Preparation for a Major Earthquake — Before, During and After

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Table of Contents

Table of Tables

Preparation for a Major Earthquake[1] — Before, During and After

About this Document

This document consist of the following nine elements that explain preparation before, during and after a major earthquake in the San Francisco Bay Region (hereafter SFBR).

Before a Major Earthquake

1. Assessing the potential response of a specific location to an earthquake.
2. Mitigating structural weaknesses of the house.
3. Mitigating hazards in the house.
4. Create and implement a earthquake preparedness plan.
5. Purchase and store supplies.

During a Major Earthquake

6. Behavior for protecting the individual during a major earthquake.

After a Major Earthquake

7. Mitigating threats to the house following a major earthquake.
8. Sheltering in-place
9. Impacts to the regional transportation system.

No warranty is stated, implied, or inferred for the contents of this document. The reader is advised to validate the contents of this document by review of the relevant literature available on the World Wide Web and various libraries.

1. Assessing the Potential Response of a Specific Location to an Earthquake

A large and growing body of scientific knowledge exists of the potential hazards associated with a major earthquake in the San Francisco Bay Region. Though available to the lay public this knowledge is technically in nature, therefore location specific interpretation is the domain of a professional – Geologist, Engineering Geologist or Geotechnical Engineer.

It is recommended that services be obtained a qualified professional Geologist, Engineering Geologist or Geotechnical Engineer to review the extant literature, in particular geological maps, and possibly performing a site inspection, to determine location specific potential hazards associated with a major earthquake.

1.A Moment Magnitude earthquake measuring (a) 7.0-7.9 is a major earthquake, or (b) 8.0 or larger is a great earthquake. Any earthquake greater than 7.0 can produce significant damage over a region. Definition of Moment Magnitude see: http://en.wikipedia.org/wiki/Moment_magnitude_scale

World Wide Web Resources

The World Wide Web (Web) is a resource for a vast amount of information concerning preparation for a major earthquake. Such information covers a broad range of knowledge, including but not limited to – individual and family preparation for, and response during and following a major earthquake; selection and purchase of preparation supplies, including food and food preparation equipment, camping equipment. The reader is encouraged to supplement use of this document by reviewing information contained at a Web address referenced in this document by the notation – See:

***NOTE**: If a Web addresses does not link to the relevant topic, perform a Web search using the criteria stated in the Item column of a given table.*

- Performing topical research using a Web search engine.

The National Disaster Education Coalition (NDEC) is a good source for supplemental information concerning preparation for a major earthquake.

> *The National Disaster Education Coalition (NDEC) is composed of federal government agencies and national not-for-profit organizations that work together to develop and disseminate consistent educational information for the public about disaster preparedness. The goal of the NDEC is to formulate information and advise the public about how to prepare and respond appropriately to natural and human-caused disasters. NDEC member agencies ensure that disaster safety messages are appropriate, accurate, research-based, and crafted appropriately for the audience by using understandable language.*

The reader is encouraged to review information produced by the NDEC.

See:

http://www.disastereducation.org/default.html

The NDEC document Talking About Disaster: Guide for Standard Messages contains valuable information in preparation for a major earthquake, in particular the sections titled Disaster Supplies Kit; Earthquakes; Evacuation, Sheltering and Post-Disaster Safety; and, Family Disaster Plan.

See:

http://www.disastereducation.org/guide.html

Tables of Checklists

The following sections contain specific recommendations and tables of check lists, for preparation for, response during, and survival following a major earthquake.

The information contained in the following table is based in-part on information posted to the FEMA Web site.

See:

http://www.ready.gov/earthquakes

2. Mitigating Structural Weaknesses of the House

Mitigating hazards in the home will serve to reduce the possibility that members of the family will be injured or killed, that the house will be significantly damaged or collapse, or both.

Table 1: Mitigating Structural Weaknesses of the House

Check	Item	Description
	Structural integrity of the house	Contract with a qualified[a] professional Structural Engineer to perform an analysis on the house to determine if – (a) the house is constructed to state-of-knowledge engineering standards, or to various lesser standards which may have been used in the past and (b) what measures can be taken to improve the resistance of the house to damage from a major earthquake.

IMPORTANT: *Have a qualified[a, b] professional Geotechnial Engineer or foundation contractor inspect the house to determine if the house is properly retrofitted to withstand a major earthquake. Retrofitting includes properly connecting the house to the foundation. Strong ground motion during a major earthquake can overcome the inertia of a house not properly retrofitted and severely damage the house, including moving the house off the foundation. Such damage may result in the house not being habitable. State of knowledge hardware systems are designed specifically to connect a house to the foundation.*

See:

http://www.strongtie.com/ and http://www.strongtie.com/ftp/fliers/f-plans07.pdf

	Trees	If your property contains trees, in particular large trees that could fall on the house or ancillary structures such as a garage, periodically have a qualified professional arborist[b] check the health of such trees. If dead standing trees exist within the fall zone of structures consider having such trees removed.

a. Before signing a contract the following should be performed. – (1) Contact the State of California Board for Professional Engineers, Land for Professional Engineers, Land Surveyors and Geologists and confirm that the engineer (a) holds the appropriate State of California license(es), and (b) that there are no complaints or demerits to the engineer's professional record as held by the State of California. (2) Obtain certificates for Errors and Ommissions Insurance and Liability Insurance from the engineer. The Certificate should be (a) current dated, (b) state the location of the intnded work and your name, (c) specify the dollar amount of coverage, (e) confirm coverage exists with the aforementioned Board.

See:

http://www.pels.ca.gov/consumers/lic_lookup.shtml

3. Mitigating Hazards in the House

A house and ancillary structures may contain a variety of hazards and potential hazards created by the way in which objects are positioned within the house, and substances that can pose a threat to life and house if the substances breach the containers in which they are stored.

Table 2: Mitigating Hazards in the House

Check	Item	Description
	Breakable items	Store breakable items such as bottled foods, glass, and china in low, closed cabinets with latches.
	Desktop	Secure to the desktop or equipment stand so that the equipment does not slide off the desk or stand.
	Filing cabinets	Secure to wall, or if a row of cabinets to each other, so the cabinets do not topple over. Cabinets should have latches that prevent the drawers from opening. Objects on top of cabinets should be secured so they do not slide off top.
	Heavy objects hung on walls	Do not hang heavy items, such as pictures and mirrors, on walls above beds, couches, dinning tables or any location where people sit, lie or sleep.
	Items attached to ceilings	Brace overhead light fixtures and ceiling fans. If possible secure a chain to such objects such that if the object separates from its foundation it will not fall.
	Objects on shelves	Place large or heavy objects on lower shelves.
	Poisons and flammable materials	Store weed killers, pesticides, and flammable liquids securely in closed cabinets with latches and on bottom shelves.
	Shelving	Fasten bookcases, shelves, sculptures, or any type of heavy or tall objects, securely to walls.
	Storage racks and shelving	Braced and bolted to a wall and the floor.
	Water heater	Secure water heaters by strapping to wall studs and bolting the water heater to the floor or pedestal on which it is located.

4. Create and Implement a Earthquake Preparedness Plan

A coherent plan should be created and codified in writing, that addressees the principal elements of preparedness for a major earthquake – before, during and after.

Elements of a Earthquake Preparedness Plan

Following is a list of elements to consider for inclusion in a preparedness plan.

Refuge in the house – Map delineating locations of furniture within each room of the house, and instructions to **DROP, COVER and HOLD-ON**[1].

Supplies – Map delineating the locations and contents of specific items stored for earthquake preparedness.

Utilities – Map delineating the locations of the valves for shut off of gas and water, and the switch for shut off of electricity.

Parent's place of employment – Cell and landline telephone numbers, maps of locations, written directions, and telephone numbers to the American Red Cross Shelter, hospital, police station and fire station nearest the parents place of employment.

Children's schools – Cell and landline telephone numbers and maps for schools, teachers, American Red Cross Shelter, hospital, police station and fire station nearest the schools.

Parent's siblings, other relatives and neighbors – Cell and landline telephone numbers and maps for American Red Cross Shelter, hospital, police station and fire station nearest the relatives

Children's instructions – Shelter in-place, not to seek their parents and reach out to neighbors and emergency response personnel. How to shut-off the gas, electricity and water. How to access to earthquake preparedness supplies, in particular food, water and camping equipment. How to setup a tent or tarp for shelter and keep warm.

Create a binder, or poster attached to a closet door or similar accessible location in the house, that contains all relevant information for major earthquake response, including but not limited to, locations and instructions for turning off utilities to the house, the locations of established shelters, contact information including telephone numbers and e-mail addresses for "family contacts". A copy of the binder, poser, or both should be placed in the stores for earthquake preparation.

Locate and Re-unite the Family

Family members may, or will, be separated from one another during and following an earthquake. Separation is likely if a major earthquake occurs during the work week day time when adults are at work and children are at school. If a major earthquake occurs during the weekend, members of the family may be separated doing activities in familiar and unfamiliar locations. During and following a major earthquake individuals will likely experience high anxiety concerning the whereabouts and safety of all members of the family. As with all individual responses during and following a major earthquake it is paramount remain focused, ***DO NOT PANIC***, think

1.**DROP** to the floor and take **COVER** by getting under a sturdy table or other piece of furniture, **HOLD ON** until the shaking stops. If there isn't a table or desk near you, cover your face and head with your arms and crouch in an inside corner of the building.

and act rationally in your efforts to locate members of the family.

Make arrangements with relatives or friends that live well beyond the SFBR, preferably out-of-state, to serve as the "family contact" following a major earthquake. Following a major earthquake it will likely be easier to telephone a location, preferably out of state.Make sure all family members have an accessible list of – names of family members; addresses for home, work and school; the "family contact" names, addresses, and phone numbers.

Make laminated cards for parents that state all relevant contact information for each child and cards that state contact information for each parent. Mail copies of both types of cards to the out of state family contact person. The cards can easily be made using Microsoft Word or another word processing application. Reduce the size of the document to a convenient size, say 3" x 4" and have the hard copy laminated. Place the cards in purses, wallets and attach to the inside of children's backpacks. Update the information on the laminated cards and cell phones every September before the beginning of the school year, and immediately following a family move. An example of a laminated card follows.

Table 3: Contact Information Card

After a major earthquake do the following.
1. Telephone one or both parents. If the telephone is answered by a voice message machine state your location.
2. Telephone the out of state family contact. If the telephone is answered by a voice message machine state your location and call back telephone number.
3. Tune in to an EAS radio station.
4. If you cannot reach Dad or Mom seek help from an adult – preferably emergency response personal.

Remain calm, try to stay focused and do not panic.

Aunt Mildred: Home 123 Any Street De Moines, Iowa 50301 Tel: 515-123-4567 Cell: 515-321-7654	**Aunt Mildred: Work** Des Moines Botanical Center 909 Robert D. Ray Drive Des Moines, Iowa 50316 Tel: 515-456-7890 Cell: 515-321-7654	**Uncle Ralph: Home** 325 Central Park West New York, New York Tel: 212-123-4567 Cell: 212-321-7654	**Uncle Ralph: Work** New York Stock Exchange 20 Broad Street, #2601 Tel: 212-456-7890 Cell: 212-321-7654
Dad: Work: Google 1600 Amphitheater Parkway Mountain View Telephone: 650-253-0000, ext. 123 Cell: 650-599-1234 **Nearest to Work:** **Police:** Mountain View Police Department 1000 Villa Street, Mountain View 650-903-6344 **Fire:** Mountain View Fire Department 1000 Villa Street, Mountain View 650-903-6365 **Hospital:** El Camino Hospital 2500 Grant Road Mountain View Telephone: 650-940-7000	**Mom: Work** Stanford Hospital 300 Pasteur Drive Palo Alto Telephone: 650-723-6411, ext. 123 Cell: 650-599-1234 **Nearest to Work:** **Police:** 711 Serra Street Stanford University 650-723-9633 **Fire:** 711 Serra Street Stanford University 650-723-9633	**Santa Clara County Sheriff – Patrol Headquarters:** (408) 808-4405 **California Highway Patrol:** Redwood City 355 Convention Way 650-369-6261 Sacramento Communications Center 916-861-1300	**Emergency Alerting System (EAS) radio stations:** KCBS AM [740] and FM [106.9] KQED FM [88.5]

Following a major earthquake in the SFBR it is likely that the regional cellular network will remain operational and the landline network will fail. However following a major earthquake it is also likely that the volume of users trying access a cellular network will overwhelm the capacity of the network, resulting in denial of service. As such, make arrangements with the "family contact" to telephone all cellular telephone numbers of family members on a list provided to them following a major earthquake.

See:

http://www.disastereducation.org/library/public_2004/Family_Disaster_Plan.pdf

Immediately following a major earthquake the telephone system, LAN and cellular, may be managed to allow outbound calls, but not inbound calls. This possibility should be taken into consideration, and communicated to family and friends outside the SFBR.

In the days and weeks following a major earthquake individuals and families will have to assume a posture of adaptive management to surviving until government is capable of moving conditions to an orderly physical and psychological state.

Adaptive management (AM), also known as adaptive resource management (ARM), is a structured, iterative process of optimal decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring.

The last major earthquake in the continental United States was the Great San Francisco Earthquake of 1906. Today the size and expanse, dependencies and connections for sustaining goods and services to the human population is enormously greater than 1906. Though much has been anticipated and accorded in emergency response planning, the response will consist of implementing that which was planned and adapting the response to new realities and challenges as they arise. Improvement in the response will be iterative in nature such that the efficacy of the response better meet the needs of the affected human population.

See:

http://en.wikipedia.org/wiki/Adaptive_management

Re-uniting the family following a major earthquake will likely prove problematic. Given the likelihood that the regional transportation network will be damaged, the only options for movement may be walking and riding a bicycle. Older or disabled family members may become immobile. Remember that there will be pervasive trauma, confusion and likely some chaos, and many people will be trying to located members of their family.

Note the following.

- *Children re-united with one parent, followed by the parent leaving, should not be left alone. Try to establish a plan with neighbors such that children will be property cared for following a major earthquake. Remember – (a) Children will likely be severely traumatized and separation from a once-found parent will increase the trauma. In some situations the best plan may be for the parent to shelter in-place at the house and wait for the missing members of the family to return home or establish communication.*
- *After a reasonable amount of time contact the government agencies, for example police and fire departments, locally and in the city or town that the missing family members should have been when the earthquake occurred. In a similar vein contact the American Red Cross. Be prepared to provide contact information for yourself and each missing person, for example place of employment and cell telephone number.*

Parents, in the presence of children, need to maintain composed and a reassuring demeanor. Children readily sense fear and panic.

Table 4: Locate and Re-unite the Family

Check	Item	Description
	American Red Cross shelters	American Red Cross Shelters within a reasonable distance from the house, for example 15 miles. Print the location and contact information, including a map to the shelters, to hard copy. Following a major earthquake the American Red Cross will likely be a major information hub for locating family members. This information should be included in the family information binder, children's day packs, parents brief cases and all family automobiles. See: http://app.redcross.org/nss-app/
	Adult	
		• Cell phone and landline telephone numbers for children's schools, teachers, and emergency support stations near the home and school(s), for example hospital, fire and police departments. • Cell phone and landline telephone numbers of siblings place of employment and personal. • Addresses and maps for sibling's place of employment and home.

Table 4: Locate and Re-unite the Family

Check	Item	Description (Continued)
	Children	
		Teach children under what circumstances, and how, to telephone 911, or the police or fire department, and which radio stations to tune to for emergency information. Instruct children that immediately following a major earthquake the telephone systems – cell network and landline network – may not work.
		Teach children, if they are at home and there are no adults present, how to perform the following. • If at home, not to panic and remain at home. Children should not seek their parents as this may expose them to other immediate danger. • Shelter in place outside of any structures, in particular the house. This follows from the possibility that structures have been damaged during a major earthquake, and could be further damaged, or collapse, during aftershocks. • If deemed necessary to shut-off the gas, electricity and water. Necessity will require imparting to children a sense of conditions that warrant shut-off. • Access to, and fundamental familiarity with, earthquake preparedness supplies. • Discrete use of the supplies of food and water. • How to setup a tent or tarp for shelter, if weather conditions are adverse, and change clothing, as appropriate, to remain warm. • Reach out to emergency response personnel if they become present in the neighborhood. • Impart to children that their parents or another adult, preferably a neighbor, will seek them out.

Table 4: Locate and Re-unite the Family

Check	Item	Description (Continued)
	Family	
		A plan should be devised, and codified in writing, that lists the process through which all members of the immediate family are located and re-united. A simple version of the plan should be placed in each child's pack that they daily carry to their school. The plan should include, but not be limited to the following. • Information for contacting the "family contact". • Cell phone and landline telephone numbers for parents work, siblings, and family members, for example grandparents, uncles and aunts. • Cell phone and landline telephone numbers, home and work, for several neighbors. • Review the plan occasionally in a family meeting.

The Community

A community can be defined as the maximum number of humans as a group in which dependencies and inter-dependencies can be rapidly established to meet the necessary needs of the community. For the purpose of preparation for a major earthquake and response, a community is defined as the geographic area of a street bounded at its ends by two streets. This definition effectively constrains the community to neighbors living beside, or across the street from each other for the length of a given street.

Following a major earthquake your community of neighbors will likely develop an immediate and deep interdependency. To the extent possible help your neighbors with their needs and deficiencies as it will strengthen bonds that will naturally develop following a major disaster of any type.

Table 5: The Community

Check	Item	Description
	Physically impaired	Work with local emergency services and American Red Cross officials to prepare special reports for people with mobility impairments on what to do during an earthquake.
	Publish information	Publish a special section in your local newspaper, or distribute to the community, emergency information on earthquakes, including phone numbers and addresses of local emergency services entities such as fire and police stations, the American Red Cross, and hospitals.
	Representatives of utilities	Interview representatives of the gas, electric, and water companies about shutting off utilities.

Table 5: The Community

Check	Item	Description (Continued)
	Work together	Work together in your community to apply your knowledge to building codes, retrofitting programs, hazard hunts, and neighborhood and family emergency plans
	Workshops	Conduct workshops in the neighborhood concerning locating and ameliorating hazards in the home.

5. Purchase and Store Supplies

It is recommended that supplies be stored for each member of the family sufficient for a minimum of seven days, preferably up to 30 days. *The quantity of supplies stored should be sufficient to meet the need of the entire family sheltering in-place at the house until Federal, State of California and local responses are adequate to establish a supply stream to meet the needs of the human population in the SFBR.*

A foundation of preparation for a major earthquake is stocking supplies that will allow the family to survive following a major earthquake without significant assistance from the local, state or federal government. This foundation follows from several basic realities – (a) Government at all levels, as well prepared as they may appear, should be viewed as not adequately prepared owing to no major earthquake having occurred in the SFBR since the Great San Francisco Earthquake of 1906. (b) Most citizens will prove to be near-completely unprepared for a major earthquake in the SFBR. (c) Following a major earthquake in the SFBR government at all levels will move forward in an adaptive management mode – as such the greater the degree of preparation of supplies by the family, the less the family will be affected by adaptive management imparted by government.

Supplies must be stored in a location, or locations, that provide the following conditions.

- Secure from theft or tampering.
- Secure from rodents such as rats, mice, squirrels, gophers, racoons, skunks, coyotes, dogs, cats, insects and other animals that may consume or contaminate the supplies.
- Secure from exposure to the elements, in particular sun light and water, and vented against mold.
- A location for storage secure, to the extent possible, from burial or destruction due to collapse of the containing structure. The best location for storage is outside the house, in a separate structure such as a ground-level patio, palette(s) located in a garden area, or a dedicated cement pad. Note that outdoor storage of supplies other than a metal outdoor shed will require containing supplies in foot lockers.
- Ease of access for periodically checking the condition of the supplies.

DO NOT store supplies in a basement, below-the-house crawl space, or an elevated location such as a space above a garage. This follows from the possibility that such locations will be buried by debris, burned beyond usefulness if a fire ensues, or both.

The best structures for storing supplies are a outdoor shed[1] with a floor elevated from contact

1. See:

http://www.homedepot.com/webapp/wcs/stores/servlet/Search?keyword=sheds&langId=-1&storeId=10051&catalogId=10053

with the ground surface, or a footlocker.[1] The shed should have a wide door with a hasp that can be locked with a no-key hardened combination lock.[2]

Supples should be stored in strong durable containers[3] that are labeled for contents. Food and non-food supplies should be stored separately with same-type items in the same container, for example a single container can hold cooking utensils and dinnerware. Flammable or hazardous substances should be stored separately, for example a single container can hold a stove and lantern, white gasoline fuel, and a fire extinguisher. Relatively large quantities of liquid fuels, for example gasoline for a portable electric generator, should be stored in a dedicated fuel container, for example a jerry can[4].

Additional stores of supplies in preparation for a major earthquake should be considered for each family automobile and the work locations of the parents. Ancillary supplies are potentially critical if a parent, or both parents, commutes a significant distance to work. Such supplies need not be extensive, sufficient for the amount of time it may take to walk from the place of employment to the family house. As such, daypack, food, water, flashlight, extra clothing for cold or rain may be appropriate.

1. See:

   http://www.ameripack.com/cases/Zarges-cases/Military-case/prod-4962

2. See:

   http://www.padlocks4less.com/padlocks/combination-padlocks.html

3. See:

   http://www.rubbermaid.com/Category/Pages/ProductDetail.aspx?Prod_ID=RP091427

4. See:

   http://www.amazon.com/s/ref=nb_sb_noss?url=search-alias%3Daps&field-keywords=jerry+can&x=0&y=0

Food and Cooking Supplies

Food will be a focus of interest following a major earthquake, as much for the need to maintain a nutritious balance of good quality food, as the focus of individuals and members of the family with a considerable amount of time.

- *A major earthquake can occur at any time of the year.* ***The food supply should be stocked to assume a major earthquake occurs at the most weather adverse time of the year under the most unfavorable conditions – the middle of a very rainy Winter.*** *A supply for this scenario should focus on a well-balanced mix of foods that produce high-caloric intake. Supplies should include high-carbohydrate "energy" bars such as Power Bars which can be easily placed in a pocket or day pack, and consumed at the onset of fatigue or cold. Don't forget the tea, coffee, creamer and sugar.The food supply must accommodate special diet needs of the old, infirm, young and very young.*
- ***The food supply should be taken seriously.*** *Following a major earthquake supermarkets, if they have not collapsed, contain only several days of food for a nominal amount of customers. If supermarkets remain functional, there will likely be an abnormal number of customers, food will sell very quickly, and there is the possibility of civil unrest regarding food. The government will move quickly to setup field food kitchens, however the lines will likely be very long, owing to the general lack of preparation of the population for a major earthquake. Waiting in a line for food by the old, infirm, young and very young is very undesirable. The best preparation is to be prepared with a robust supply of food at hand.*

Table 6: Food and Cooking Supplies

Check	Item	Description
	Food	Enough food to sustain each member of the family for a minimum of seven days. Food supplies may include cans, freeze dried, dehydrated, and any other type of packaging that provides a relatively long shelf life. Food types with a shorter shelf life can be eaten as expiration dates are approached and the food stocks replenished with recently purchased foods. Note that freeze dried foods require water to reconstitute, as such if this food type is stored adjustments should be made accordingly to the quantity of water stored. See: http://www.rei.com/search?query=dehydrated+food See: http://www.grandpappy.info/hfood30d.htm
	Can opener	Several non-electric can openers, and a pocket knife with a can opener.

Table 6: Food and Cooking Supplies

Check	Item	Description (Continued)
	Cooking utensil; dinnerware; and knives, forks and spoons	A basic kit of cooking utensils and non-breakable dinnerware will be necessary for food preparation and eating. The size of the kit should be based on the number of members of the family. Cutlery and knives, forks and spoons for preparing and eating meals. See: http://www.rei.com/search?query=cooking+utensils
	Grill	A grill large enough to accommodate cooking utensils. If fuel for a portable stove is not available an open fire for cooking and possibly boiling water as a measure of disinfection, may be necessary. See: http://www.rei.com/search?query=grill+campfire
	Matches	A supply of matches, including water-proof matches.
	Stove	A camping stove will be necessary for preparing food and possibly boiling water as a measure of disinfection. The best option is a duel-fuel camping stove, for example a Coleman 2 Burner Dual Fuel Compact Liquid Fuel Stove, or other such stove that will burn more than one type of fuel. Backpacking stoves are available that burn multiple fuels, such as the MSR XGK EX Stove. Backpacking stoves are small, precarious in supporting large cooking utensils, and relatively expensive, however they work very well and are likely sufficient for a single person or family with two members. See: http://www.rei.com/search?query=camp+stoves
	Stove fuel	Sufficient fuel for a minimum of seven days. Assume that a major earthquake occurs in winter and three hot meals and hot drinks will be the daily norm. The type of fuel will depend on specific stove.

Non-food Supplies

Non-food supplies constitute the items that will be required, or advantageous, to have available following a major earthquake. Note that these items will likely be difficult to purchase following an earthquake.

It is recommended that a working flashlight and durable shoes with flat soles that protect the feet –not flip-flops, crock-type, any other type of sandal – be placed in close proximity to the bed of each member of the family. If a major earthquake occurs during the night a flashlight and shoes will be necessary to find safe refuge and other members of the family.

Table 7: Non-food Supplies

Check	Item	Description
	Backpack	Backpack for hauling water and supplies from a distribution center to the house.
	Battery powered flashlights	Flashlight and extra long-life batteries. **NOTE**: Purchase a flashlight for each member of the household and several for backup. Purchase long-life batteries sufficient to power all flashlights for seven days. Place an operation flashlight next to the bed of each member of the family and periodically check that all flashlights are operational. Batteries are date stamped for best performance life, therefore the stored batteries should be periodically checked to ensure the date stamp has not expired. See: http://www.rei.com/search?query=flashlight http://www.duracell.com/en-US/category/all-purpose-batteries.jspx?utm_source=google&utm_medium=cpc&utm_term=batteries&utm_campaign=Duracell_Search_Category%2BInterest

***NOTE**: Rechargeable batteries are not recommended for preparation for a major earthquake as a power source is required to maintain usability. Solar charging systems are available however if a major earthquake occurs in the winter solar charging my be hindered by cloud cover. Unless a portable electrical generator is available, rechargeable batteries may prove useless for nighttime needs.Very long shelf life batteries are available for purchase, see the following.*

See:

http://en.wikipedia.org/wiki/Lithium_battery

	Battery powered radio	Portable battery operated radio and extra long-life batteries. See: http://www.amazon.com/s?ie=UTF8&rh=n%3A172282%2Ck%3Abattery%20operated%20radio&page=1

Table 7: Non-food Supplies

Check	Item	Description (Continued)
	Blankets	Blankets made of synthetic material for extra warmth during the night and day. Synthetic material is far easier to clean than natural materials and quickly dries. See: http://www.rei.com/product/827072/rei-outdoor-blanket
	Cash and credit card	Cash and credit card. Debit cards may prove not as useful.
	Clothing	Clothing appropriate for four seasons, including winter and rain. The best approach for adequate clothing is dressing in layers and wearing base layers made of cotton against the skin and polypropylene garmet(s) worn over the cotton. Polypropylene garments will retain warmth when wet and easy are to clean. Remember that a major earthquake in the SFBR may result in the family having to live outdoors for weeks.
	Day pack	Several day packs in the event a member of the family must walk or bicycle from the house. See: http://www.rei.com/search?query=day+pack
	Fire extinguisher	All purpose type. Place in a central location and apprise all members of the family of its location.
	First aid kit	Well equipped first aid kit and instruction manual. See: http://www.redcross.org/services/hss/lifeline/fakit.html
	Ground clothes	Waterproof “blue” or nylon tarps in several sizes for many uses. See: http://www.rei.com/search?query=ground+cloth
	Hand Cranked flashlight-radio	Hand cranked flashlight-radio with a USB port to allow charging of cellular network telephones. See: http://www.amazon.com/s/ref=nb_sb_noss?url=search-alias%3Daps&field-keywords=handcrank+radio+flashlight#/ref=a9_sc_1?rh=i%3Aaps%2Ck%3Ahand+crank+radio+flashlight&key-words=hand+crank+radio+flashlight&ie=UTF8&qid=1323623053
	Hardware	A variety of hardware, for example a assortment of different sized nails; nuts, bolts and washers; wood, metal, dry wall and deck screws; and spooled wire, for securing small-scale damage to the house such as broken windows, and establishing outdoor facilities for sheltering in-place.

Table 7: Non-food Supplies

Check	Item	Description (Continued)
	Lantern	One or several white gas lanterns. Assume adequate fuel for each lantern for daily use beginning at sunset and some arbitrary time for turning to bed, the duration of use should be assumed to be four weeks. Purchase adequate supplies for all lanterns including mantels, wooden matches and a repair kit. Candle lanterns are an inexpensive addition to a lantern. However care must be taken to not have a candle lantern start a fire. **NOTE**: Electric lanterns will be constrained by lack of a electricity to recharge the lantern batteries. Gas lanterns fueled by butane will be constrained by lack of availability of the canisters and the expense of canisters relative to white gas. If the decision is to purchase a canister fueled lantern be certain to stockpile an adequate number fuel canisters for a minimum of seven days.
	Medication	A minimum of a seven day supply of essential medications, including asthma and allergy medication. Rotate the stored medication from storage to use and replenish the stored on a 30 day cycle. This will ensure that the stored medication is always fresh.
	Outdoor furniture	Various types of outdoor furniture for example, beach chairs, portable tables, cots, and other appurtenances in anticipation of living outdoors. See: http://www.rei.com/search?query=furniture
	Pet food	If the family has pets a minimum of a seven day supply of appropriate pet food in cans should be stocked.
	Pillows	Pillows for sleeping. Preferably synthetic which are easy to clean.
	Plywood	Several sheets of 3/8 inch thick light plywood to cover broken windows or small gaps in walls of the house. Several sheets of 5/8 inch thick exterior grade plywood. Nails of appropriate size to nail the plywood in place.

Table 7: Non-food Supplies

Check	Item	Description (Continued)
	Portable electricity generator	Electrical generators are the best option for sustainable uninterrupted on-site production of electricity, especially for families with members that are elderly, infirm, disabled, young or very young. Purchase of an electrical generator will require periodic operation to ensure the device is in working order, a repair kit and appropriate tools for maintenance and repair, a willingness to learn basic maintenance and repair, and storage of fuel is required though the gasoline in automobiles may provide an auxiliary source of fuel. See: http://www.hondapowerequipment.com/products/Generators/

Portable electricity generators can be hazardous. The primary hazards to avoid when using a generator are carbon monoxide (CO) poisoning from the toxic engine exhaust, electric shock or electrocution, and fire. People are killed by incidents related to portable generator use. ***Never*** *use a portable generator in an enclosed or partially enclosed space, such as a tent or storage shed. Portable generators can produce high levels of CO very quickly. Remember that CO cannot be smelled or seen. Even if exhaust fumes cannot be smelled, exposure to CO may still occur. If anyone in proximity to an operating portable generator start to feel sick, dizzy, or weak* ***immediately*** *move that person outside into fresh air. Alert others in the home or in the vicinity to get to fresh air.* ***Do not delay.*** *If you experience serious symptoms, get medical attention immediately. Inform medical staff that CO poisoning is suspected.The CO from portable generators can rapidly lead to full incapacitation and death.* ***Never*** *try to power the house wiring by plugging the portable generator into a wall outlet.*

	Rope, twine and tape and wire	1/4 inch polypropylene rope and a roll of polypropylene twine. Several roles of duct tape and electrical tape of the black type, and wire in several sizes.
	Sleeping bags	A three or four season sleeping bag for each member of the family. Synthetic bags are advised as down or cotton sleeping bags will prove difficult to dry and clean. See: http://www.rei.com/search?query=synthetic+sleeping+bag
	Sleeping pads	A sleeping pad will significantly improve the quality of sleep. See: http://www.rei.com/search?query=sleeping+pad

Table 7: Non-food Supplies

Check	Item	Description (Continued)
	Tent	A durable tent, or tents, of sufficient size to accommodate all members of the family and emergency supplies that will degrade if exposed to sun or water. See: http://www.rei.com/search?search=camping+tent&jxBest%20use=Camping&jxBest+use=Family+%26+car+camping&hist=query%2Ccamping+tent^jxBest+use%2CCamping^jxBest+use%2CFamily+%26+car+camping
	Tools	An assortment of non-powered hand tools and tool box. Tools to consider including are – 22 ounce hammer, cross-cut saw, coping saw, metal shears, screw drivers including standard and phillips head, cross-cut saw, coping saw, metal shears, locking pliers, standard pliers.
	Water bottles	One water bottle for each member of the family, and several additional in the event a member of the family must walk or bicycle from the house. See: http://www.rei.com/search?query=water+bottle

Water

Maintaining a condition of adequate hydration is very important following the highly stressful occurrence of a major earthquake. Dehydration can produce severe symptoms and in the extreme is a medical emergency.

See:

http://www.mayoclinic.com/health/dehydration/DS00561/DSECTION=symptoms

The state of hydration, or dehydration, of an individual can readily be ascertained by the color of a individuals urine. Refer to the following Web site for information, including a urine color chart, on hydration, in particular the health indicators of dehydration.

See:

http://www.urinecolors.com/dehydration.php

In the U.S.A. the reference daily intake (RDI) for water is approximately one gallon per day for human males older than 18, and about 0.7 gallons per day for human females older than 18 including water contained in food, beverages, and drinking water. Infants and children have daily water requirements different from adults and their requirement should be determined based on age and weight as given in the following Web article.

See:

http://www.articles.complexchild.com/00037.pdf

The amount of water required daily varies with the individual, as it depends on the health condi-

tion of the subject, the amount of physical exercise, and on the environmental temperature and humidity. An individual's thirst provides a better guide for how much water they require rather than a specific, fixed quantity. The daily consumption of water per person following a major earthquake may be increased due to stress or illness.

See:

http://en.wikipedia.org/wiki/Drinking_water

It is advised not to attempt to collect water from beneath the ground. During a major earthquakes sewage pipelines may fail resulting in contamination in the near-surface with human pathogens. If the house is located in a rural environment, on a slope with upslope neighbors, such contamination can occur from upslope failure of a septic system, in particular the drain field. Owners of rural houses should know the specific location of the septic tank, line to the drainfield, and geometry of the drainfield. These system components may fail during a major earthquake, thereby contaminating near-surface water.If the house is reliant on groundwater, and the well is relatively shallow, steps should be taken to disinfect the groundwater until an analysis cab be completed by a qualified commercial analytical laboratory to determine if the groundwater is contaminated with chemical or biological agents.

Table 8: Water

Check	Item	Description
	Amount of water per person	An adequate supply of potable water must be stored to meet a daily need for each family member of eight 8-ounce glasses of fluid. This volume translates to approximately 4 gallons for a seven day supply per member of the family. Potable water can be purchased from grocery stores or volume goods warehouses in the form of clear plastic bottles or glass bottles. **NOTE**: Water a plastic bottle is date stamped and the plastic will degrade if left outdoors exposed to sunlight. As such water in plastic must be monitored regularly to check on the condition of the plastic and expiration date. Glass is the preferred option. The best solution for storing potable water is to purchase a bulk volume storage tank manufactured specifically for storing potable water. The size of the tank purchased will depend on the number of family members that will be reliant on the supply See: http://gototanks.com/Fresh-Water-Tanks.aspx[a]

The water in a hot water heater tank is a viable source of potable water. If the tank has not been damaged and is in an upright position the water in the tank can be accessed by the spigot at the base of the tank. Before accessing the tank make certain that access does not pose a threat of injury.

Table 8: Water

Check	Item	Description (Continued)
	Bathing and cleaning	Additional water should be stored for sponge bathing, and dish and cloth washing. The amount depends on the number of members of the family, and the unknown time it will take government to supply water for bathing and cleaning.
	Bleach	A dilute solution of bleach and water can be used as a general disinfectant for cleaning a portable toilet seat in an effort to minimize the transmission of human pathogens. See: http://water.epa.gov/drink/emerprep/emergencydisinfection.cfm **NOTE**: Bleach is very caustic and should be used with caution.
	Solar heated shower	A solar powered heated shower will provide a source of warm water for showering. Propane powered water heaters are also available and will require extra propane canisters. See: http://www.rei.com/search?query=shower+solar
	Water filter	A water filter of the type used by backpackers should provide an adequate source of potable water. In choosing a filter it is best to purchase one that has the ability to filter out pathogens. It is recommended that at minimum one replacement filter be purchased for the filter. See: http://www.rei.com/search?query=water+filters

a.If a decision is made to purchase a bulk volume storage tank note the following – (a) a hand pump or hose will be needed to draw water from the tank, (b) if a hose is used, make certain the hose is drinking water safe, and (c) periodically drain and refill the tank to ensure a relatively fresh water supply.

See:

http://www.amazon.com/GatorHyde-Drinking-Water-Safe-Garden/dp/B001MKVWG8

Personal Hygiene

Normal personal hygiene will be compromised following a major earthquake. Domestic water service and human waste sewage disposal may cease due to failure of buried pipelines. It is probable that the first response of government, coincident with search and rescue, will be providing food, shelter and infrastructure for meeting hygienic needs of a large number of people. As with all disasters, a focus of early response will be to minimize the potential for human pathogens emerging in the population.

The family can help to circumvent the time and waiting for services from government by establishing basic procedures and processes for disposal of human waste in a manner that immunizes disease vectors from the water affecting the family, and establishes a modicum of privacy to maintain individual decorum.

Following a major earthquake, a pit latrine should be dug for disposal of human waste Human waste on the ground surface will create undesirable odors and, particularly if a major earthquake in the SFBR occurs during the rain season, a vector for transmission of human pathogens. Any solid human waste deposited on the ground should immediately be buried six to 12 inches below the ground surface. Urine is less of a problem, aside from odor, however using one location for urination is not advised – spread the fertilization powers of urine throughout the vegetation.

See:

http://www.inspectapedia.com/septic/Latrine.htm

Note locations for disposal of human waste, solid and urine, must be downslope or cross-slope to locations for food preparation and sleeping. It is one thing to foul ones nest, yet a totally different thing to sleep or eat in the foul.

A potential will exist following a major earthquake for diseases to emerge. Good practices for personal hygiene will minimize this potential. Clean hands with soap after defecating or urinating and before beginning the preparation of food. Avoid contact with standing water and water flowing at ground surface as the latter may originate from a failed sewer line or septic system.

Individuals and families will be extremely stressed and insecure following a major earthquake in the SFBR. As such, it is imperative that preparations be made to minimize stress and insecurity, in particular quickly establishing regimes and process that mimic, to the extent possible, the pace and dependencies that exist prior to a major earthquake.

Table 9: Personal Hygiene

Check	Item	Description
	Bleach	A dilute solution of bleach and water can be used as a general disinfectant including cleaning a portable toilet seat in an effort to minimize the transmission of human pathogens. See: http://www.idph.state.il.us/envhealth/factsheets/emergcyh2o.htm
	Gloves	Disposable gloves for general cleaning.
	Hand shovel	Use to throw soil, or preferably a mixture of soil and vegetation, into the hand-dug pit laterine following each use.
	Portable toilet seat	A portable toilet seat is optional. See: http://www.amazon.com/s/ref=nb_sb_noss/182-3038124-4872352?url=search-alias%3Daps&field-keywords=portable+toilet+seat

Table 9: Personal Hygiene

Check	Item	Description (Continued)
	Sanitizing wipes and gel	Required in a water-short situation. Necessary to minimize the possibility of hand-transmitted human pathogens. See: http://www.amazon.com/s/ref=nb_sb_noss/182-3038124-4872352?url=search-alias%3Daps&field-keywords=sanitizing+hand+wipes
	Shovel	Required to dig and maintain a hand-dug pit laterine.
	Soap	Hand soap with disinfectant properties and bath soap.
	Tarps	Tarps will be essential provide a privacy barrier for a hand-dug pit latrine for deposit of human waste, providing shelter against the elements, and for creative use as needs arise.
	Toilet paper	For obvious reasons.
	Towels	An assortment of bath and hand towels, and washcloths. Towels can also serve as bandages, pillow stuffing or ground clothes, among many other uses.

6. Behavior for Protecting the Individual During a Major Earthquake

At the onset of a major earthquake maintain your focus and control – ***DO NOT PANIC***. Acknowledge that a earthquake is occurring. Be cognizant of your surroundings until the earthquake ceases. Focus on potential collapse or fall hazards such as the facade of buildings, exterior structural walls of buildings telephone poles, overhead wires, trees, and the like. If you are located on steep ground be aware that landslides may be propagated during an earthquake. To the extent possible attempt to move to an open area devoid of collapse or fall hazards, otherwise seek the best and most appropriate location that will protect you against such hazards.

***NOTE**: It is ill-advised to enter or exit a structure during an earthquake.*

The information contained in the following table is based in-part on information posted to the FEMA Web site.

See:

http://www.ready.gov/earthquakes

***NOTE**: A contrarian approach exists to the recommendation of the American Red Cross for response to an earthquake when indoors. This approach, known as the "Triangle of Life" is rejected by the American Red Cross, and by way of recommendation, FEMA.*

See:

http://www.bpaonline.org/Emergencyprep/arc-on-doug-copp.html

Table 10: Behavior for Protecting the Individual During a Major Earthquake

Check	Item	Description
	Indoors	
		DROP, COVER and HOLD-ON: Drop to the floor and take cover by getting under a sturdy table or other piece of furniture, hold on until the shaking stops. If there isn't a table or desk near you, cover your face and head with your arms and crouch in an inside corner of the building.
		Move away from locations where glass could shatter, for example windows, mirrors, pictures or where heavy objects could fall, for example bookcases or other heavy furniture. Windows will shatter, sometimes explosively.
		Drop to the ground and take cover by getting under a sturdy table or other piece of furniture. Hold on until the shaking stops. If there isn't a table or desk near you, cover your face and head with your arms and crouch in an inside corner of the building. DO NOT position yourself next to an exterior – structural walls may collapse during an earthquake.
		Stay away from book cases, floor mirrors, grandfather clocks, lighting fixture, furniture, or any other item that could topple during an earthquake.
		If in a bed when an earthquake occurs, remain in the bed. Hold on and protect your head with a pillow, unless you are under a heavy object, for example a light fixture that could fall, in which case move to the nearest safe place location.
		Use a doorway for shelter only if it is in close proximity and the door is known to be a strongly supported, load bearing doorway. Arches or garage doors can be zones of weakness in the structure of a house, more prone to collapse, so it may not be a good idea to shelter under them.
		Remain inside until the shaking stops and it is safe to go outside. *Research has shown that most injuries occur when people inside buildings attempt to move to a different location inside the building or try to leave the building.*

Table 10: Behavior for Protecting the Individual During a Major Earthquake

Check	Item	Description (Continued)
		Be aware that the electricity may go out or the sprinkler systems or fire alarms may turn on.
		DO NOT USE an elevator during or following an earthquake.
	Outdoors	
		Be very aware of your surroundings taking note of overhead power and utility cables, buildings, trees and elevated structures. ***DO NOT PANIC***.
		Move away from buildings, trees, telephone and electrical lines, elevated overpasses and expressways. The best location is a broad open space such as a football or baseball field, or an expanse of lawn devoid of the aforementioned.
		Stay as safe as possible during a major earthquake. Be aware that some earthquakes are actually foreshocks and a larger earthquake might occur. Minimize your movements to a few steps to a nearby safe location.
		Stay outdoors.
		Move away from buildings, street lights, and utility wires.
		Once in the open, stay there until the shaking stops. The greatest danger exists directly outside buildings, at exits and alongside exterior walls. Many of the 120 fatalities from the 1933 Long Beach earthquake occurred when people ran outside of buildings only to be killed by falling debris from collapsing walls. Ground movement during an earthquake is seldom the direct cause of death or injury. Most earthquake related casualties result from collapsing walls, flying glass, and falling objects.

Table 10: Behavior for Protecting the Individual During a Major Earthquake

Check	Item	Description (Continued)
	Moving Vehicle	

Trapped in an Automobile Draped by Downed Power Lines

Earthquakes can cause overhead power lines to fall, which must always be considered dangerous – stay a significant distance away from down lines. ***Assume any downed line is a power line and that the line is energized with electricity.*** *Power lines draped over highway barriers or fences can energize these structures for great distances. Do not touch anything that is in contact with a downed line. If a line falls on your automobile, stay in the automobile – you likely are safe as long as you remain in the automobile.*

Never try to cut a downed line. ***Every fallen line must be considered energized and dangerous.*** *Report all downed lines to the authorities – immediately contact the electric utility company or the local police.*

If you observe a downed line, stay far away from it and warn other people to stay away. Never try to reposition a downed line with sticks, poles or other items that are normally considered to be "nonconductors". Electrical current can travel through most materials, including materials believed to be resistant to conduction.

If the your automobile comes into contact with a downed line stay inside the automobile and wait for help. The automobile's rubber tires help protect you from becoming a pathway for current to flow to the ground. If you must leave the automobile, open the door and leap as far away from the automobile as possible. <u>Above all, do not touch the vehicle and the ground at the same time.</u>

		Stop the vehicle as quickly as safety permits and stay in the vehicle. To the full extent possible, do not stop near or under buildings, trees, overpasses, or overhead utility cables.
		Proceed cautiously once the earthquake has stopped. Avoid roads, bridges, underpasses, ramps and such, that might have been damaged by the earthquake.
	Trapped Under Debris	
		Do not light a match.
		Do not move about or kick up dust.
		Cover your mouth with a handkerchief or clothing.
		Tap on a pipe or wall so rescuers can locate you. Use a whistle if one is available. Shout only as a last resort as shouting can cause you to inhale dangerous amounts of dust.

Table 10: Behavior for Protecting the Individual During a Major Earthquake

Check	Item	Description (Continued)
	Immediately Following a Major Earthquake	
		Expect aftershocks. These secondary earthquakes are usually less violent than the main earthquake but can be strong enough to do additional damage to weakened structures. Aftershocks can occur in the first hours, days, weeks, or months after a major earthquake.
		Listen to a battery operated or hand-cranked radio or, if possible, television.
		Listen for the latest emergency information.
		Use the telephone only for emergency communication.
		Open cabinets cautiously.
		Beware of objects that can fall off shelves.
		Stay away from damaged areas unless your assistance has been specifically requested by police, fire, or relief organizations.
		If you live in the coastal zone be aware that a major earthquake can generate a tsunami. If government authorities issue a tsunami warning, assume that a series of very dangerous ocean waves have been generated and will likely impact the coast. Move to higher ground, especially as instructed by the authorities. Do not visit the beach.
		Help injured or trapped people. Remember to help your neighbors who may require special assistance with infants, the elderly, and people with disabilities. Give first aid as appropriate. Do not move seriously injured persons unless they are in immediate danger of further injury. Call for help.
		Immediately clean up spilled medicines, bleaches, gasoline or flammable liquids. Leave the area if you smell gas or fumes from other chemicals. Do not attempt to clean up any materials located within a severely damaged structure.
		Inspect the entire length of all chimneys for damage. Unnoticed damage could lead to a fire. If you cannot make a firm judgement of the structural integrity of a chimney do not start a fire in a stove or fireplace connected to the chimney. Do not sit, lie or sleep within the “fall zone” of a chimney that is know to be damaged or cannot be assessed for damage as a chimney may spontaneously collapse or collapse during an aftershock.

Table 10: Behavior for Protecting the Individual During a Major Earthquake

Check	Item	Description (Continued)
	Inspect Utilities	
		Check for gas leaks. If gas is smelled or a blowing or hissing noise is heard, open windows and quickly leave the house or other types of building. Shut off the gas at the outside main valve and, if possible, contact the appropriate utility from a neighbor's home. Remember if the gas is shut off for any reason, it must be turned back on by a professional.
		Look for electrical system damage. If sparks or broken or frayed wires are observed, or if hot insulation is smelled, shut off the electricity at the main fuse box or circuit breaker. Do not attempt to shut off the electricity if you will have to step in water to access the fuse box or circuit breaker. Contact an electrician for professional advice. Remember it is far better to not shut off the electricity than to be electrocuted trying.
		Check the sewage and water lines for damage. If damage is suspected and the structural integrity of the house is not compromised, avoid using the toilets and call a plumber. If water pipes are damaged, contact the water company and avoid using water from the tap.

7. Mitigating Threats to the House Following a Major Earthquake

Specific actions should be taken immediately following action to secure the house following a major earthquake is crucial to prevent damage, or additional damage, to the house.

It is very important to establish clear unambiguous instructions on the valves and panels that turn off the gas, electricity and water. *These instructions should be reinforced by demonstrating to all members of the family and employees that work on the property, the actions required to turn of these utilities following a major earthquake.*

The information contained in the following table is based in-part on information posted to the FEMA Web site.

See:

http://www.ready.gov/earthquakes

Table 11: Mitigating Threats to the House Following a Major Earthquake

Check	Item	Description
		*Coordinate and execute the following tasks with you neighbors. Remember that a gas, electricity or water leak "next door" may be almost as dangerous as a leak in your house. Hold a valve-inspection party so that you and your neighbors know the location of each others gas, electricity and water valves, and the instructions and tools are readily available so that your neighbors can shutoff these services in the event nobody is at home or an imminent danger exists following a major earthquake.*
	Electricity	1. On the panel that controls the flow of electricity to the house, paint a distinct arrow labeled OFF that points to the control, and control setting, to shut-off the flow of electricity to the house. 2. If the shut-off valve for gas, the electricity panel, or both, are located in dark areas, for example a basement or other type of space beneath the house, a serviceable flash light should be placed at the entrance to the space. Periodically check to make certain the flash light is working.
		*Determining when to shut-off gas, electricity and water is problematic. If elements of the house are damaged it may be best to shut-off the utilities. If the house is burning, gas is smelled, or both, than it likely best to immediately shut-off gas and electricity. Utilities should be restored to the house only by a qualified technician, generally and best through Pacific Gas and Electric (PG&E). Following a major earthquake PG&E and all utilities will be working nonstop to restore critical services, as such it may be days or weeks before restoring gas to houses is ranked a high priority.*
	Gas	Secure by chain or cable a gas wrench to the gas meter that serves the house. Paint an arrow on the gas valve indicating which direction to turn the valve to shut off the gas. A gas wrench can be purchased at a well-supplied hardware store. See: http://www.pge.com/mybusiness/edusafety/gaselectric/turngasoff/ See: http://www.eps-direct.com/gas_shut_off_4n1_%20tool.html An alternative to a gas wrench is an automatic earthquake-activated shut off valve. The advantage of this valve is gas to the house will be shut off with no human intervention. See: http://en.wikipedia.org/wiki/Earthquake_Valve
	Water	Make certain the main water valve to the house is clearly marked, for example paint the valve handle yellow, and maintain the valve free of soil, vegetation or any other material that may obscure its location. The valve is turned to counterclockwise to turn of the water.

Table 11: Mitigating Threats to the House Following a Major Earthquake

Check	Item	Description

If the alignment of buried utilities – sewer or septic system, water and possibly electricity – are unknown it may be of value to have the alignments of such utilities located. The alignments may be shown on the final as-built drawings for the house, otherwise utility corporation such as PG&E and the sewer district and water supplier, may be capable of supply or finding such alignment. Otherwise for-profit organizations exist for locating such utilities.

8. Sheltering In-place

Waiting and Waiting and...

A major earthquake is seconds, or minutes, of terror followed by day, or weeks, of waiting. Interviews with veterans of the Loma Prieta earthquake and Hurricane Katrina tell us that after responding to the effects of a major natural catastrophe, the survivors have to cope with waiting – for information to arrive, for the power to come on, for rescue teams, and to actually be able to fall asleep. Next comes the waiting in lines. After a major earthquake, the waiting – with its sense of powerlessness – is punctuated and aggravated by aftershocks. Part of preparing for a major earthquake is having low-key, family or small-group activities for passing the hours of waiting in a social and comforting fashion. Some individuals and families may wish to resurrect the activities of generations past – telling stories, singing, reading together, playing cards, playing chess or board games, crocheting, or whittling, repairing or mending things as a group. Cell phones, iPads, Kindles and Nooks – with their communications and gaming capabilities – will be another avenue, assuming that battery recharging capabilities exist as a component of preparation, or electricity services are amongst the early services to be restored. In this regard, it is possible that low-voltage portable recharge stations will be up and running, formally or informally, within days after a major earthquake. Plan for a mix of daylight, low-light, and dark-hour activities, including the indispensable draw and comfort of a small and intimate open fire, and activities suitable for a tent when it's raining. Reading aloud to children is important during the challenging times that will follow a major earthquake, and is way that older and less-mobile individuals can contribute while other adults are mixing and cleaning up – this an ages old inter-generational occupation that will serve well. In selecting books for children choose familiar books with cherished that have stood the test of many generations and include books that anticipate your children's tastes several years into the future.

During the hours and days immediately following a major earthquake members of the family, and the family as a cohesive unit, will be in a state of disorientation and stress. As these states subside and the tasks ahead become clear it is a good idea to establish and maintain daily routines that mimic the individual and family function prior to an earthquake. As with most activities following a major earthquake adjustments will be of an adaptive nature until civil and social continuity begins to take form and old habits and horizons emerge. Routines are important to humans, especially so for children as it provides a dependable and consistent anchor as they grow and learn to survive in an engaged and productive mode.

Table 12: Sheltering In-place

Check	Item	Description
	Athletic equipment	A good mix of athletic equipment to keep children, and adults, active and alert and to promote solid sleep. The mix might include equipment for baseball (soft and wiffle), croquet, volleyball, soccer, jump rope (individual and team), Hacky Sack, Frisbee, and any other types of equipment that will get people up and moving.
	Books	Books appropriate to the age, intellect and interests of each children, or an amalgam of all children of the family. A mix of fiction and non-fiction may be most appropriate. Try to gage the number of books to a seven day time frame with a nominal amount of independent reading during the day, and possible group reading at night. Books might also include topics relevant to the childs grade level and learning topics in an effort to maintain some continuity of formal education.
	Electronic books	Electronics books offer a great range of topics in a very compact and transportable format. An e-reader such as Kindle or Nook, or tablet computer such as an iPad are most likely most appropriate for small hands with wide interest in the world. Some e-readers are configured with back-light screens that will allow night-time reading by the individual or to the group. E-readers may require replacement batteries or recharging. Batteries for an e-reader can be included in the stored supplies. If an e-reader contains internal batteries that can be recharged via a USB cable a hand-cranked radio with a solar panel and USB port may be used for recharge.
	Games	Time-honored board games such as chess, checkers, monopoly cards, and any current types that will literally provide hours of engagement for children. Computer-based games are appropriate but require some type of electronic device, for example smart phone, tablet, or lap top computer. A mix of board and electronic games will provide a needed balance between the tactile and the virtual.
	Music	Music is a great anchor for a family, in particular during the evening. The challenge will be producing music with instruments, that may or may not be available, or some type of electronic device connected to speakers, for example an iPod and external speakers. The challenge, as with all electronic devices, will be maintaining the devices in a charged state. An option is to purchase a suite of inexpensive musical instruments, for example Jews harps, kazoos, musical spoons, bongo drums and perhaps an auto-harp. These instruments can be played by the most tin-ear amongst us, and songs selected from memory, for example our days in youth camps, or supplemented by books of folk songs with lyrics.

9. Impacts to the Regional Transportation System

A major earthquake will likely cause significant damage to the regional transportation system. General impacts to the SFBR that will likely include, but not be limited to – (a) the regional motor vehicle road network, including city streets and rural roads, State of California and Federal highways, (b) railroads including the various alignments servicing regions outside the SFBR such as the Capital Corridor, Altamont Commuter Express, CalTrain and BART (c) docking facilities for ferry services throughout the San Francisco Bay, and (d) airports.

The repair to the damage may require time-frames on the order of months, and possibly years to repair. Immediately following a major earthquake transportation systems that appear undamaged will likely be closed in order for the responsible government entities adequate time to perform field-inspection and validation that such systems can be opened for use by the public.

The full extent of impact will not be apparent until after the event, however possible impacts include the following.

Freeways – State of California and Federal freeways may be significantly damaged resulting in long-term closure. The damage may include – (1) Deformation and rupture of freeway surfaces. (2) Collapse of overpasses, underpasses and elevated points of intersection such as the western and eastern termini of the Bay Bridge. (3) Collapse, displacement or both, of all bridges in the SFBR including the trans-San Francisco Bay bridges. (4) Collapse and displacement of tunnels, for example the Caldecott Tunnel on State of California Highway 24 and Waldo Tunnel on Federal Highway 101. (5) Landslides beneath portions of freeways constructed on steep, potentially unstable slopes such as the Waldo Grade on Federal Highway 101. (6) Landslides, including very large landslides, bury freeway surfaces, for example deep engineered cuts on State of California Highway 280 through the Town of Woodside and similar cuts on State of Highway 92 through the City of San Mateo. (7) Collapse of energized electricity transmission lines across highways, in particular high-voltage lines that cross freeways, for example State of California Highway 280 through the Town of Woodside and the Altamont Pass alignment of Federal Highway 580.

Roads and Streets – Damage to roads may include – (1) Deformation and rupture of surfaces. (2) Landslides, including very large landslides, that bury road surfaces. Areas most prone to landslides are mountainous terrain such as the Santa Cruz Mountains, inner Coast Range immediately east of east bay cities from Richmond south to Morgan Hill, and portions of Marin and Sonoma County. Steep slopes that have been altered by the human enterprise may undergo failure in parts of San Francisco, the Oakland hills and other locations where extensive civil work was performed to facilitate the construction of houses and other structures. (3) Rupture of buried utility pipelines that trend beneath the alignment, for example liquid petroleum fuels, natural gas, and water pipelines. (4) Collapse of energized electricity transmission lines, trees or other structures, across roads.

Railroad Alignments – Damage to railroad alignments may include – (a) Tracks moved out of parallel. (b) Failure of fill masses that support alignments. (c) Failure of massive concrete structures that elevate sections of track. (d) Failure of electric power supply systems to the track system of BART. (e) Displacement of tunnels, including the BART Transbay Tube and Caldecott Tunnel. and (f) Failure of bridges.

Assuming a major earthquake debilitates the transportation network in the SBFR individual movement in the SFBR will be limited for an indeterminate amount of time, to two options – (a) walking, and (b) a bicycle.

Table 13: Impacts to the Regional Transportation System

Check	Item	Description
	Walking shoes	Two basic types of shoes will be most practical following a major earthquake are – (a) athletic shoes suited to walking long distances and (b) hiking boots. The advantage of boots is the protection afforded from walking amongst debris and ankle support. Note that walking amongst debris may be necessary during the recovery phase of a major earthquake.
	Bicycle	A broad range of types and costs of bicycles exist in the market. The best type of bicycle is likely a mountain bike, or a hybrid between a mountain bike and road bike. It is ill-advised to select a bike on the basis of least-cost as a cheap bike is likely to be a mechanical problem following a major earthquake. A bicycle built by Specialized is a good choice with a wide-range of configurations and costs. See: http://www.specialized.com/us/en/bc/home.jsp
	Batteries	A supply of long-life batteries should be stored sufficient for at minimum seven nights of bicycle ridding.
	Fenders	Removable light-weight fenders should be purchased in the event a major earthquake occurs during the rain season.
	Helmet	A properly fitted helmet should be purchased for each family member that may ride a bicycle. See: http://www.rei.com/search?query=bicycle+helmets
	Lights	Front and rear lights are necessary for night riding. See: http://www.rei.com/search?query=bicycle+light
	Lock	A high-quality lock and cable to lock the bicycle to an immovable object. See: http://www.rei.com/search?query=bicycle+lock
	Mounting rack	A floor rack on which to mount the bicycle. Keeping a bike elevated will reduce degradation of the tires. If a floor rack is not used the tire pressure should be checked and correctly maintained once a month or more often if the bicycle is ridden. See: http://www.rei.com/search?search=bicycle+rack&scv_page_size=109&seq=1&hist=query%2Cbicycle+rack

Table 13: Impacts to the Regional Transportation System

Check	Item	Description (Continued)
	Pumps	Two types of pumps are essential – (a) a pump that is attached to the bike and (b) a floor pump with a large pressure gage. See: http://www.rei.com/search?query=bicycle+pump
	Puncture-proof tires	Solid material tires are available for bicycles. See: http://www.amerityre.com/
	Tool kit	For repairs to the bicycle in the event the bicycle is damaged or requires maintenance. See: http://www.rei.com/search?query=bicycle+tool+kit
	Tubes and patch kit	Extra tubes and a patch kit for repairing punctures are recommended. Following a major earthquake the streets, roads and highways will like be veneered with debris of which many types may readily puncture a bicycle tire. An extra tube and patch kit should be carried when a bicycle is ridden.

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