON A TILTED AXIS. PERHAPS AT NIGHT THE STARS REMIND US THERE IS MORE OUT THERE. A LOT MORE.

**\*ITS ALL ALIVE**\_OUR BIG EARTH IS REALLY JUST A TINY DOT IN THE SCOPE OF THE UNIVERSE. THIS LARGER VIEW OF THINGS- OF THE SOLAR SYSTEM AND UNIVERSE, AND ALL ITS ACTIVE FORCES AND CONSTANT MOVEMENTS REMINDS THAT IT IS ALL ALIVE. SOME OF THE SIMPLE SITUATIONS NOTED THIS CHAPTER THAT WE ADDRESS WITH OUR EARTH DWELLINGS DEAL WITH THOSE LIVE CONDITIONS. FROST, SNOW, RAIN, WIND ARE REGULARS. TROPICAL STORMS, HURRICANES, TORNADOES, EARTHQUAKES, WILDFIRES AND VOLCANOES ARE THANKFULLY NOT REGULARS BUT ALSO NOT STRANGERS.



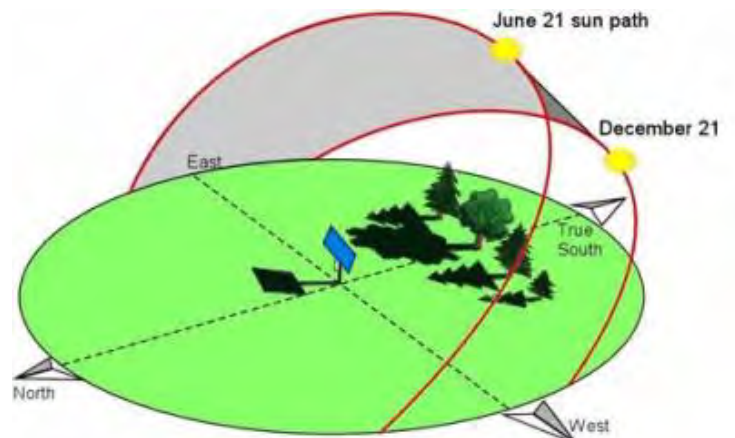
## THE SUN'S PERCEIVED PATH

**\*SUMMER PATH**\_THIS IS WAY WE PERCEIVE THE SUN'S PATH WHEN STANDING ON THE GROUND

**\*SUMMER PATH**\_THE DAY IS LONGER, THE SUN IS HIGHER. JUNE 21 IS THE LONGEST DAY AND HIGHEST SUN. NOTE THIS LONGER DAY HAS A LONGER PATH. THE SUN RISES AND SETS MORE NORTHERLY.

**\*WINTER PATH**\_THE DAY IS SHORTER, THE SUN IS LOWER. DEC 21 IS THE SHORTEST DAY AND LOWEST SUN. NOTE THIS SHORTER DAY HAS A SHORTER PATH.THE SUN RISES AND SETS MORE SOUTHERLY.

**\*IN BETWEEN**\_FROM JUNE 21 UNTIL DEC 21 THAT SUN DROPS, AND THE DAYS SHORTEN INCREMENTALLY. INVERSELY FROM DEC 21 TO JUNE 21 THAT SUN INCREASES ITS HEIGH AND THE DAYS GET LONGER INCREMENTALLY.



## SUN as a RADIANT HEAT SOURCE

**\*OBJECTS**\_RADIANT HEAT TARGETS AND WARMS OBJECTS, NOT THE AIR. THIS IS TRUE OF THE SUN, AS IT IS WITH ELECTRIC HEAT SOURCES, AND MICROWAVE OVENS. THESE ARE THEN REFERRED TO AS RADIANT HEAT SOURCES.

**\*INTENSITY**\_IN THE CASE OF OUR SUN THE SOLAR POTENTIAL IN 'SPACE' IS AT 100%. THEN IT HAS TO FIGHT THRU OUR EARTH'S ATMOSPHERE AND A SITE'S MICRO ENVIRONMENT. THAT 100% INTENSITY GETS COMPROMISED. AT THE EARTH'S SURFACE THESE INTENSITIES VARY-BUT ARE MEASURABLE. THAT MEASURED BOTTOM LINE IS A DESIGN TOOL. SEE THE PV POTENTIAL MAP BELOW.

**\*OBJECT CHARACTERISTICS**\_ OBJECTS CAN ABSORB AND RETAIN THAT HEAT ENERGY AND CAN REFLECT THAT HEAT ENERGY. EVERY OBJECT (MATERIAL) HAS A (MORE OR LESS) MEASURABLE CAPACITY FOR HOW IT MANAGES THAT ENERGY. THIS IS A DESIGN TOOL.

**\*OBJECT POSITIONING**\_THE ANGLE OF INCIDENCE BETWEEN THE RADIANT HEAT SOURCE AND THE OBJECT'S SURFACE IS A BIG DEAL. WHEN PERPENDICULAR THE MOST ENERGY CAN BE RECEIVED. THE MORE OBLIQUE THE ANGLE THE LESS EFFECTIVE ABSORPTION IS. UNDERSTANDING HOW THIS WORKS IS ANOTHER DESIGN TOOL.

**\*SO**\_THESE DESIGN TOOLS CAN HELP MANAGE THE SUN'S ENERGY. APPLICABLE TO GENERAL HOME DESIGN, CRITICAL STUFF IN PASSIVE SOLAR DESIGN, AND REQUIRED IN POSITIONING PV PANELS. ALL GOOD- . THE UNFORTUNATE COMPLICATIONS ARE THAT THE SUN'S ENERGY IS DELIVERED INCONSISTENTLY, AND THERE ARE TIMES IT IS A PRIZED BENEFIT, AND TIMES IT IS A LIABILITY. DESIGNING FOR IT GETS TRICKY.

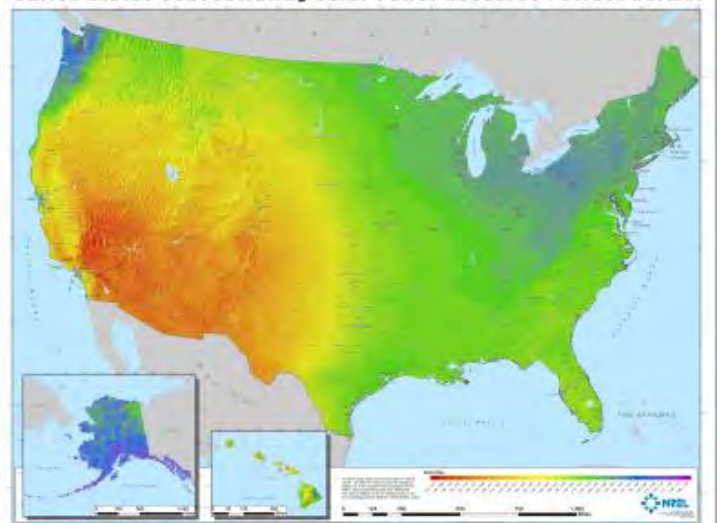
## THIS (PHOTOVOLTAIC POTENTIAL) MAP

**\*SOLAR POWER RESOURCE MAP**\_GRAPHICALLY DEPICTS THE POTENTIAL 'OUTPUT' OF THE SUN. THIS MAP MEASURES THE POTENTIAL IN KILOWATTS PER SQUARE FOOT PER DAY (KWH/M²/DAY). THE MANY MAPS AVAILABLE TO LOOK AT MAY BASE THEIR MEASUREMENT CRITERION SLIGHTLY DIFFERENTLY BUT THEY ALL SHOW THE HOT SPOT IN THE SOUTHWEST FEATHERING NORTH AND EAST.

**\*MAGIC BUT NO MAGIC**\_THE SOUTHWEST HAS THE GREATER SOLAR POTENTIAL. LATTITUDE, CLOUD COVER, ATMOSPHERIC POLLUTION, AND ACTUAL ELEVATION ALL PLAY A ROLE.

**\*STATE BY STATE SOLAR UTILIZATION**\_NOT AT ALL REFLECTED IN THIS MAP IS THE FACT THAT VERMONT, MASSACHUSETTS, NORTH CAROLINA, NEW JERSEY, MARYLAND RANK IN THE TOP DOZEN STATES ALONG WITH THE WEST/SOUTHWEST STATES IN THE PERCENTAGE OF ENERGY BEING SOLAR PRODUCED. YOU DON'T HAVE TO BE ORANGE OR YELLOW ZONE TO EFFECTIVELY PRODUCE RENEWABLE ENERGY.

United States Concentrating Solar Power Resource : Direct Normal



**BASICS\_HEAT AND WATER AND NATURAL TRANSFERENCE**

**HOT TO COLD TRANSFER**

\*HOT TO COLD\_THERMAL TRANSFER IS A NATURAL OCCURANCE . THIS TRANSFER CONTINUES BETWEEN 'STUFF' UNTIL THERMAL EQUILIBRIUM IS REACHED.

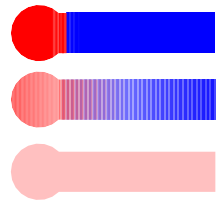
\*by **RADIATION**\_A HEAT SOURCE TRANSFERS ITS ENERGY VIA ELECTROMAGNETIC WAVES TO (COLDER) OBJECTS THROUGH A NEUTRAL MEDIA. (AIR, A GAS, OR A VACUUM). RADIANT HEAT SOURCES INCLUDE THE SUN, A FLAME,

\*by **CONDUCTION**\_A HEAT SOURCE TRANSFERS ITS ENERGY THRU A SOLID MEDIA. HEAT TRANSFERS DIRECTLY MOLECULE TO MOLECULE. THE SPEED OF TRANSFER IS A FUNCTION OF THE SPECIFIC GRAVITY OF THE MEDIA. ANY BUILDING FLOOR, WALL, ROOF IS TRANSFERING HEAT BY CONDUCTION WHENEVER THERE ARE TEMPERATURE DIFFERENTIALS ON THE INDOOR/OUTDOOR SIDES. IT IS ALWAYS OUR INTENTION TO SLOW THAT CONDUCTION PROCESS AS MUCH AS POSSIBLE WITH THE USE OF INSULATION(S).

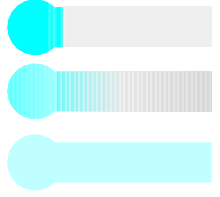
\*by **CONVECTION**\_HEAT IS TRANSFERED USING A FLUID MEDIA SUCH AS AIR, OR WATER. IT CAN BE A NATURAL CONVECTION OR FORCED CONVECTION. EXAMPLE OF NATURAL CONVECTION IS HOTTER AIR RISING WITHIN A SPACE, AND COOLER AIR DROPPING WHICH IS A FUNCTION OF THEIR RELATIVE DENSITY (WEIGHT). THE COMMON EXAMPLE OF FORCED CONVECTION IS THE HEATING OF AIR IN A FURNACE AND DISTRIBUTING THAT WITH A FAN AND DUCT SYSTEM, OR HEATING WATER IN A BOILER AND DISTRIBUTING IT IN A PIPE WITH THE AID OF A PUMP.

\*by **COMBINATIONS**\_THE NATURAL CONVECTION PROCESS OF WARMER AIR RISING (AND MIXING) HAPPENS IN ANY CONTAINED SPACE. SO A HEAT SOURCE MAY BE ONE DEFINED AS RADIANT OR CONDUCTIVE IN INITIATING THE HEAT, THEN BECOMES PART OF THE CONVECTIVE DISTRIBUTION. SIMILARLY HEAT FROM THE SUN, OR A FIREPLACE IS A RADIANT SOURCE THAT HEATS OBJECTS DIRECTLY BUT ALSO STARTS DISTRIBUTING ITSELF WITHIN THE SPACE THRU CONVECTION.

HOT → TO COLD



WET → TO DRY



EQUILIBRIUM

**MANAGING HOT TO COLD TRANSFER**

\*GENERAL RULE\_DENSER MATERIALS WILL TRANSFER HEAT MORE READILY. LESS DENSE MATERIAL WILL SLOW THE TRANSFER. TEMPERATURES RISE THRU METALS (HIGHER DENSITY). THEY ARE SLOWER SIGNIFICANTLY TRVELLING THRU INSULATIONS.THE PRIMARY IDEA BEHIND TEMPERATURE INSULATIONS IS USING (LOTS+LOTS OF) AIR POCKETS (LOWER DENSITY).

**WET TO DRY TRANSFER**

\*WET TO DRY\_WATER WILL SEEK TO DRY ITSELF AND WILL MOVE ANYWHERE IT CAN TO BECOME DRYER.

\*by **PRECIPITATION**\_WATER THAT FALLS ON THE EARTH WILL GET CONSUMED BY A DRYER EARTH CONDITION. ITS BEING ABSORBED IN THIS INSTANCE REFLECTS A COMBINATION OF WET TO DRY TRANSFER, AND GRAVITY. WHEN THAT EARTH IS ALREADY SATURATED THE NEWLY ARRIVED WATER CANNOT BE ABSORBED AND MUST RUN OFF, OR BUILD UP. d2.5.

\*by **CAPILLARY ACTION**\_WATER MIGRATES WITHIN THE BODY OF A MATERIAL FROM WET TO DRY. THE MIGRATION CAN RUN IN ANY DIRECTION. IT CAN HAVE SEVERAL DIFFERENT SCIENTIFIC SPECIFIC REASONS BASED ON THE MATERIAL AND CONDITIONS. THE CLASSIC EXAMPLE FOR WATER MOVING BY CAPILLARY ACTION IS THE PAPER TOWEL OR SPONGE WHICH SUCKS AND SPREADS WATER UNTIL SATURATION. ENABLING THIS PROCESS ARE MICRO VOIDS OR 'CHANNELS' IN THE MATERIAL THAT PERMIT TRAVEL OF WATER AND VAPOR, A WET TO DRY ENVIRONMENT AND SOMETIMES HEAT. SOILS AND BUILDING MATERIALS BOTH HAVE CAPILLARY ACTION POTENTIAL. THIS CAN BE A PROBLEM IN BUILDING. COMMON EXAMPLES ARE WATER RISING UNDER A SLAB, AND WATER MOVING IN BRICK WALLS TO WHERE IT BECOMES A POTENTIAL MOISTURE PROBLEM.

\*by **HIGH HUMIDITY SEEKING LOW HUMIDITY**\_NATURAL MIGRATION OF WETTER AIR TO DRYER AIR SIMILARLY TRIES TO ACHIEVE EQUILIBRIUM. IT IS GOING ON ALL THE TIME, BUT FOR THE MOST PART, EXCEPT FOR MISTY, FOGGY CONDITIONS, WE DON'T SEE IT. MOISTURE IN THE AIR, VAPOR, DOES BECOME VISIBLE WHEN IT TRANSFORMS ITSELF INTO DEW- VISIBLE DROPS OF WATER- OR FROST. DEW AND FROST ALSO ILLUSTRATE THE ROLE OF AIR TEMPERATURE IN THIS MOISTURE TRANSFER GAME. CONTINUED...

**MANAGING WET TO DRY TRANSFER**

\*PROMOTING IT\_MATERIALS CAN BE PLACED IN WET/HUMID ENVIRONMENTS SPECIFICALLY TO ABSORB OR ADSORB (GOOGLE IT) MOISTURE/WATER. A SPONGE ON A WET COUNTER TOP, RICE IN A SALT SHAKER, SILICA GEL PACKS IN PRODUCT PACKAGING WHERE MOISTURE WANTS TO BE CONTROLLED. LARGER SCALE, EVEN INDUSTRIAL SCALE 'DESICCANTS' ARE EMPLOYED TO HASTEN TRANSFER.

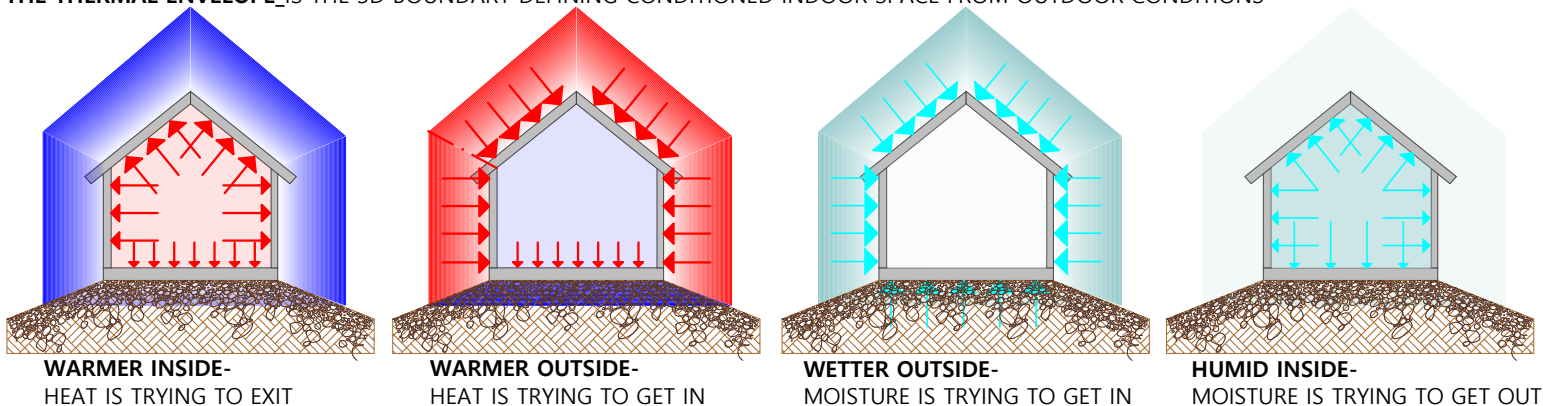
\*RESTRICTING CAPILLARY ACTION\_BREAKING THE PATH OF THE PROJECTED MOISTURE TRAVEL IS ACCOMPLISHED BY PLACING A MATERIAL WITH A LOWER (OR NO) POROSITY AT STRATEGIC LOCATIONS. BUILDING DOES IT ALL THE TIME WITH PURPOSE

\*RESTRICTING HUMIDITY/VAPOR TRANSFER\_DITTO REGARDING BREAKING THE PATH OF TRAVEL. THE LOWER POROSITY MATERIALS THAT DO THE BLOCKING REQUIRE CAREFUL SELECTION BECAUSE OF THIS MICRO SCALE OF THE WATER.

**HOT/COLD/WET/DRY AND THE THERMAL ENVELOPE**

\*4 BASIC CONDITIONS\_4 CONDITIONS OF NATURAL TRANSFER ILLUSTRATED BELOW. IF WE COULD DEAL WITH ONE AT A TIME IT WOULD BE A PIECE OF CAKE. INSULATING AND MOISTURE BARRIERS COULD BE LOCATED PRECISELY. BUT TEMPERATURE CHANGES, HUMIDITY CHANGES, RADIANT HEAT FROM THE SUN, DAYTIME-NIGHT TIME CYCLES MAKE FOR A NOT SO PREDICTABLE SITUATIONS.

\*THE THERMAL ENVELOPE\_IS THE 3D BOUNDARY DEFINING CONDITIONED INDOOR SPACE FROM OUTDOOR CONDITIONS



WARMER INSIDE- HEAT IS TRYING TO EXIT

WARMER OUTSIDE- HEAT IS TRYING TO GET IN

WETTER OUTSIDE- MOISTURE IS TRYING TO GET IN

HUMID INSIDE- MOISTURE IS TRYING TO GET OUT

# SITE\_mother nature d2.5

## BASICS\_TEMPERATURE, HUMIDITY AND COMFORT

### TRANSFERENCE AND THE BODY

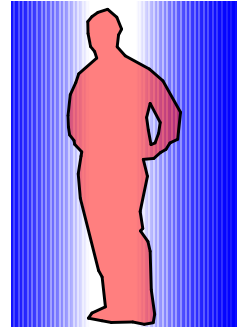
\*HEAT AND WATER TRANSFERENCES NOTED (d2.4) ARE VERY MUCH AS APPLICABLE TO OUR BODIES AS TO OUR BUILDING. THEY HELP US UNDERSTAND HOW TO MANAGE COMFORT. OUR PERSONAL COMFORT IN TURN DICTATES A LOT OF BUILDING DECISIONS.

### BODY BEHAVIOR

\***BODY TEMPERATURE @ 98.6+/-0**\_THE BODY IS CONSTANTLY CREATING HEAT ENERGY EVEN WHEN STATIONARY. THE BODY NEEDS TO BE SURROUNDED BY A COOLER ENVIRONMENT SO THAT BODY HEAT HAS A PLACE TO GO. (HOT TO COLD) IT SO HAPPENS THAT ENVIRONMENTAL TEMPERATURE THAT IS MOST EFFECTIVE-MAKES US FEEL COMFORTABLE/NEUTRAL- IS 70<sup>0+/-</sup>. TEMPERATURES ABOVE 70<sup>0</sup> MAKE US FEEL WARMER AND TEMPERATURES BELOW 70<sup>0</sup> MAKE US FEEL COOLER. TOLERANCE LEVELS AMONGST US CAN VARY SIGNIFICANTLY BUT DISCOMFORT OCCURS AT SOME POINT FOR ALL.

\***HOT WEATHER FACTORS**\_BODY HEAT CANNOT ESCAPE AS FAST WHEN IT IS SURROUNDED WITH HUMID AIR. THE MORE MOISTURE IN THE AIR THE MORE DIFFICULT FOR THE BODY TO EVACUATE ITS HEAT (SEE HEAT INDEX NOTE BELOW). WHEN THE OUTSIDE AIR IS DRYER THE ESCAPING BODY HEAT IS NOT TRAPPED AND WE FEEL COOLER. WHEN A BREEZE EXISTS IT WILL MOVE THAT ESCAPING BODY HEAT AWAY QUICKLY AND HAVE US FEEL MUCH COOLER.

\***COLD WEATHER FACTORS**\_ESCAPING BODY HEAT IS WISKED AWAY IN THE WIND THEREBY HAVING HEAT EXIT THE BODY MORE QUICKLY WHICH RESULTS IN FEELING COLDER. STRONGER WINDS WISK AWAY THE HEAT FASTER. (SEE WIND CHILL NOTE BELOW) ESCAPING BODY HEAT IS ALSO SPED UP IF MOISTURE IS PRESENT. OUTSIDE HUMIDITY CAN MOVE INTO THE CLOTHING LAYERS NEXT TO/NEAR THE SKIN AND SUCK OUT MORE BODY HEAT THAN DRY AIR.



### OUTSIDE COMFORT

\***AIR TEMPERATURE**\_CREATES OUR BASIC EXPECTATION OF HOT/COLD/COMFORT. HUMIDITY AND WIND ARE ADDITIONAL AND SIGNIFICANT FACTORS.

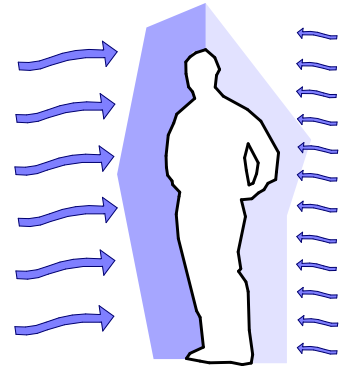
\***HEAT INDEX (ABOVE 70<sup>0</sup>)**\_IS A CHARTED VARIABLE THAT ADJUSTS TO A 'FEELS LIKE' TEMPERATURE BASED ON RELATIVE HUMIDITY. THIS 'FEELS LIKE' ADJUSTMENT GETS REAL WHEN TEMPERTURES ARE 70 DEGREES AND ABOVE.

\***WIND CHILL (BELOW 40<sup>0</sup>)**\_WIND MAKES US FEEL COLDER WHEN AIR TEMPERATURES ARE BELOW 40<sup>0</sup>. WE ARE OFTEN INFORMED OF A WIND CHILL FACTOR OR 'FEELS LIKE' TEMPERATURE IN THE COLD MONTHS.

\***BETWEEN 40<sup>0</sup> AND 70<sup>0</sup>**\_HEAT INDEX OR WIND CHILL HAVE BOTH BECOME REPORTED WEATHER CONDITIONS. AT TEMPERATURES BETWEEN 40<sup>0</sup> AND 70<sup>0</sup> NOTHING MAY BE REPORTED BUT WE RECOGNIZE COMFORT VARIANCES AS A FUNCTION OF HUMIDITY AND MOVING AIR.

\***THE (RADIANT) SUN**\_STAND IN IT AND IT WARMS YOU UP REGARDLESS OF THE AIR TEMPERATURE. IT SEEMS TO PENETRATE AND WARM BEST WITH CLEAR SKIES AND NO WIND.

\***CLOUDS**\_THEY DO NOT CHANGE AIR TEMPERATURES BUT CAN BLOCK THE SUN SO BODIES AND OBJECTS ARE PREVENTED FROM WARMING UP, AND DEPENDING ON THE TIMING OF THE SUN AND CLOUDS, CAN 'TRAP' HEAT BELOW THEM WHICH THEN SLOWS HEAT FROM ESCAPING TO THE ATMOSHERE. (HOT TO COLD).



### INDOOR COMFORT- some design terms+parameters

\***DESIGN INTERIOR TEMPERATURES**\_USUALLY 70<sup>0</sup> FOR THE HEATING CYCLE AND 75<sup>0</sup> FOR THE COOLING CYCLE. BUT BASED ON AN INDIVIDUALS OWN 'COMFORT ZONE'.

\***DESIGN INTERIOR RELATIVE HUMIDITY**\_THE BIG RANGE IS 30% TO 60% RELATIVE HUMIDITY. BELOW 30% AND PEOPLE AND BUILDINGS DRY OUT. ABOVE 60% AND MOLD/MILDEW MOISTURE DETERIORATION BECOME POSSIBLE. SOME SUGGEST 35-45% HUMIDITY IN SUMMER AND 45-55% IN WINTER IS IDEAL.

\***DESIGN OUTDOOR TEMPERATURES**\_LOCATIONS ALL HAVE STATISTICALLY ESTABLISHED OUTDOOR TEMPERATURES INTENDED FOR HVAC DESIGN. THESE DESIGN TEMPERATURES REPRESENT (VERY HIGH OR VERY LOW) AVERAGES THAT ARE INTENDED TO BE 'SAFE' FOR DESIGN PURPOSES.

\***DESIGN OUTDOOR RELATIVE HUMIDITIES**\_DITTO ABOVE

\***DELTA T**\_IS THE DIFFERENTIAL BETWEEN THAT INDOOR DESIGN TEMPERATURE+OUTDOOR DESIGN TEMPERATURE IN DEGREES

\***HOT TO COLD**\_REMEMBERING THE UNALTERABLE RULE OF PHYSICS THAT HOT MOVES TO COLD ATTEMPTING TO EQUALIZE THE TEMPERATURE. IF ITS COLDER OUTSIDE THE HEAT IS TRYING TO ESCAPE. IF ITS WARMER OUTSIDE THE HEAT IS TRYING TO GET IN.

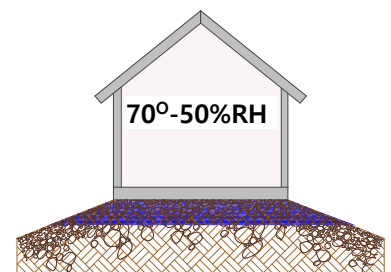
\***R, R-VALUE**\_HOME CONSTRUCTIONS PUT AN INSULATING BARRIER UP BETWEEN INSIDE AND OUTSIDE IN ORDER TO SLOW THE TRANSFERENCE DOWN BECAUSE THE INTENT IS TO HOLD THOSE INDOOR TEMPERATURES AT 70<sup>0</sup> AND 75<sup>0</sup>. THE BETTER THAT INSULATING BARRIER THE LONGER IT TAKES FOR TRANSFERENCE. THE LONGER THE TRANSFERENCE TAKES THE LESS HEATING AND COOLING ENERGY NEEDS TO BE USED TO MAINTAIN THOSE DESIRED INDOOR TEMPERATURES.

\***THE THERMAL ENVELOPE**\_(c9) IS DEFINED BY THE FLOORS/WALLS/ROOFS WHERE WE ELECT TO PUT THE RESISTANCE BARRIER BETWEEN THE DESIRED INDOOR TEMPERATURES AND THE REAL OUTDOOR TEMPERATURES.

\***SURFACES/SURFACE AREA**\_THE THERMAL ENVELOPE SURFACES ALL HAVE AN AREA (IN SQUARE FEET). THOSE SURFACES WANT AN APPROPRIATE RESISTANCE INSULATING BARRIER BETWEEN THE TEMPERATURE DIFFERENTIALS -DELTA T. THE GREATER THE DELTA-T THE MORE BARRIER WE WANT.

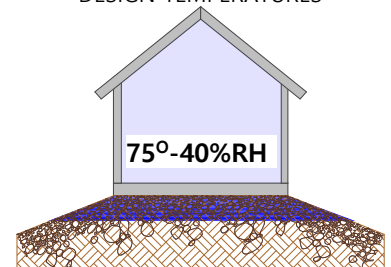
### JANUARY CONDITIONS:

CHECK LOCAL  
'DESIGN TEMPERATURES'



### JULY CONDITIONS:

CHECK LOCAL  
'DESIGN TEMPERATURES'



**INTRO TO BUILDING SCIENCE**

\***COMPREHENSIVE BUILDING SCIENCE** IS JUST THAT AND INVESTIGATES A VERY BROAD RANGE OF BUILDING DESIGN/CONSTRUCTION TOPICS. THE VERY IDEA OF IT AS A PURPOSEFUL DISCIPLINE IS BRILLIANT. PUTTING SOME SCIENCE BEHIND CONSTRUCTION DECISIONS. BUILDING SCIENCE IS NOW A RECOGNIZED DEGREE BASED PROFESSION.

\***PICKING ON MOISTURE** IT SO HAPPENS THAT MOISTURE MIGRATION IS AND HAS ALWAYS BEEN ONE OF THE BIG TOPICS/ISSUES IN CONSTRUCTION AND THE BUILDING SCIENCE COMMUNITY HAS MADE SOME IMPORTANT STRIDES IN OUR UNDERSTANDING OF MOISTURE MIGRATION AND THE INTEGRATED ROLE TEMPERATURE PLAYS. THE TERM HYGRO-THERMAL IS MORE COMPLETE (THAN MOISTURE MIGRATION) AS IT TELLS US THAT WATER AND TEMPERATURE ARE A TEAM AND THEY NEED TO UNDERSTOOD AS JOINT FORCES.

**A COMPLIMENTARY TOOL FOR UNDERSTANDING TEMPERATURES AND HUMIDITY**

\***THE DESIGN CONDITION** WHILE OUR INDOOR DESIGN COMFORT CRITERION IS MOSTLY CONSISTENT, THE OUTDOOR CONDITONS THAT NEED TO BE MANAGED ARE WILDLY INCONSISTENT. THIS EXTERIOR DIVERSITY CAUSES THIS HYGRO-THERMAL DESIGN CONDITION TO BE ONE OF THE MORE DIFFICULT/ELUSIVE IN OUR HOME BUILDING.

\***HYGRO-THERMAL REGIONS** THIS MAPPING AND CLASSIFICATION SYSTEM, AND MORE IMPORTANTLY, THE BETTER UNDERSTANDING OF THE INTERCONNECTEDNESS OF MOISTURE AND TEMPERATURE BEHAVIORS PERMITS BETTER SOLUTIONS. THIS 'BUILDING SCIENCE' DRIVEN WAY OF ADDRESSING THIS IS A COMPLIMENT TO THE BUILDING CODE CLASSIFICATION SYSTEM (d2.7).

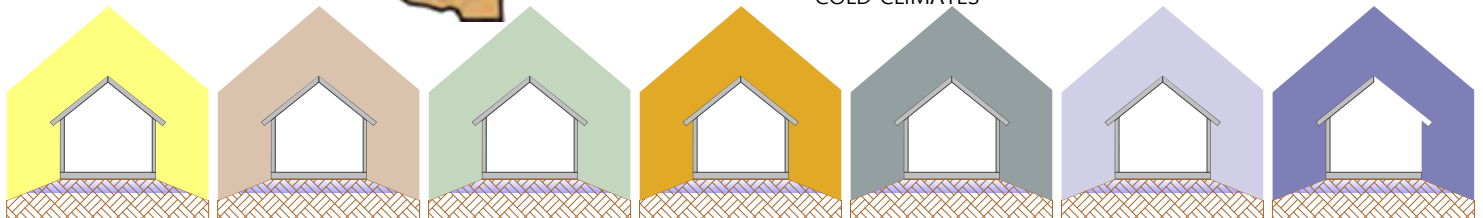


HYGRO-THERMAL REGION MAP lifted from BUILDING AMERICA document

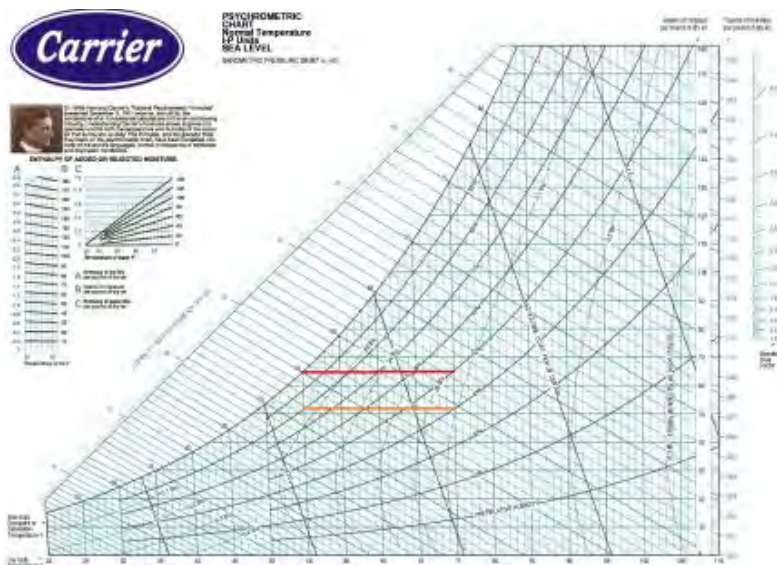
\***THESE REGIONS** EACH HAVE SPECIFIC TEMPERATURE AND PRECIPITATION LIMITS WHICH GET A LITTLE DENSE TO THE LAYMAN BUT ARE EASILY SEARCHED. THE HYGRO THERMAL REGIONS AND MAPPING HAVE AN AGRICULTURAL HISTORY. OUR CODE BASED CLIMATE ZONES (d2.7) HAVE A CONFUSING HISTORY BUT FAIR TO SAY WAS INITIALLY TEMPERATURE BASED. CONSIDERATIONS FOR HUMIDITY HAVE BEEN ADDED.

**RESOURCES**

- \*DOE (DEPARTMENT OF ENERGY) BUILDING AMERICA PROGRAM OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY
- \*EEBA (ENERGY+ENVIRONMENTAL BUILDING ASSOCIATION)
- \*BUILDING SCIENCE CORPORATION
- SPECIAL NOTE: THE BUILDING SCIENCE COPORATION HAS MADE SIGNIFICANT CONTRIBUTIONS TO THE ENTIRE BUILDING SCIENCE INITIATIVE INCLUDING THE 'BUILDING AMERICA ' PROGRAM AND THESE BUILDERS GUIDES ADDRESSING SPECIFIC REGIONS.
- \*HOT-DRY+MIXED-DRY CLIMATES
- \*HOT HUMID CLIMATES
- \*MIXED HUMID CLIMATES
- \*COLD CLIMATES



HOT-DRY HOT-HUMID MIXED-DRY MIXED-HUMID MARINE COLD VERY COLD



**THE DEW POINT and CONSTRUCTION ASSEMBLIES**

\***THE DEW POINT** IS WHEN THE DEW SHOWS UP-ON THE WINDSHIELD, ON THE BEER BOTTLE, ON THE WINDOW- AND IN THE WALL. THAT POINT OCCURS WHEN TEMPERATURE AND HUMIDITY ON THE 2 SIDES 'CLASH' AND MOISTURE TRANSFORMS INTO WATER DROPS. IN THEORY THAT CAN OCCUR ANYWHERE-IT SHOWS UP ON SURFACES WHERE WATER DROPS CAN BE SEEN. BUT IT ALSO CAN SHOW UP INSIDIE FLOOR/WALL/ROOF ASSEMBLIES WHERE IT CANNOT BE SEEN. NOT WANTED.

\***PREDICTING MOISTURE IN AN ASSEMBLY** THE CHART CROSS REFERENCES INTERIOR TEMPERATURE AND HUMIDITY, AND PREDICTS THE OUTSIDE INFLUENCING TEMPERATURE THAT WILL CAUSE VAPOR TO RETURN TO LIQUID STATE-CONDENSATION-. CONDENSATION WITHIN A CONSTRUCTION ASSEMBLY IS THE CONCERN.

**THE PSYCHROMETRIC CHART**

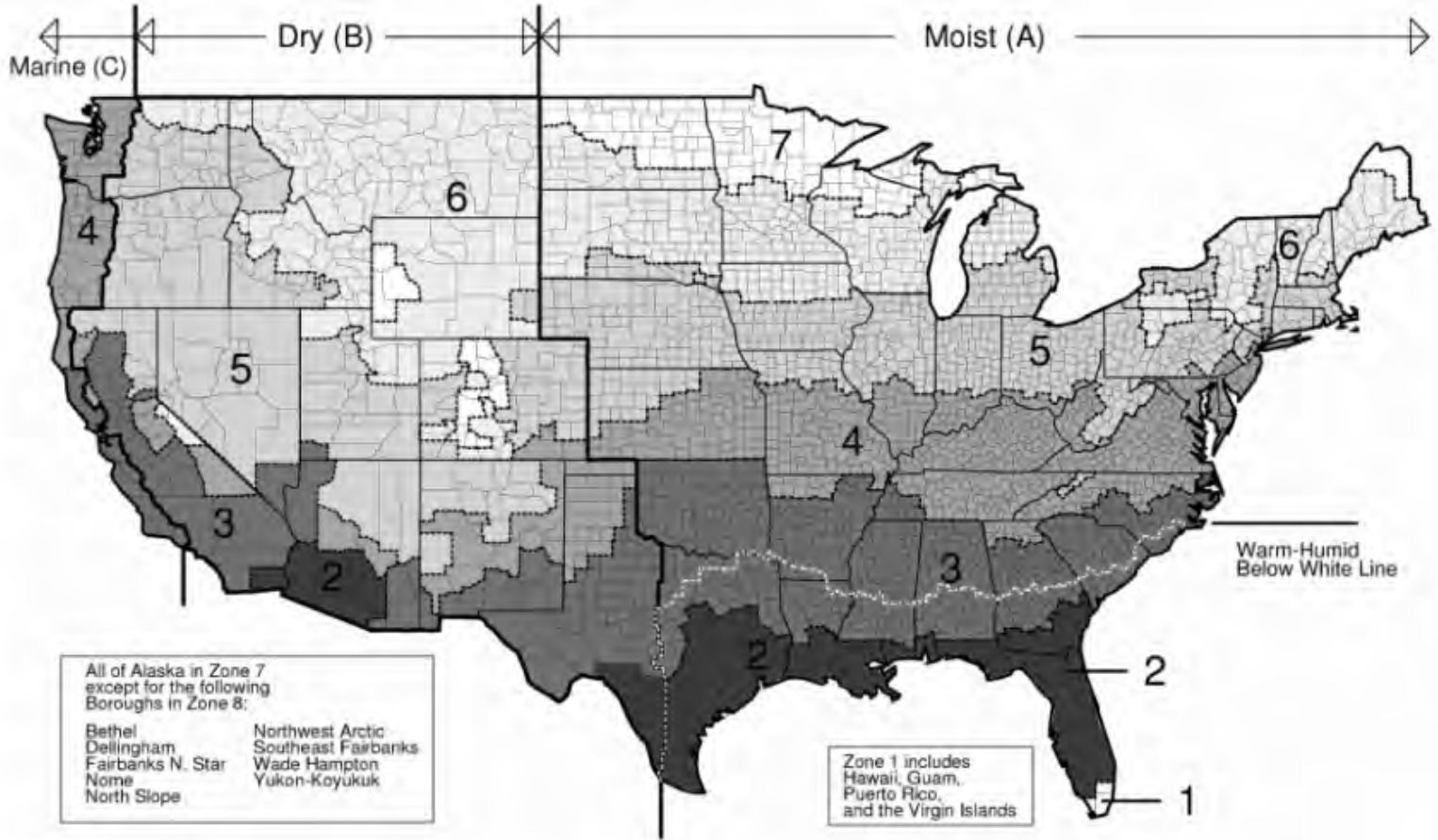
\*IS A TIME HONORED DESIGN TOOL THAT CHARTS THE TEMPERATURE/ HUMIDITY RELATIONSHIP, AND INFORMS US OF ARRIVAL CONDITIONS OF THE DEW POINT.

**THE CODE CLIMATE ZONE MAP**

**\*CLIMATE ZONES\_** THE CODE DEFINES CLIMATE ZONES BY MAP/LOCATION BASED ESSENTIALLY ON AVERAGE TEMPERATURES, WITH A (A) MOIST ,(B) DRY, (C) MARINE, MOISTURE DESIGNATION ADDED.

**\*TIE TO ENERGY\_**MINIMUM INSULATION REQUIREMENTS ARE LISTED BY BUILDING COMPONENT BELOW THE MAP. USING THESE COMPONENT REQUIREMENTS IS THE SIMPLE WAY TO MEET CODE ENERGY REQUIREMENTS.

**\*SIMPLE\_**USING THIS SIMPLE RESOURCE WILL HEAD ONE IN THE RIGHT DIRECTION. OTHER OPTIONS FOR MEETING MINIMUM REQUIREMENTS ARE CODE DEFINED AND ARE VIABLE OPTIONS., AS IS THE WISDOM OF EXCEEDING MINIMUM REQUIREMENTS. SEE(9)



**Figure N1101.7 (R301.1)**  
**CLIMATE ZONES**

**TABLE N1101.7 (R301.1)**  
**CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY**

**TABLE N1102.1.2 (R402.1.2)**  
**INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT\***

CLIMATE ZONE	FENESTRATION U-FACTOR <sup>b</sup>	SKYLIGHT <sup>b</sup> U-FACTOR	GLAZED FENESTRATION SHGC <sup>b,e</sup>	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE <sup>f</sup>	FLOOR R-VALUE	BASEMENT <sup>c</sup> WALL R-VALUE	SLAB <sup>d</sup> R-VALUE & DEPTH	CRAWL SPACE <sup>c</sup> WALL R-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.35	0.55	0.25	38	20 or 13 + 5 <sup>h</sup>	8/13	19	5/13 <sup>f</sup>	0	5/13
4 except Marine	0.35	0.55	0.40	49	20 or 13 + 5 <sup>h</sup>	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.32	0.55	NR	49	20 or 13 + 5 <sup>h</sup>	13/17	30 <sup>a</sup>	15/19	10, 2 ft	15/19
6	0.32	0.55	NR	49	20 + 5 or 13 + 10 <sup>h</sup>	15/20	30 <sup>a</sup>	15/19	10, 4 ft	15/19
7 and 8	0.32	0.55	NR	49	20 + 5 or 13 + 10 <sup>h</sup>	19/21	38 <sup>a</sup>	15/19	10, 4 ft	15/19



**SIMPLE CODE REQUIREMENT**

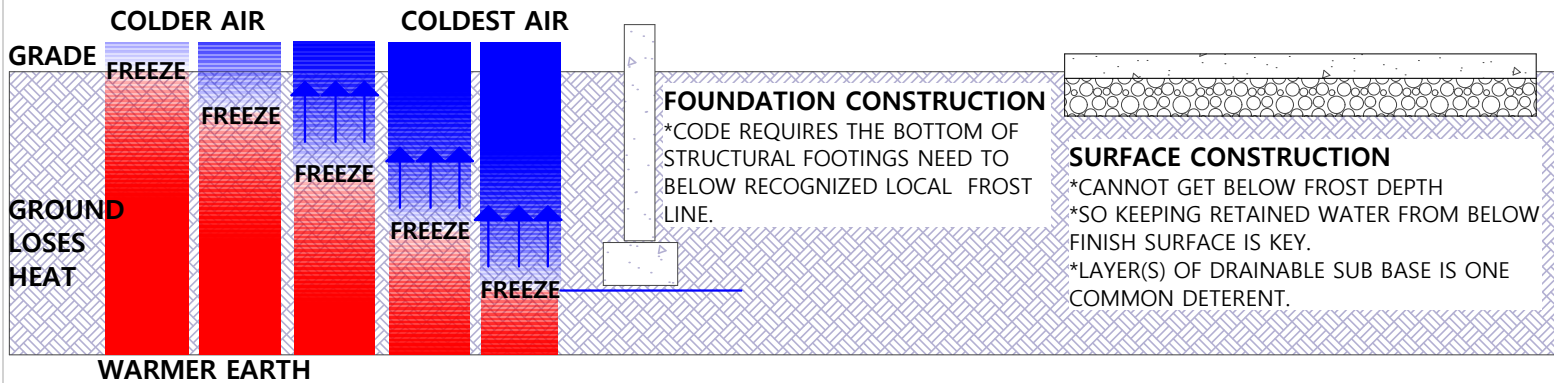
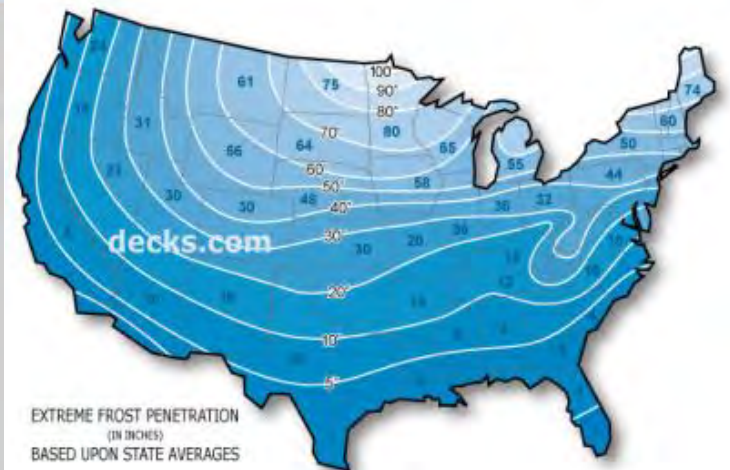
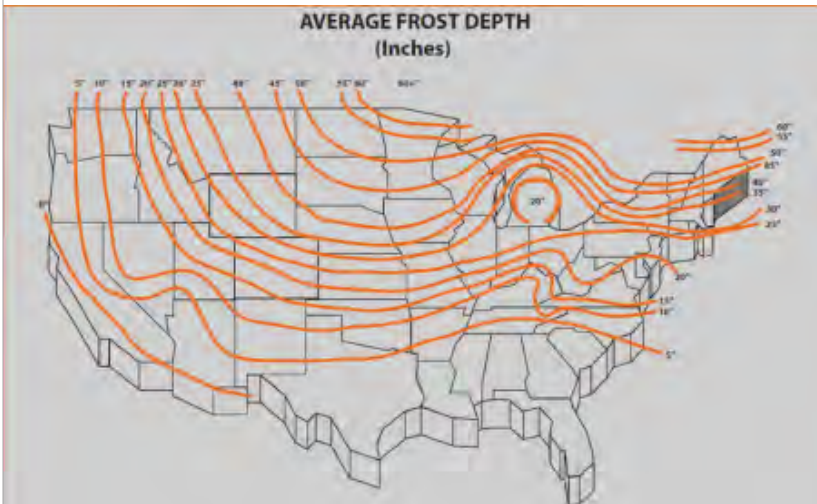
- \***WINTER COMES**\_HEAT ESCAPES THE EARTH AND EARTH BEGINS TO FREEZE FROM THE SURFACE DOWN. OVER THE COURSE OF THE WINTER THAT DEPTH INCREASES. IN COLDER CLIMATES IT OBVIOUSLY GOES DEEPER.
- \***BUILDING REQUIREMENTS** \_ANY FOUNDATION/FOOTING WORK IS REQUIRED TO GET BELOW THAT FROST LINE SO AS TO NOT BE EFFECTED BY FREEZING/EXPANDING EARTH. PER THE CODE THESE FOOTING DEPTHS ARE DOCUMENTED AND ENFORCED LOCALLY, BY JURISDICTION. THERE IS NO 'CODE' FROST MAP. THE MAPS BELOW ARE BUT 2 EXAMPLES (OF MANY) THAT NONETHELESS OFFER A PRETTY GOOD IDEA OF DEPTHS BY GENERAL LOCATION.
- \***FOUNDATION TYPE**\_THIS FROST BASED REQUIREMENT FOR A FOOTING DEPTH CAN READILY EFFECT A FOUNDATION SYSTEM SELECTION. THESE FOUNDATION SYSTEM CHOICES ARE COVERED THESE GUIDES IN LOTS OF PLACES.

**THIS (AVERAGE FROST DEPTH) MAP**

- \*IS INCLUDED BECAUSE IT IS A VERY FAST READ. THE BOTTOM LINE NOTED ABOVE IS THAT FROST DEPTHS FOR HOME BUILDING ARE LOCALLY DICTATED AND ENFORCED.
- \*REAL FROST DEPTHS ARE EFFECTED BY FACTORS THE CODE SIMPLY CANNOT ADDRESS AND ARE BUT INTRODUCED BELOW.

**THIS (DEEP FROST) MAP**

- \*THIS MAP (REPRODUCED BY DECKS.COM) MAKES A POINT THAT INDEPENDENT DECK FOOTINGS POSITIONED AWAY FROM HEAT PRODUCING BASEMENT AND CRAWL SPACE FOUNDATIONS MAY BE SUBJECT TO GREATER FROST DEPTHS.



**SOME SIMPLE RULES**

- \***HOT TO COLD**\_IS MOTHER NATURES PRIMARY RULE OF MOVEMENT. THE WARMER EARTH WILL RELEASE ITS HEAT TO A COLDER AIR TEMPERATURE. EQUILIBRIUM IS REACHED WHEN THE SURFACE OF THE EARTH IS 32°, AND THE AIR TEMPERATURE IS 32°. SURFACE FROST. EARTH'S HEAT CONTINUES TO ESCAPE CAUSING THAT FREEZE POINT TO DECEND. IN NORTHERN MAINE THAT CAN BE 5-6 FEET.
- \***ITS THE WATER THAT FREEZES, NOT THE SOIL**\_NO WATER NO FROST. CONTROL THE WATER, CONTROL THE FROZEN SOIL.
- \***EXPANSION VOLUME**\_WATER EXPANDS IN VOLUME 9% WHEN FROZEN. THAT VOLUME CAN GET A SIGNIFICANTLY LARGER WHEN ICE CRYSTALS ARE INVITED TO LATCH ON. WHICH IS ANOTHER CURIOUS NATURAL PHENOMENON (THAT IS BEYOND THE SCOPE AND MEANS OF THIS GUIDE)
- \***EXPANSION DIRECTION**\_WHATEVER THAT EXPANSION VOLUME AND RATE, IT WILL EXPAND IN THE DIRECTION OF THE HEAT LOSS, WHICH IS TOWARD THE COLDER TEMPERATURES ABOVE.
- \***EXPANSION PRESSURE**\_SUBSTANTIAL ENOUGH TO MOVE CONSTRUCTION AROUND. THESE FROST HEAVES CAN LIFT BUILDINGS.

**SOME SIGNIFICANT VARIABLES**

- \***MICROCLIMATES/CONDITIONS**\_SUN EXPOSURE, WIND EXPOSURE, SOIL TYPE, VEGETATION, ALL EFFECT FROST PENETRATION. THERE CAN BE DECIDEDLY DIFFERENT PENETRATION LEVELS ON ONE GIVEN SITE DUE TO THESE VARIABLES.
- \***HEATED STRUCTURES AND NON HEATED STRUCTURES** \_ANY HEATED STRUCTURE WILL NOT BE TARGETED BY FROST EXPANSION AS THE HEAT LOSS WILL HAVE A MORE FAVORABLE DIRECTION TO TRAVEL (TOWARD COLDER OPEN AIR). SEE (c3) FOUNDATION PROTECTIONS FOR A LITTLE MORE SPECIFIC INFO. PERMANENTLY NON HEATED STRUCTURES, INCLUDED INDEPENDENT DECK FOOTINGS NOTED ABOVE, ASSUME THE AIR TEMPERATURE, AND THEREFORE SUBJECT TO THAT NAKED FROST PENETRATION.

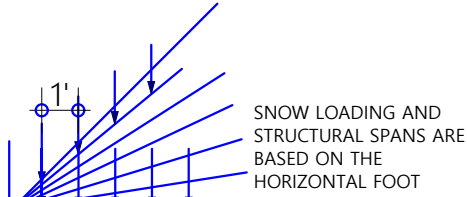
**SNOW, NO SNOW, AND ROOF LOADING**

\***SNOW LOADING**\_ROOF CONSTRUCTION AND THE STRUCTURE BELOW MUST BE ABLE TO SUPPORT ANY/ALL SNOW THAT SITS ON A ROOF. A TYPICAL AND MOSTLY SAFE WAY TO CALCULATE THIS IS USING A LOCATIONS RECORDED GROUND SNOW LOAD AND USE THAT FOR THE ROOF LOAD. NUMBERS ARE IN LBS PER SQUARE FOOT. THE CODE MAP BELOW SHOWS HOW VARIED THIS LOADING IS BASED ON LOCATION-FROM ZERO TO 100 PSF (LBS PER SQUARE FT). SO THE LOADING CAN BE SUBSTANTIAL AND MUST BE ALLOWED FOR.

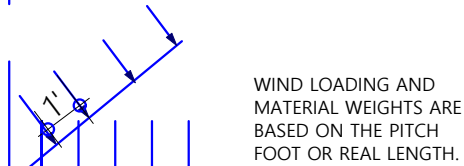
\***NON SNOW LOADING**\_CONCERNS CONSTRUCTION MATERIAL (E.G. ROOFING BUNDLES) AND WORKMEN WEIGHT, DITTO SERVICE AND RE-ROOFING. CONSIDERED HERE ALSO ARE LIGHTER WIND LOADING. THIS ALLOWANCE IS USUALLY NOTED AS 20 PSF, AND THEREFORE BECOMES A (THE) MINIMUM ROOF LOADING REQUIRED FOR STRUCTURAL CALCS. REGARDLESS OF SNOW REGION (WHERE SNOW LOADING DOES NOT EXIST).

\***CONTINGENCIES**\_WET SNOW, DRY SNOW, DRIFTING SNOW, BARREN WIND BLOWN ROOF PLANES, WINDWARD, LEEWARD ROOF IMBALANCES, ICE BUILD UP IN VALLEYS AND ON OVERHANGS. MOTHER NATURE DEFIES EXACT LOADING DETERMINATIONS.

\***THEREFORE**\_GROUND SNOW LOADS IN MOST INSTANCES ARE RECOGNIZED AS BEING SLIGHTLY HIGHER THAN REAL TIME ROOF LOADING, AND THEREFORE ARE A SAFE LOAD TO USE FOR SIMPLER RESIDENTIAL CONSIDERATIONS. IRC SNOW LOADING ROOF SPANS CHARTS USE GROUND SNOW LOAD, (AND THE HORIZONTAL FOOT NOTED BELOW). SOME LOCATIONS, PROJECTS MAY REQUIRE PROJECT SPECIFIC ENGINEERING.



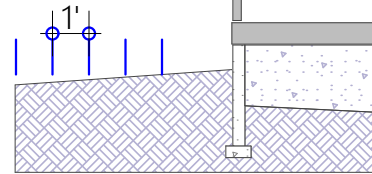
**ROOF PITCHES\_ THE HORIZONTAL FOOT**



**ROOF PITCHES\_ THE ON PITCH FOOT**

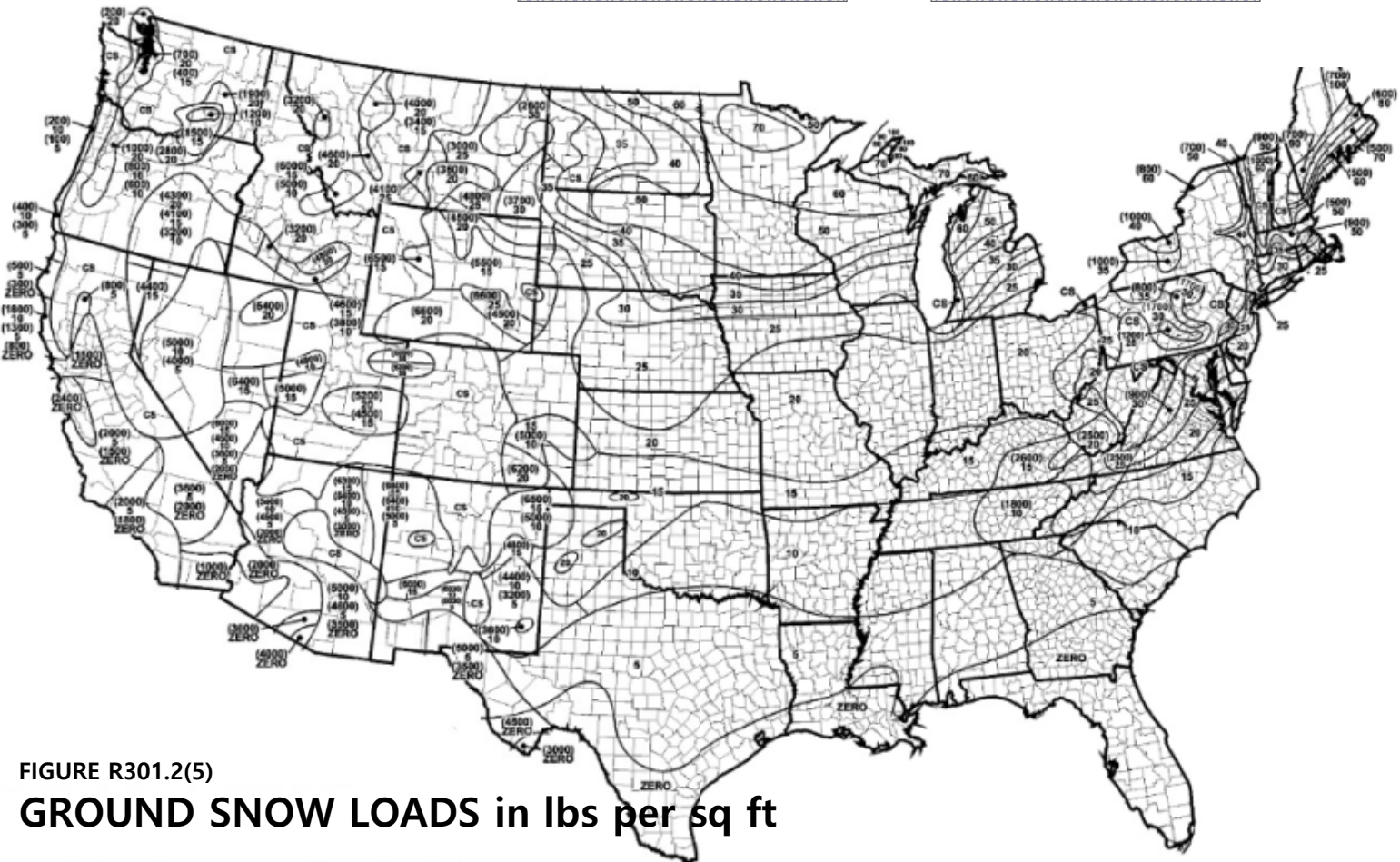
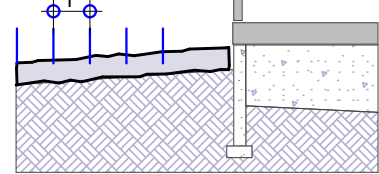
**NON SNOW ROOF LOAD=UP TO 20PSF CHECK LOCALLY**

**NO RECORDED GROUND SNOW LOAD**



**ROOF SNOW LOAD=TO GROUND SNOW LOAD**

**RECORDED GROUND SNOW LOAD**



**FIGURE R301.2(5)**  
**GROUND SNOW LOADS in lbs per sq ft**

### PRECIPITATION

**\*THE NORM**\_CONSISTENT RAINFALL FOLLOWING STATISTICAL ANNUAL AVERAGES WOULD BE A GREAT THING. BUT PRECIPITATION SEEMS TO IGNORE THE TERMS CONSISTENT AND AVERAGE TOO FREQUENTLY CAUSING US TO DEAL WITH TOO MUCH PRECIPITATION OR TOO LITTLE. THESE 2 SITUATIONS ARE OBVIOUSLY DIFFERENT PROBLEMS. THE TOO WET CONDITION IS ABOUT CONTROLLING/DISPERSING WATER SAFELY AND THE TOO DRY PROBLEM ASKS HOW THAT WATER CAN BE COLLECTED SO IT IS AVAILABLE WHEN MOST NEEDED. BELOW COMMENTS ARE FOCUSED ENTIRELY ON THE 'TOO MUCH' WATER SITUATION.

**\*PROTECTING THE HOME-SURFACE DRAINAGE**\_HARD SURFACES DO NOT ABSORB WATER. WATER 'RUNS OFF'- QUICKLY. ALL THAT WATER NEEDS TO BE DIRECTED- AWAY FROM A FOUNDATION AND TO A PRESCRIBED OUTLET OF SOME KIND CAPABLE OF DEALING WITH IT. (d4.3)

**\*PROTECTING THE HOME-STORM/FOUNDATION DRAINAGE**\_WATER THAT DOES ENTER THE SOIL AROUND A HOME'S PERIMETER WANTS TO BE EVACUATED. THE FOUNDATION DRAIN IS SPECIFICALLY POSITIONED SO IT CAN COLLECT THAT WATER AND MOVE IT AWAY FROM THE HOUSE. (c3)

**\*PROTECTING THE HOME-WET TO DRY**\_(d2.4) PRECIPITATION HAS WATER SITTING, SOAKING, AND RAISING HUMIDITY. ALL OF IT WANTS TO DRY OUT BY MIGRATING INTO THE (DRYER) HOME. IT NEEDS TO BE KEPT OUT.

### CALCULATING WATER VOLUME

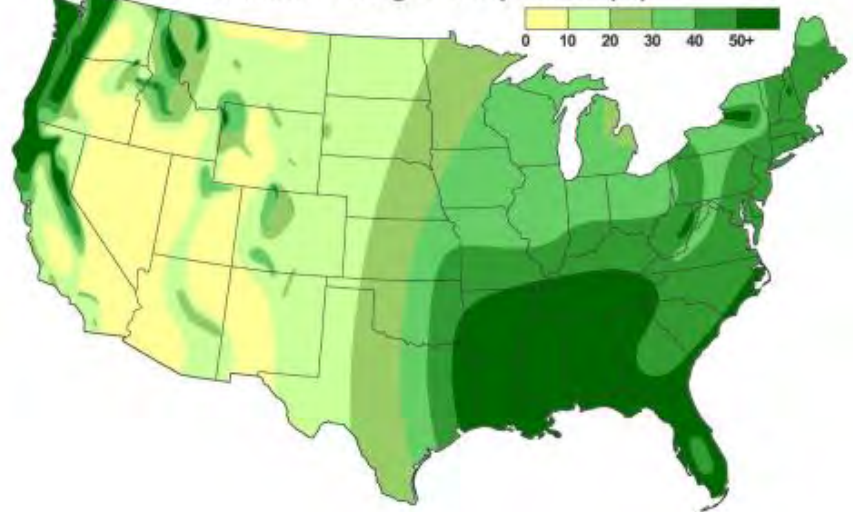
**\*WATER VOLUME**\_A VERY TYPICAL MODEST HOME MAY HAVE A ROOF AREA OF 2000 SF AND 1000 SF OF DRIVEWAY. A 1" RAIN OVER THAT 3000 SF OF IMPERVIOUS SURFACE COLLECTS 250 CUBIC FEET, OR 1870 GALLONS OR 34 55 GALLON DRUMS. MULTIPLY THAT TIMES THE ANNUAL NUMBER. LOTS OF WATER. THEN ADD THE NEIGHBORHOOD LOTS, THE STREETS ETC ETC. HUGE VOLUMES OF WATER THAT REQUIRES STORM WATER MANAGEMENT.

### THIS MAP

**\*MAP**\_SHOWS ANNUAL AVERAGE TOTAL OF RAINFALL AND SNOWFALL. SNOWFALL IS USUALLY CALCULATED IN A 10 TO 1 RATIO. (10" SNOW=1" RAIN) AND INCLUDED IN PRECIPITATION TOTALS. THESE TOTALS ARE EASILY RESEARCHED USING FAR MORE DETAILED MAPS AND BY SPECIFIC LOCATION.

**\*OTHER DATA**\_BECAUSE HISTORICAL DATA IS SIMILARLY EASY TO RESEARCH IT CAN BE DETERMINED THE MONTHLY AND YEARLY VARIATIONS IN PRECIPITATION WHICH WILL INDICATE A LEVEL OF PREDICTABILITY. THIS CAN BE USEFUL IN THINKING ABOUT ON SITE STORM WATER MANAGEMENT. BIG EVENTS ONCE EVERY YEAR IS ONE THING. BUT IF BIG EVENTS HAPPEN FREQUENTLY ONE WANTS TO GET A SYSTEM IN PLACE THAT CAN WITHSTAND REPEATED ACTIVITY.

Annual Average Precipitation (in)



### FLOODING

**\*CODE STIPULATIONS**\_IRC SECTION R322 IS TITLED 'FLOOD RESISTANT CONSTRUCTION'. IT SETS UP SOME PARAMETERS FOR MINIMUM REQUIREMENTS WHEN BUILDING IN FLOOD ZONES. BUT WHAT FLOOD ZONE? MAPPING IS NOT IN THE CODE BOOKS. FLOOD MAPPING IS AVAILABLE ON THE FEMA WEB SITE. YOU CAN ZOOM IN ANYWHERE. IT ALSO NEEDS TO BE CHECKED LOCALLY. THIS IS PART OF A THOROUGH SITE INVESTIGATION.

**\*HOW BIG A FLOOD**\_MINOR FLOODING MAY POSE NO DANGER OR HARDSHIP. MAJOR FLOODING OBVIOUSLY CAN. THE SCARY THING IS THAT MANY INFRASTRUCTURE SITUATIONS HAVE A TIPPING POINT WHERE JUST A LITTLE MORE WATER RISE AND THE SYSTEM FAILS. THE INFRASTRUCTURE DESIGN BEGINS WITH DRAINAGE DITCHES AND CULVERTS AT DRIVEWAY HEADS- AND SCALES UP TO THE LEVIES ON THE MISSISSIPPI. SMALL FAILURES START THE PROBLEM. WATCH THE PROBLEM GROW ALL THE WAY DOWNSTREAM.

### THIS MAP

**\*MAP**\_SHOWS FREQUENCY OF FLOODING BY COUNTY. THIS MAP HAS BEEN SELECTED TO ILLUSTRATE A POINT.

**\*COMPARISON WITH THE PRECIPITATION MAP**\_THERE APPEARS A GEOGRAPHIC INCONSISTENCY BETWEEN TOTAL PRECIPITATION AND FLOODING. FLOODING IS A FUNCTION OF WHERE THE WATER GOES AFTER IT FALLS, NOT THAT IT FALLS.

**\*THE RAIN EVENT**\_IS A VEGETATIVE AREA, AND A DEVELOPED AND ESTABLISHED ONE THAT HAS HAD GENERATIONS TO TWEAK DRAINAGE DESIGNS.

**\*IMPERVIOUS SURFACE SAMPLE PROBLEM**\_THE MATH OF WATER VOLUME IS NOTED ABOVE. LOOK AT PHOTOS OF FLOOD EVENTS AND COLLECTED WATER VOLUME GETS WAY WAY BEYOND THE 55 GAL DRUM VOLUME VISUAL REFERENCE. IMPERVIOUS SURFACES ARE ONE SIGNIFICANT CONTRIBUTOR TO THAT VOLUME. ITS SIMPLE. IF WATER CANNOT BE GROUND ABSORBED IT HAS TO RUN SOMEWHERE. AS A CURIOUS REFERENCE LOOK AT THE ARIZONA PRECIPITATION AND FLOOD FREQUENCY MAPS. INFREQUENT RAIN EVENTS AND A LOT OF IMPERVIOUS SURFACE COMBINE AND RESULT IN FREQUENT FLASH FLOODS. BEYOND ROOFS AND ROADS, THE DESERT HAS LIMITED VEGETATION AND A HARDPAN DESERT FLOOR THAT, LIKE A DRY SPONGE, WON'T TAKE WATER UNTIL IT SOFTENS A BIT.

Frequency of Flood Events by County: 1996-2013



# SITE\_mother nature d2.11

## DESIGN CONDITION\_WATERSHEDS, AQUIFERS, THE WATER TABLE

### OTHER INTERESTING WATER PHENOMENA

\* THESE 3 MENTIONS BELOW ARE CERTAINLY WORTH BEING AWARE OF- AND PRETTY INTERESTING IN AND OF THEMSELVES. ALL ARE PART OF THAT ALWAYS IN OPERATION NATURAL WATER CYCLE. OVERVIEWS WILL INDICATE HOW THESE MAY EFFECT HOME DESIGN AND PLANNING.

### WATERSHED

\***MAP**\_THIS USGS MAP IS THE 'COVER' MAP FOR THEIR INTERACTIVE WATERSHED SEARCH MAPPING. BY CLICKING ON A 'REGION' YOU WILL BE TAKEN TO A MORE DETAILED MAP WHICH THEN NAMES AND OUTLINES SPECIFIC WATERSHEDS. FINAL DESTINATIONS CAN BE TRACKED.

\***WHERE THE WATER GOES**\_THE 3 PRIME WATERSHED DESTINATIONS FOR THE 'LOWER 48'; ARE THE ATLANTIC AND PACIFIC OCEANS AND THE GULF. THE GULF IS CONTIGUOUS WITH THE ATLANTIC OCEAN OF COURSE BUT IS IMPORTANT TO DISTINGUISH BECAUSE IT RECEIVES ALL WATER FROM THE GREAT MISSISSIPPI COLLECTOR WHICH HAS BEEN OUTLINED ON THIS MAP TO REMIND US OF ITS INCREDIBLE SIZE. THE 4th DESTINATION WHICH IS AN ANOMOLY IS THE 'GREAT BASIN'; MOSTLY IN NEVADA AND UTAH, WHICH RETAINS AND DRINKS ALL THE WATER IT RECEIVES.

\***HOME DESIGN AND PLANNING IMPACT**\_NO REAL DIRECT IMPACT. AN INDIRECT CONCERN IS ALWAYS TO 'PROTECT THE WATERSHED' WHICH SPEAKS TO THE REQUIREMENT OF KEEPING OUR WATER CLEAN.

### Locate Your Watershed



Click on the Map Above to View a Particular Region

### GROUNDWATER-AQUIFERS

\***MAP**\_THIS USGS MAP MAJOR DOCUMENTED AQUIFERS WITH ITS COMPLETE LEGEND CAN BE DOWNLOADED\_ [water.usgs.gov/ogw/aquifer/USAaquiferMAP11\\_17.pdf](http://water.usgs.gov/ogw/aquifer/USAaquiferMAP11_17.pdf)

\***SOMETIMES A MYSTERY**\_AQUIFERS BASICALLY ARE VOLUMES OF SOIL OR ROCK THAT ARE CAPABLE OF COLLECTING AND RETAINING WATER IN THE MANY VOIDS THE SOIL OR ROCK PERMITS. THE AQUIFER'S SOURCE IS GROUNDWATER- PRECIPITATION THAT SEEPS FROM THE EARTH'S SURFACE DOWNWARD AND IS (VERY SLOWLY) COLLECTED IN THE AQUIFER. LOTS OF TYPES, LOTS OF SIZES, LOTS OF VARYING CHARACTERISTICS AND LOTS OF CONCERNS ABOUT POLLUTED/POISONED WATER. A HUGE PERCENTAGE OF OUR INDUSTRIAL, AGRICULTURAL, GENERAL USE AND DRINKING WATER IS AQUIFER SOURCED.

\***GOOD RESOURCE**\_SDWF-SAFE DRINKING WATER FOUNDATION HAS AN AQUIFER FACT SHEET THAT IS COMPLETE AND EASY TO READ. IT IS HIGHLY RECOMMENDED.

\***HOME DESIGN AND PLANNING IMPACT**\_THAT WATER IS AVAILABLE AT A SITE AND THAT IT IS GOOD WATER (d1.5)

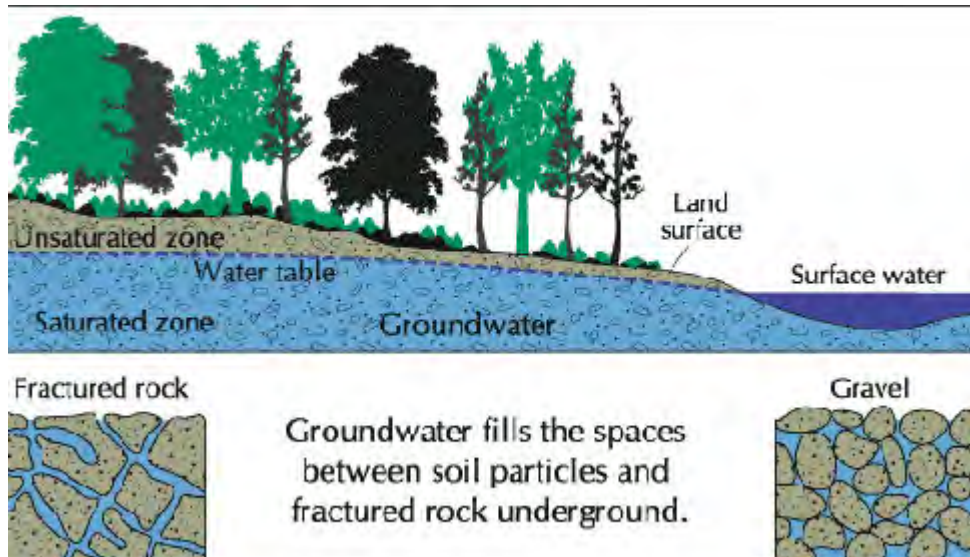


### THE WATER TABLE

\***ILLUSTRATION**\_IS ANOTHER USGS SOURCED ILLUSTRATION THAT IS WIDELY DISTRIBUTED AND USED. PRECIPITATION IS FILTERED THROUGH THE UNSATURATED ZONE AND THEN RESIDES IN THE SATURATED ZONE. A DIRECT LINK TO A BODY OF SURFACE WATER-RIVER OR LAKE- CAN EXIST AND THE GROUND WATER BECOMES INTERLINKED WITH THAT BODY OR WATER.

\***THE WATER TABLE**\_IS THE 'LINE' BETWEEN UNSATURATED ZONE AND THE SATURATED ZONE. WITH AN ALREADY HIGH WATER TABLE CLOSER TO THE SURFACE) AND COOPERATING SOILS, LOGIC SAYS THAT IF THE RAIN CONTINUED TO FALL THE UNSATURATED ZONE WILL BECOME SATURATED AND THE WATER TABLE WOULD RISE.

\***HOME DESIGN AND PLANNING IMPACT**\_A HIGH WATER TABLE, AND OR ONE CLOSER TO THE SURFACE WHOSE SOILS MAY PERMIT IT TO RISE ARE NOT GOOD. (c3.1-3.5)



**WIND AND CONSEQUENCES**

**\*WINDS\_**THERE ARE PLEASANT BREEZES. THERE ARE STORMY GUSTING WINDS THAT ARE NOT SO PLEASANT BUT LARGELY HARMLESS. THERE ARE LOCATIONS WHERE WINDS ARE CONSTANT AND ONE EITHER GETS USED TO THEM OR MOVES AWAY, AND THERE ARE HIGH WINDS THAT ARE DANGEROUS. BUILDINGS NEED TO BE RESPECTFUL OF THE LATER.

**\*WIND AND BUILDINGS\_**BELOW ARE 4 OF THE DAMAGE/DANGER CATAGORIES THAT BECOME A CHECK LIST WHEN DESIGNING FOR THE WIND. HELPFUL IN UNDERSTANDING THIS WOULD BE TO GRASP SOME BASICS OF WIND BEHAVIOR (c8). WE THINK OF IT BEING A "PUSHING" FORCE, BUT IT IS MORE MULTIDIMENSIONAL. IT BOTH PUSHES, PULLS, AND IT DRAGS. AIR PRESSURE DIFFERENTIALS ARE CREATED THAT CAN BE POWERFUL.

**\*WIND AS 'UPLIFT'\_**THE WIND PUSHES AND PULLS VERTICALLY AND WANTS TO LIFT THE HOUSE OFF ITS FOUNDATION. OR LIFT THE ROOF OFF THE HOUSE.

**\*WIND AS 'LATERAL FORCE'\_**THE WIND PUSHES AND PULLS Laterally AND WANTS TO SHEAR THE BUILDING OFF ITS FOUNDATION. OR COLLAPSE THE BUILDING BOX.

**\*WIND HAVING AT 'COMPONENTS AND CLADDING'\_**THE WIND PUSHES, PULLS AND DRAGS AND WANTS TO STRIP OR LIFT THE ATTACHED SIDING AND ROOFING FROM THE STRUCTURE.

**\*WIND BLOWN DEBRIS\_**ALL SORTS OF STUFF GETS AIRBORN AND BECOME DANGEROUS PROJECTILES. HOUSE PARTS, YARD PARTS, TREE PARTS- ALL FAIR GAME.

**STRUCTURE AND CODE**

**\*ENGINEERING\_**DESIGNING FOR WIND IS CONSIDERABLY MORE COMPLICATED THAN FOR GRAVITY LOADS. COMMON SENSE CONFIRMS THIS. (c.8) INTRODUCES THE CODE BASED STRUCTURAL VERIFICATIONS REQUIRED IN STICK FRAME RESIDENTIAL BUILDING. ONE NEEDS TO BE A PRETTY HARDY DIYer JUST TO READ IT. AS NOTED BELOW ONLY GEOGRAPHIC AREAS THAT ARE IN THE HIGHER WIND ZONES ARE EFFECTED, AND THOSE AREAS HAVE ENGINEERING SERVICES THAT ARE THERE TO HELP WITH THIS. IT IS OF BENEFIT, AS ALWAYS, TO UNDERSTAND A LITTLE ABOUT THOSE WIND FORCES, AND MAYBE WATCH A FEW HURRICANE DISASTER VIDEOS TO UP THE RESPECT FACTOR.

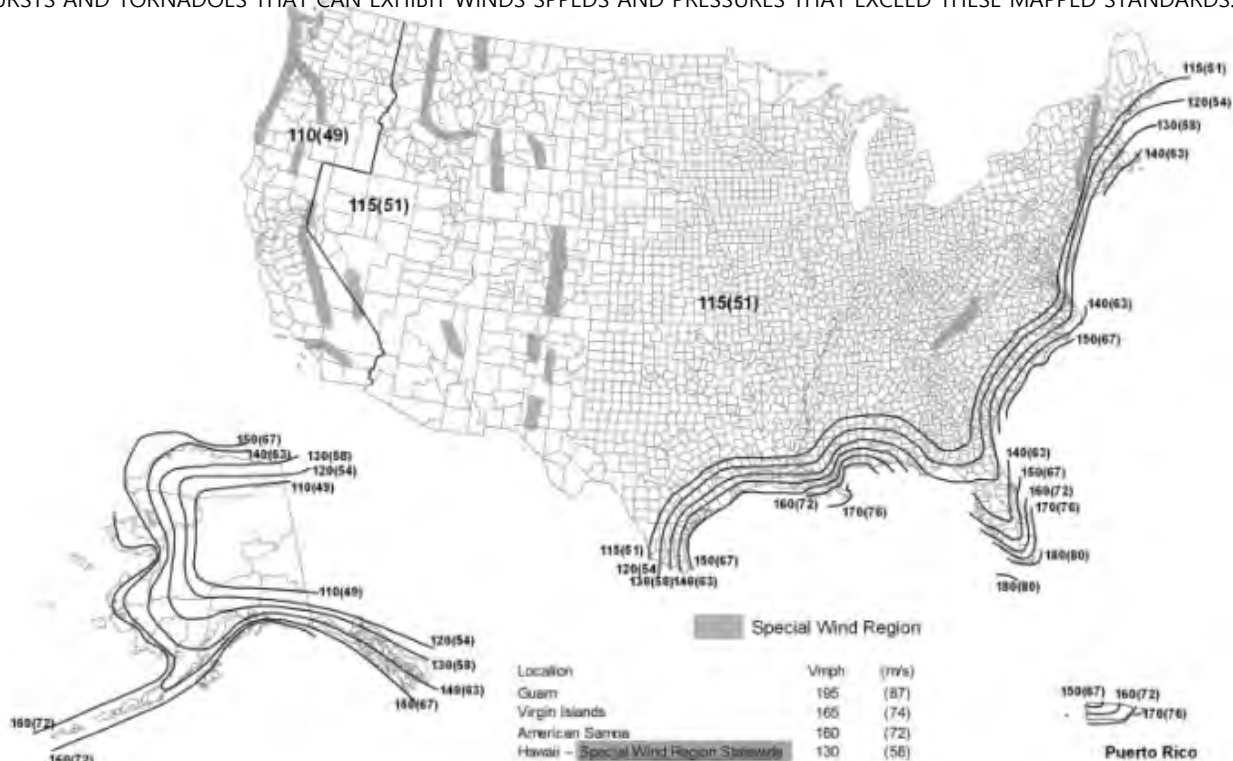
**THIS CODE MAP**

**\*WIND SPEED\_**IS SHOW ON THE CODE MAP REPRESENTING VELOCITY IN MILES PER HOUR. WIND SPEEDS BECOME INTERPRETED INTO WIND PRESSURE IN PSF (LBS PER SQ FT) WHICH BECOMES THE DESIGN CRITERION. HIGHER WIND VELOCITY=HIGHER PRESSURE REQUIRES MORE BRACING AND SECURE FASTENING TO KEEP EVERYTHING TOGETHER.

**\*THE 115 MPH BASELINE\_**COVERS A GOOD PERCENTAGE OF THE USA, AND DOES NOT REQUIRE ANY 'EXCEPTIONAL' CONSTRUCTION PRACTICES.

**\*HIGHER WIND ZONES\_**TRADITIONAL HIGH WIND ZONES ALONG COASTAL AREA AND IN SPECIFICALLY DEFINED MOUNTAIN AREAS HAVE WIND SPEEDS ASSOCIATED WITH THEM THAT DO DEMAND GREATER DETAIL ATTENTION FOR KEEPING STRUCTURES SOUND.

**\*NO GUARANTEES\_**WIND ZONE MAPPING IS HISTORY/DATA BASED, AND IS UPDATED AND CORRABORATED -BUT CANNOT PREDICT WIND EVENTS LIKE MICRO BURSTS AND TORNADOES THAT CAN EXHIBIT WINDS SPPEDS AND PRESSURES THAT EXCEED THESE MAPPED STANDARDS.



**Notes:**

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind region shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

**FIGURE R301.2(4)A**  
**ULTIMATE DESIGN WIND SPEEDS**

**WEATHERING**

**\*WIND, WATER, SUN, TEMPERATURE** ARE ALWAYS PRESENT AND CHANGING. SO ALL MATERIALS THAT LIVE IN THESE CONDITIONS OF BASIC WEATHER ARE CONSTANTLY SUBJECT TO THEIR FORCES, AND WILL 'WEATHER'. EACH OF THESE FORCES HAS A WIDE RANGE OF INTENSITY. EACH FORCE HAS ITS OWN SET OF NATURAL LAWS GOVERNING MATERIAL RESPONSE. THE PERMUTATIONS/COMBINATIONS OF THE FORCES AND INTENSITIES ARE BROAD. IMAGINE LIVING OUTSIDE PERMANENTLY WITHOUT THE BENEFIT OF CLOTHES.

**\*MATERIALS SCIENCE** BUILDING AND CONSTRUCTION IS INTENDED TO LAST AND WITHSTAND THESE FORCES. MATERIAL SCIENCE AND ENGINEERING IS A FIELD/ENDEAVOR DEDICATED TO UNDERSTANDING MATERIAL RESPONSES TO NOT ONLY THESE NATURAL 'WEATHER' FORCES BUT TO ALL PERFORMANCE REQUIREMENTS. MATERIAL CHOICES HAVE EXPANDED, BUT NO MIRACLE MATERIAL EXISTS. THEY ALL HAVE STRENGTHS AND WEAKNESSES.

**\*THE PREPAREDNESS CONCEPT** KNOW THE CONDITIONS, KNOW THE CHOSEN MATERIALS AND HOW THEY BEHAVE (WEATHER) OVER TIME IN WHATEVER WEATHER CONDITIONS ONE ELECTS TO BUILD IN. WINDY COAST, HIGH ELEVATION MOUNTAINS, MUGGY LOW SOUTHLAND ALL BRING DIFFERENT KINDS OF WEATHERING POTENTIAL.

**\*THE OPPOSITES** HOT-COLD, FREEZE-THAW, WET-DRY, IN SUNLIGHT-IN SHADE, WINDWARD EXPOSURE-LEEWARD EXPOSURE, THE SAME MATERIAL IN THE SAME GEOGRAPHY WILL BEHAVE DIFFERENTLY IN ALL THESE 'OPPOSITE' AND EVERYDAY CONDITIONS. THINK OF A STRUCTURE WITH AN OPEN SOUTHERLY VIEW AND A NORTH SIDE SURROUNDED WITH TREES. THE MATERIAL FACING SOUTH WILL LIKELY BE CLEAN, DRY, MAYBE WITH SPLIT/CRACKED MATERIALS FROM SUN EXPOSURE, WHILE THE NORTH SIDE MATERIALS MIGHT BE DAMP, STAINED AND HOSTING MILDEW OR MOSS.

**\*ORGANIC-INORGANIC** KEEPING IT SIMPLE- ORGANIC MATERIALS USED IN EXTERIOR APPLICATIONS NEED TO BE CAREFULLY SELECTED AND USUALLY TENDED TO. INORGANIC MATERIALS IN EXTERIOR APPLICATIONS ARE INHERENTLY MORE ROBUST. SOME INORGANIC BUILDING PRODUCTS ARE 'NATURAL', AND SOME/MANY ARE MANUFACTURED.

**THIS (RATHER LIMITED) CODE MAP**

**\*MAP** THIS MAP IS SHOWING A BUT ONE WEATHERING CONDITION ADDRESSING CONCRETE IN COLD CLIMATES THAT EXPERIENCE CONTINUAL FREEZE THAW CYCLES EXCERBATED WITH THE USE OF SALT AS A DEICER. IT IS INCLUDED IN THE CODE TO ENCOURAGE BEST CONCRETE MIXES WHERE (CONCRETE WEATHERING) PROBABILITY IS HIGHER.

**\*FREEZE-THAW CYCLE-ONE EXAMPLE** CONCRETE IS ONE OF THE (MANY) MATERIALS THAT CAN SUFFER FROM THE FREEZE/THAW CYCLE WHEN SMALL AMOUNTS OF WATER ENTER THE CRACKS/CREVICES/PORES OF A MATERIAL, FREEZE AND EXPAND (9%), THAW AND SHRINK (-9%). ON A SOUTH FACING WALL IN A COLD CLIMATE THIS COULD GO ON ALL WINTER. THAT IS A WORK OUT. SPLAYING, WHERE SMALL CHUNKS OF CONCRETE BUST OFF THE SURFACE IS THE POTENTIAL 'WEATHERING' CONDITION.



a. Alaska and Hawaii are classified as severe and negligible, respectively  
 b. Lines defining areas are approximate only. Local conditions may be more or less severe than indicated by region classification. A severe classification is where weather conditions result in significant snowfall combined with extended periods during which there is little or no natural thawing causing deicing salts to be used extensively.

FIGURE R301.2(3)  
 WEATHERING PROBABILITY MAP FOR CONCRETE\*\*

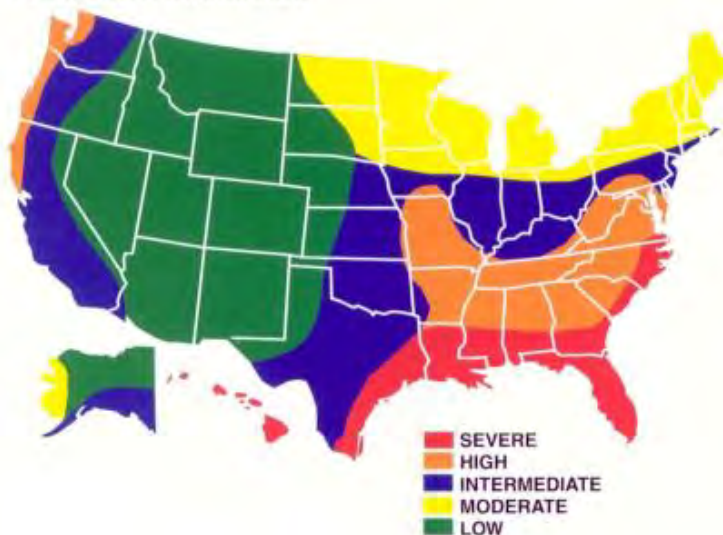
**WOOD DECAY BY FUNGI**

**\*MOISTURE** IS THE GREAT ENABLER OF DECAY. IF CONSTRUCTION CAN REMAIN DRY DECAY LIKLIHOOD IS SIGNIFICANTLY REDUCED.

**\*RESEARCH** FUNGAL TYPES, BEHAVIOR, IDENTIFICATION, REMEDIATION CAN ALL BE RESEARCHED. GONE UNDETECTED PRETTY SERIOUS DAMAGE CAN BE DONE. DAMAGE SPREADS AND CAN BE STRUCTURAL.

**\*CODE SECTION R317** PROTECTION OF WOOD AND WOOD BASED PRODUCTS AGAINST DECAY. TERMITES.

FROM AWPAS STANDARDS



WOOD DETERIORIZATION HAZARD ZONES (USDA ORIGINAL SOURCE)

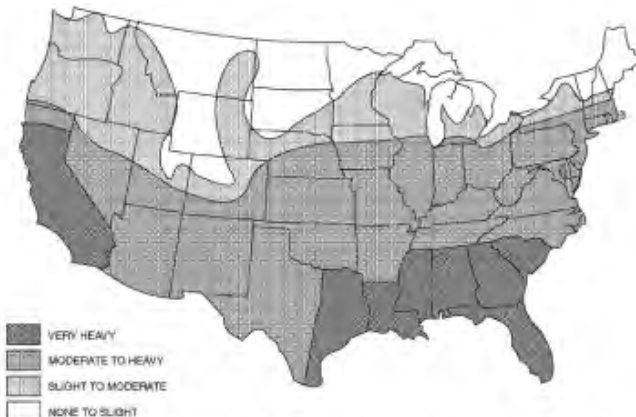
**WOOD DESTRUCTION BY INSECTS**

**\*\*MOISTURE** DITTO, THE GREAT ENABLER. SOME EXISTING DECAY SEEMS TO CREATE THE INCENTIVE FOR TERMITES AND CARPENTER ANT (ARMIES) TO BECOME ACTIVE AND SIMILARLY DESTRUCTIVE.

**\*RESEARCH** TERMITE SPECIES, BEHAVIOR, IDENTIFICATION, REMEDIATION CAN ALL BE RESEARCHED. GONE UNDETECTED PRETTY SERIOUS DAMAGE CAN BE DONE. DAMAGE SPREADS AND CAN BE STRUCTURAL.

**\*OTHER INSECTS** BEETLES AND CARPENTER BEES ARE KNOWN ALSO TO INVAD AND ENJOY WOOD. KNOWING THEIR BEHAVIORS IS SIMILARLY WISE. THEIR DAMAGE POTENTIAL IS DIFFERENT AND NOT AS INTIMIDATING.

**\*CODE SECTION R318** PROTECTION AGAINST SUBTERRANEAN TERMITES. THIS CODE SECTION MAY WELL BE LOCALLY EDITED



Note: Lines defining areas are approximate only. Local conditions may be more or less severe than indicated by the region classification.

FIGURE R301.2(5)  
 TERMITE INFESTATION PROBABILITY MAP

## **SOIL GASES**

**\*GENERAL NOTE\_**'STUFF' THAT IS DOWN IN THE SOIL WILL TEND TO WANT TO COME UP TO THE SURFACE AS A GAS OR VAPOR AND CAN ENTER A HOME UNLESS THERE IS A PROTECTIVE BARRIER PLACED BETWEEN SOIL AND HOME. THIS IS ONE INSTANCE WHERE THE SOLUTION OF PLACING THAT BARRIER IS SIMPLER THAN UNDERSTANDING THE PROBLEM.

**\*WHATS IN THE SOIL?** 2 SITUATIONS OF SOIL BORNE 'STUFF' THAT IS NOT AT ALL UNCOMMON AND NOT COMPLICATED IS METHANE AND RADON. OTHER POTENTIALLY HARMFUL 'STUFF' MAY BE PRESENT IN A SOIL.

**\*METHANE\_**WHILE DESOMPOSING, ORGANIC WASTE GIVES OFF (METHANE) GASES THAT ONE DOESN'T WANT IN THE HOUSE. ORGANIC WASTE DECOMPOSING HAPPENS IN NATURE ANYWHERE AND EVERYWHERE, SO IT IS IN PRINCIPLE A VIABLE CONCERN. IN CONSTRUCTING OUR HOME'S FOUNDATION SYSTEMS WE NORMALLY MUST DIG BELOW ALL ORGANIC MATERIAL TO GET TO SOLID SOIL, SO IN PRACTICE ORGANIC MATERIALS ARE REMOVED.

**\*RADON\_**RADON IS CREATED WHEN URANIUM BREAKS DOWN IN THE SOIL. WHERE THERE ARE URANIUM DEPOSITS DOWN IN THE EARTH THIS THEN IS A POSSIBLE CONCERN. BREATHING IN RADON GAS RISKS LUNG CANCER. THIS HAS BEEN MEASURED AND DOCUMENTED INCLUDING DIRECTLY CONTRIBUTABLE DEATHS FROM LUNG CANCER. A MEASURABLE THRESHOLD FOR RADON IN THE SOIL HAS BEEN ESTABLISHED THAT THEN TRIGGERS THE REQUIREMENT FOR PREVENTATIVE MEASURES. THE PREVENTATIVE MEASURE IS THAT PROTECTIVE BARRIER (PLASTIC MEMBRANE) THAT TRAP GASES BENEATH THE HOUSE, PROVIDES A PATHWAY (GRAVEL) TO A VENT PIPE THAT EXITS THE HOME ABOVE THE ROOF PLANE. THE BEAUTY AND SIMPLICITY OF THIS PROTECTIVE BARRIER PRECAUTION IS THAT IT WILL ALSO PROTECT THE HOUSE FROM RISING WATER VAPOR/MOISTURE AND OTHER POTENTIALLY UNDESIREABLE GASES. THE GRAVEL AND PLASTIC BARRIER ARE FREQUENTLY. REQUIRED ANYWAY

## **RADON**

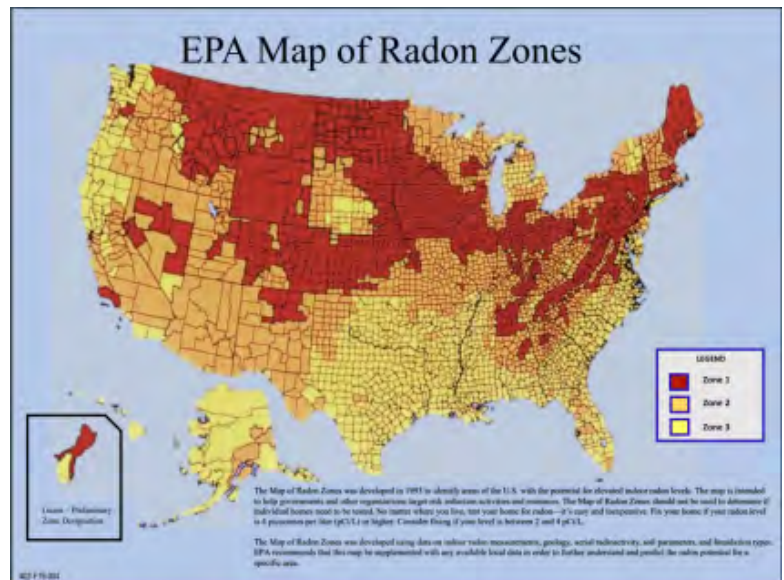
**\*EPA MAP\_**SHOW THE ZONE 1 (DARK COLOR), ZONE 2 (ORANGE), AND ZONE 3 (YELLOW) DESIGNATED BY COUNTY. ZONE 1 REPRESENTS THE LOCATIONS WHERE RADON MANAGEMENT IS REQUIRED.

**\*CODE COMPLIANCE\_**THIS IS ANOTHER NATURAL DESIGN CONDITION THAT PAYS NO ATTENTION TO STATE BOUNDARIES AND IS THEREFORE ADMINISTERED BY LOCAL JURISDICTIONS. THIS EPA DEVELOPED RADON MAP HAS BEEN ADOPTED BY THE CODE. SEE APPENDIX F, FOR BOTH THIS MAP AND THE MORE SPECIFIC MANAGEMENT INSTRUCTIONS.

**\*TESTING\_**KITS ARE AVAILABLE AT MOST HOME IMPROVEMENT STORES, OR INTERNET. THE KIT SITS IN THE CONTAINED ENVIRONMENT AND CHARCOAL MEDIUM ABSORBS THE RADON. KITS ARE MAILED TO FACILITIES AND THE RADON 'COUNT' IS MEASURED. LONGER TERM (90 DAYS+) TESTING IS BETTER.

**\*TESTING BEFORE CONSTRUCTION\_**REQUIRES SOIL SAMPLING, HAS SOME COST TO IT, AND IS NOT CONSIDERED A RELIABLE INDICATOR. THE EPA SUGGESTS TAKING THAT MONEY, IF IN DOUBT (ZONE 2 LOCATIONS), AND INSTALL A SYSTEM

**\*TESTING AFTER CONSTRUCTION\_**ONCE A HOME IS CONSTRUCTED RADON TESTING CAN BE DONE-SOME RECOMMEND EVERY 2 YEARS-. RADON TESTING HAS BECOME PART OF THE HOME INSPECTION CHECKLIST WHEN HOMES ARE BOUGHT AND SOLD.



### HURRICANES

**\*SEE WIND(d2.12)**\_OUR WIND SPEED MAPS ARE LARGELY A RESPONSE TO TROPICAL STORMS AND HURRICANE ACTIVITY. COMPARE THE WIND SPEED MAPS WITH THE 2 MAPS BELOW AND IT IS OBVIOUS THE SOUTH EAST ATLANTIC AND GULF COASTS ARE CLEARLY THE FAVORED TARGET.

**\*WIND SPEED**\_CLASSIFIED IN THE SAPHIR-SIMPSON SCALE FOR QUALIFYING HURRICANE EVENTS ARE **SUSTAINED** WIND SPEEDS BASED IN MILES PER HOUR. OUR CODE USES **ULTIMATE DESIGN WIND SPEED** (aka 3 SECOND GUST) WHICH IS NOT THE SAME RATING METHOD.

**\*WATER**\_HURRICANES ALL HAVE RAIN AND SURGE ASSOCIATED WITH THEM. THE PURE RAINFALL IS QUANTIFIED IN INCHES. SURGES ARE TOUGHER TO GET A HANDLE ON. SEA LEVEL RISES AND STRONG WINDS ESSENTIALLY PUSH WATER INLAND. KATRINA (2005) IS THE CURRENT RECORD HOLDER OF 27.8 FT. - OF COURSE MEASURED AFTER THE EVENT. THE PROBLEM IN PREPARING IS WE NEVER KNOW EXACTLY HOW SEVERE WILL BECOME.

**\*BUILDING PREPARATION**\_WIND RELATED CAUTIONS ARE NOTED d2.12. THE FLOODING AS A CONSEQUENCE OF RAIN AND SURGE ARE NOT SPECIFICALLY ADDRESSED THESE GUIDES BUT THE SIMPLE ANSWER IS HIGH FLOOD ZONES WITH WATER MOVEMENT (VE ZONES) WE PUT HOMES UP ON SERIOUSLY BRACED STILTS SO THE WATER WON'T RISE TO THE LIVING LEVELS AND THE WATERS SURGING MOVEMENT WON'T COLLAPSE THE STRUCTURE.

### THIS MAP

**\*MAP**\_THIS MAP SPEAKS FOR ITSELF SHOWING THE HURRICANE PATH. THE ORIGIN OFF THE COAST OF AFRICA IS INCREDIBLY CONSISTENT. MAYBE HALF THE EVENTS FORTUNATELY TURN NORTH WELL SHY OF EAST COAST LANDFALL.

### SAFFIR-SIMPSON SCALE

- CAT 5-----> 157 MPH
- CAT 4-----130-156 MPH
- CAT 3-----111-129 MPH
- CAT 2-----96-110 MPH
- CAT 1-----74-95 MPH
- TROPICAL STORM-----39-74 MPH
- TROPICAL DEPRESSION-----<38 MPH

### THIS MAP

**\*MAP**\_THIS MAP MARKS THE FREQUENCY OF HURRICANE AND TROPICAL STORM SINCE 1851. MANY POTENTIAL HURRICAINES GET 'DOWNGRADED' TO TROPICAL STORM CATAGORY. THE WIND DANGER WILL BE REDUCED BUT THE RAIN AND FLOODING WILL REMAIN A HIGH CONCERN.



### TORNADOES

**\*THE CHARACTERISTIC**\_THE 'CLASSIC' TORNADO IS THE ROTATING WIND COLUMN THAT FOLLOWS ITS OWN PATH. TORNADOS AND ITS COUSINS MIGHT CHARACTERISTICALLY BE SAID TO BE MORE VIOLENT BUT SHORTER LIVED THAN, FOR EXAMPLE, THE HURRICANE. AS WITH ALL NATURAL PHENOMENA THESE COME IN A VARIETY OF SIZES AND SHAPES AND INTENSITIES.

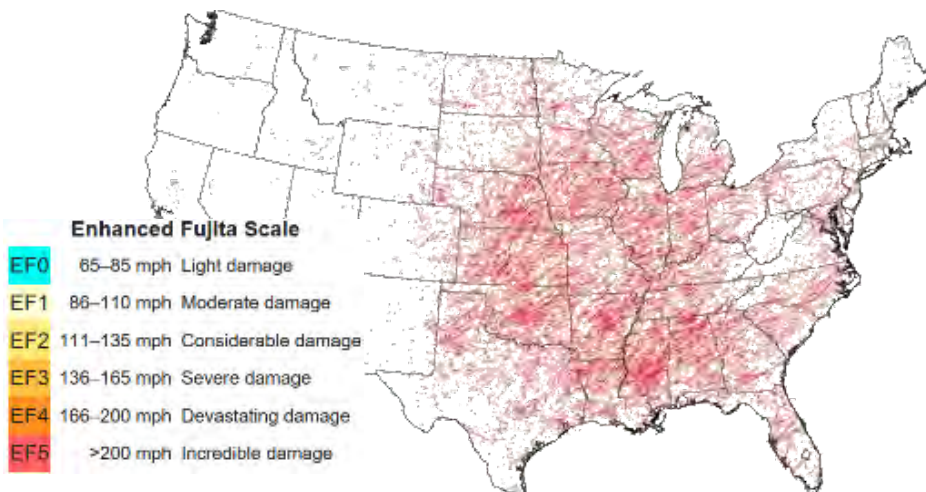
**\*BUILDING PREPARATION**\_WIND IS WHAT ONE CAN DESIGN FOR IN THE TORNADO TYPE EVENT. THE PRICIPLES FOR HOLDING A STRUCTURE TOGETHER ARE THE SAME AS NOTED (d2.12) FOR HIGH WIND ZONES. ALSO UNDERSTOOD IS THE VIOLENCE OF SEVERE TORNADO EVENTS AT THEIR HEART DEFY THE RESISTANCE AVAILABLE WITH CONVENTIONAL CONSTRUCTION REGARDLESS THE DEGREE OF 'TIE DOWN' APPLIED. 'BUNKER' TYPE CONSTRUCTION IS REQUIRED. 'BUNKER' CONSTRUCTION AS A WHOLE HOUSE, PRODUCES A GENERALLY UNPLEASANT PLACE TO LIVE, AND ONE THAT IS EXPENSIVE TO BUILD. BTHE 'SAFE ROOM' IDEA, THAT IS ONE DESIGNATED AND WELL PROTECTED SPACE WITHIN, BELOW, OR AS A SELF STANDING 'OUTBUILDING' IS A VIABLE PRECAUTION. THERE IS A CODE ANCILLARY DOCUMENT ICC500-2104 Standard for the Design and Construction of Storm Shelters.

### THIS MAP

**\*MAP**\_THIS MAP MARKS THE LOCATIONS OF RECORDED TORNADOES SINCE 1950. IT SPEAKS FOR ITSELF.

**\*TORONADO INTENSITY**\_THERE IS A RATING SYSTEM FOR TORNADO LIKE EVENTS AS THERE ARE WITH HURRICANES. MOST (77% PER NOAA DATA) ARE EF0 OR EF1 CATAGORY WHICH IS CONSIDERED 'WEAK', BUT CAN TEAR OFF ROOFS AND OVERTURN MOBILE HOMES. THAT BEING THE CASE, THESE HIGHER CATAGORIES ARE TO BE RESPECTED. LEVELS OF DAMAGE ARE PART OF THIS RATING SYSTEM AND THEIR EXTENTS DESCRIBED. THE EF5 RATING DEFINES TRUELY FRIGHTENING FORCES.

**\*TORNADO FORMATION**\_VISIT THE WEATHERWIZ.COM SITE FOR TORNADOE SUMMARY SCIENCE. ONCE AGAIN SCIENCE EXPLANATIONS DESIGNED FOR KIDS IS THE BEST.





### EARTHQUAKES

**\*DISCLAIMER\*** THIS PROJECT HAS LIMITED KNOWLEDGE OF AND MAKES NO EFFORT TO ADDRESS SEISMIC BUILDING PREPARATION.

**\*THE CHARACTERISTIC\*** THE TECTONIC PLATES ARE IN MOTION. THE GROUND IS REPOSITIONING ITSELF. THE GROUND RUMBLES AND SHAKES. THE TERM 'SHAKING' SEEMS A GOOD ONE AS MOVEMENT CAN BE UP, DOWN, LATERAL, AND OR ALL OF THESE. SO FORCES ARE MULTIDIMENSIONAL.

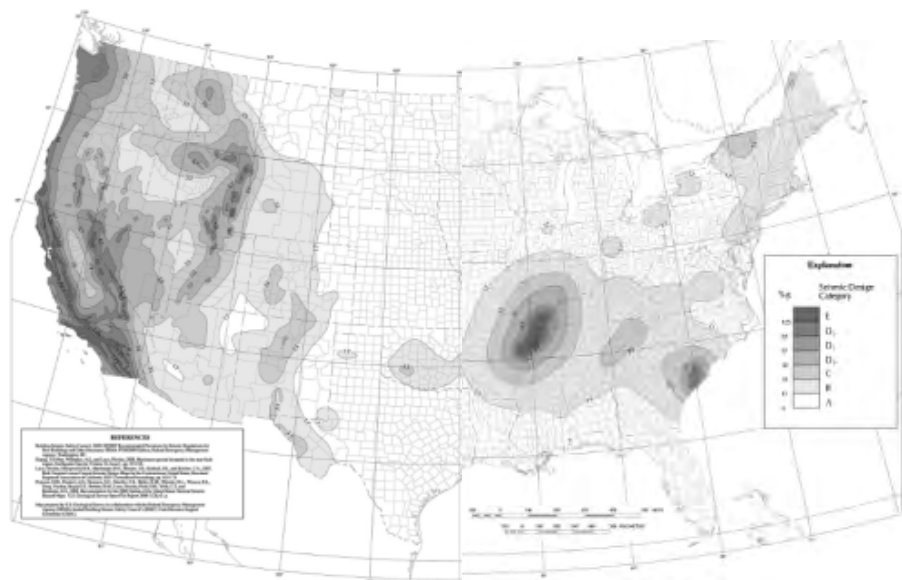
**\*MEASURING AND DESIGNING\*** SEVERAL TYPES OF MEASUREMENTS ARE EMPLOYED IN ANALYZING/DOCUMENTING EARTHQUAKE ACTIVITY. PUBLIC INFORMATION AND CONVERSATION USE THE SIMPLEST TO UNDERSTAND- THE RICHTER SCALE- WHICH IS A MEASUREMENT OF 'MAGNITUDE'-HOW BIG AND POWERFUL. SCIENTISTS AND ENGINEERS ARE LOOKING FOR MORE SPECIFIC DATA INTENDED TO FIRST BENEFIT SCIENTIFIC UNDERSTANDING AND SUBSEQUENTLY PROVIDE DESIGN CRITERION FOR BUILDINGS. THE ENGINEERS ARE LOOKING FOR HOW "FAR AND FAST" THE SOIL SUPPORTING AND SURROUNDING A STRUCTURE WILL BE MOVING HORIZONTALLY, AND VERTICALLY. SOIL TYPE IS IMPORTANT. FROM THE 'CORE' OF THE QUAKE THE GROUND IS SET IN MOTION. THE SOIL BECOMES THE MEDIUM THAT SENDS OUT THE SHAKES. SOIL CONDITIONS (ALL AROUND AND ABOVE THE 'CORE') THEN DEFINE THE ACCELERATION AND MAGNITUDE OF THE QUAKE THE BUILDING WANTS TO ABSORB.

**\*OCCUPANCY CATEGORY\*** IS THE EASY TO GET PART OF THE DESIGN CONSIDERATIONS. IT IS THE HUMAN RISK COMPONENT LARGE PUBLIC ASSEMBLY FUNCTIONS (HOSPITALS, SCHOOLS) LOGICALLY GET MORE ATTENTION AND CARE. HOME BUILDING NOT THE SAME LEVEL OF CONCERN.

**\*ONE STRUCTURAL DESIGN CONCEPT\*** THAT ILLUSTRATES THE 'SHAKE' MOTION, THAT IS EMPLOYED - NOT JUST A THEORY- IS PLACING FLEXIBLE 'SHOCK ABSORBERS' BETWEEN FOUNDATION AND STRUCTURE ABOVE. THE FOUNDATION CAN SHAKE- THE STRUCTURE ABOVE IS ISOLATED FROM THAT SHAKING WITH THE HELP OF THOSE (HORIZONTAL AND VERTICAL) FLEXIBLE ABSORBERS. PRETTY SLICK.

**\*THIS CODE MAP\*** PRODUCED BY USGS AND FEMA IS A PRETTY COMMONLY USED RESOURCE. IT IS SHOWING THE LIKLIHOOD OF INCIDENTS AND SEVERITY OF INCIDENTS DEFINED BY CATEGORIES A THRU E. THE SEVERITY THIS MAP IS BASED ON THE GROUND ACCELERATION (%g) COMPONENT NOTED ABOVE.

**\*CODE REQUIREMENTS AND INTERPRETATIONS\*** THE IRC, IN A CONFUSING AND DISJOINTED WAY, ADDRESSES COMPLIANCE REQUIREMENTS FOR PROJECTS IN CATEGORY A THRU D<sub>2</sub> ZONES CATEGORY E LOCATIONS MUST REFER TO THE IBC CODE. REQUIREMENTS FOR HOME BUILDING ARE NOT TYPICALLY THAT ONEROUS, COSTLY OR DIFFICULT. IT IS DIFFICULT DETERMINING EXACTLY WHAT IS REQUIRED. IT IS RECOMMENDED TO CONSULT FIRST WITH BUILDING OFFICIALS AND THEN WITH LOCAL ENGINEERING SERVICES AS NEEDED.



### UNWANTED WILD FIRES

**\*SMOKEY BEAR\*** THE DISTRESSING THING ABOUT WILDFIRES IS THAT THEY ARE LARGELY(90%) HUMAN CREATED. SMOKEY BEAR KNEW THIS IN 1944. ONE OF THE BIG DANGERS OF THE DAY WAS THE LIT, FLICKED, CIGARETTE BUTT WHICH WAS AN INCREDIBLY WIDESPREAD HUMAN HABIT IN THE DAY. CIGARETTE BUTTS ASIDE CONSIDER ONE SPARK BY ANY CAUSATION CAN DEVASTATE (MANY) TENS OF THOUSANDS OF ACRES. THE YEAR 2018 HAS SEEN 52,000 WILDFIRES AND 8.5 MILLION ACRES BURNED. INDIVIDUAL HOME STRUCTURE FIRES IN 2017 TOTALLED 357,000

**\*FIRE IS FIRE\*** FIRES NEED OXYGEN AND FUEL. DRY FUEL AND WIND FEED THEIR VIOLENCE AND SPEED. THIS IS TRUE WHETHER IN THE BEDROOM OR IN THE VAST NATIONAL PARK. FIRES IGNITE AND CAN BECOME UNMANAGEABLE VERY QUICKLY.

**\*PREPAREDNESS\*** FEMA OFFERS A GOOD PREPARATION BULLETIN ENTITLED 'HOW TO PREPARE FOR A WILDFIRE'.

### ECOLOGICALLY BENEFICIAL AND CONTROLLED WILDFIRES

**\*THE OTHER SIDE\*** OF THE UNWANTED AND DAMAGING WILDFIRE IS THE BENEFICIAL BURN.

**\*FIND INFORMATION\*** THE UNITED STATES DEPT OF AGRICULTURE , U.S. FOREST SERVICE

### THESE MAPS

\*MAKING THE POINT THAT FIRE AND DRY GO TOGETHER. THE DRY COMPONENT IS A CHANGING ONE. SMOKEY BEAR STILL POSTS FIRE ALERTS AT NATIONAL PARK ENTRANCES THAT ARE DAILY EVALUATIONS OF 'HOW DRY' IT IS WITHIN THE PARK, WHICH DIRECTLY RELATES TO FIRE POTENTIAL.

